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UNIVERSIDADE DO PORTO

THE ORGANIZATION OF THE RAILWAY SECTOR ACROSS THE WORLD: LESSONS FOR THE PORTUGUESE CONTEXT

JOÃO TIAGO FRAGA ROCHA

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Orientador: Professor Doutor Álvaro Fernando de Oliveira Costa

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MESTRADO EM ENGENHARIA CIVIL2024/2025

DEPARTAMENTO DE ENGENHARIA CIVIL

Tel. +351-22-508 1901

✉ m.ec@fe.up.pt

Editado por

FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Rua Dr. Roberto Frias

4200-465 PORTO

Portugal

Tel. +351-22-508 1400

✉ feup@fe.up.pt

🌍 http://www.fe.up.pt

Às avós Elvira e Alcina

“Atrás de nós
Os mastros
À nossa frente
Os monstros
E na parede
Os astros

Em que parede
Os astros
Se atrás de nós
Os mastros
E à nossa frente
Os monstros?”

Ana Luísa Amaral
Mundo

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RESUMO

Esta dissertação explora a diversidade global de arranjos institucionais no setor ferroviário, extraindo ideias comparativas para guiar a reflexão estratégica sobre Portugal. Inspirada no paradigma Estrutura-Conduta-Desempenho (ECP), integra rigor teórico com evidências empíricas para analisar como diferentes modelos organizacionais - desde monopólios verticalmente integrados até sistemas totalmente liberalizados e separados - moldam a dinâmica de mercado, a eficiência e o valor público. O estudo examina sistematicamente a evolução histórica das ferrovias desde a sua génese industrial, passando pela era da nacionalização, até o cenário contemporâneo de desrregulação, concorrência e privatização.

A investigação centra-se em casos de estudo chave - Alemanha, Suécia, Itália, Reino Unido, Japão, Austrália e Nova Zelândia e Canadá - cada um incorporando trajetórias distintas de reforma. Avalia variáveis estruturais como integração vertical, modelos de concorrência e o papel das parcerias público-privadas, bem como indicadores de desempenho, incluindo a política de preços, incentivos ao investimento, inovação e custos de coordenação A tese conclui que não existe uma estrutura vertical ótima, revelando que a eficiência de custos não é ideologicamente predeterminada, mas sim dependente da complexidade operacional e da utilização da rede.

O setor ferroviário português, embora em conformidade com as diretivas europeias de liberalização, continua a apresentar um desempenho insatisfatório, caracterizado por ineficiências herdadas, concorrência limitada e opacidade institucional. O modelo atual do país - separação vertical total com infraestrutura gerida pela Infraestruturas de Portugal - apresenta desafios de coordenação e incentivos insuficientes para inovação ou investimento privado. A dissertação avalia potenciais cenários de reforma para Portugal, desde a intervenção mínima até à introdução de concorrência regulada e separação de ativos através de empresas de aluguer de material circulante (ROSCOs), confrontando cada cenário com a experiência internacional e contextos locais.

Em última análise, esta investigação afirma que o sucesso da reforma ferroviária não depende da imitação de modelos externos, mas sim do alinhamento das escolhas estruturais com as realidades nacionais. O sistema ferroviário é tal que o desenho institucional deva responder dinamicamente à densidade, geografia, capacidade de governação e interesse público. Para Portugal, o momento exige não apenas conformidade, mas uma reformulação estratégica de sua arquitetura ferroviária - uma que integre um modelo de mobilidade contextualmente coerente e preparado para o futuro.

PALAVRAS-CHAVE: FERROVIA, MODELOS ECONÓMICOS, ESTRUTURA DE MERCADO, MERCADO FERROVIÁRIO

ABSTRACT

This dissertation explores the global diversity of institutional arrangements in the railway sector, drawing comparative insights to inform strategic reform in Portugal. Inspired in the Structure-Conduct-Performance (SCP) paradigm, it integrates theoretical rigor with empirical evidence to analyse how different organizational models - ranging from vertically integrated monopolies to fully liberalized and separated systems - shape market dynamics, efficiency, and public value. The study systematically examines the historical evolution of railways from their industrial genesis, through the era of nationalization, and into the contemporary landscape of deregulation, competition, and privatization.

The investigation centers on key case studies - Germany, Sweden, Italy, the United Kingdom, Japan, Australia and New Zealand and Canada - each embodying distinctive paths for reform. It assesses structural variables such as vertical integration, competition models, and the role of public-private partnerships, as well as performance indicators including pricing behavior, investment incentives, innovation, and coordination costs. This thesis concludes the is not a optimal vertical structure, revealing that cost efficiency is not ideologically predetermined but contingent on operational complexity and network utilization.

Portugal's rail sector, while compliant with European liberalization directives, remains underperforming, characterized by legacy inefficiencies, limited competition, and institutional opacity. The country's current model - full vertical separation with infrastructure managed by Infraestruturas de Portugal - presents coordination challenges and insufficient incentives for innovation or private investment. The dissertation evaluates potential reform scenarios for Portugal, from minimal intervention to introducing managed competition and asset separation through rolling stock leasing companies (ROSCOs), weighing each against international experience and local contexts.

Ultimately, this research asserts that the success of railway reform hinges not on mimicking external models but on aligning structural choices with national realities. Railways are socio-technical systems where institutional design must respond dynamically to density, geography, governance capacity, and public interest. For Portugal, the moment demands not mere compliance, but a strategic rethinking of its railway architecture - one that integrates global insights into a contextually coherent and future-ready model of mobility.

KEYWORDS: RAIL, ECONOMIC MODELS, MARKET ORGANIZATION, RAIL MARKET

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1
INTRODUCTION

PREFACE

Railways have long held a unique place in the architecture of national development. From the industrial revolutions of the 19th century to the climate concerns of the 21st, they have been engines of connectivity, economic cohesion, and territorial equity. Yet, behind the steel tracks and locomotives lies a far more complex system of governance and institutional design. How railways are organized - who builds, owns, operates, and regulates them - profoundly shapes their performance, sustainability, and public value. This dissertation is born out of a desire to understand these organizational structures in their rich global variety and to extract from them the most salient lessons for Portugal, a country whose railway sector sits at a crucial juncture between underperformance and potential renaissance.

This work is not an abstract economic exercise. It stems from the realisation that Portugal's railway, though technologically competent and strategically located, remains constrained by structural mismatches, historical inertia, and institutional ambiguity. And while reforms have taken place, including vertical separation and the creation of a unique road-rail infrastructure entity, Portugal's rail system has yet to emerge as a robust and competitive alternative in the national mobility landscape. With climate commitments, modal shift imperatives, and European market integration on the horizon, there is a need for deep reflection on how our railway is organized - not only in its technical operations but in its economic logic and institutional architecture.

OBJECTIVE AND RELEVANCE

The objective of this dissertation is to analyse the dominant models of railway sector organization around the world, understand their performance implications, and evaluate their relevance to the Portuguese context. To do so, it dissects the railway systems of countries that span a wide ideological and structural spectrum - from the vertically integrated giants of Japan and Canada to the radically liberalised networks of the United Kingdom and Sweden, and hybrid approaches like Germany and Italy.

Crucially, this research does not seek to advocate for any singular model. Instead, it tried to interrogates each system through the lens of economic theory - most notably the Structure-Conduct-Performance (SCP) paradigm - and empirical evidence, particularly regarding the effects of vertical separation, competition models, and the role of public-private partnerships. The application of the SCP lens was discontinued due to lacks of uniform data between all analysed countries and difficulty to apply in all contexts. It seeks to understand how these structural choices manifest in practice: in pricing behaviour, investment incentives, service quality, and coordination costs.

For Portugal, a country with a small, moderately dense network and an evolving regulatory and institutional framework, this analysis is especially relevant. While the country has implemented the European prescriptions of market liberalisation and separation of infrastructure from operations, the coexistence of legacy practices, partial competition, and a dominant state operator raises questions about the coherence and effectiveness of its current model. This dissertation aims to offer grounded, pragmatic lessons rather than ideological prescriptions.

OVERVIEW

This study is structured in four chapters (starting at 2). It begins with the conceptual and economic framework that underpins the analysis, particularly the SCP paradigm. This framework allows for a systematic examination of how market structure - whether monopolistic or competitive, integrated or separated - shapes firm behaviour and, ultimately, system performance. Special attention is paid to critical factors such as train density, pricing regimes, vertical and horizontal integration, and the presence or absence of public service obligations.

The third chapter provides a historical account of how railway markets were initially organized, with a contrast between early laissez-faire private models and the dominant mid-20th-century state-owned monopolies. It highlights the economic rationale behind nationalisation and the strategic functions railways were expected to fulfil, setting the stage for understanding why reform was later necessary.

The fourth chapter explores the wave of reforms that swept through Europe and beyond in the late 20th and early 21st centuries. It analyses the key institutional models: Sweden's clean vertical separation, Germany's holding company structure, Italy's head-on high-speed competition, the UK's radical privatisation, and Japan's model of regional vertical integration and Canada, Australia and New Zealand's unique vertically integrated market. These case studies serve as comparative lenses through which Portugal's path can be critically assessed.

The fifth chapter turns inward, dissecting Portugal's reform trajectory - from the vertically integrated Comboios de Portugal to the current model featuring full vertical separation and a unique horizontal merger of rail and road infrastructure management under Infraestruturas de Portugal. It analyses the sector's liberalisation, the limited competition landscape, the role of the national regulator (AMT), and the persistent challenges in governance, investment, and modal share.

The dissertation concludes with a set of future pathways for the Portuguese railway sector. These range from maintaining the status quo ("do nothing") to introducing managed competition through franchising and open access, to more ambitious proposals such as the privatisation of CP or the creation of rolling stock leasing companies (ROSCOs). Each path is weighed against international experience, local constraints, and long-term public interest.

In essence, this dissertation is a study in institutional choice. It acknowledges that railways are not merely technical systems but organizationally and economically contingent ones. Their performance depends as much on policy design and institutional architecture as on engineering or funding. For Portugal, the time is ripe to move from compliance with European directives to a genuinely strategic rethinking of its railway sector - one informed by global insights but tailored to national realities.

2
CONCEPTUAL AND ECONOMIC FRAMEWORK

STRUCTURE-CONDUCT-PERFORMANCE PARADIGM

The Structure-Conduct-Performance (SCP) model, or paradigm, is a foundational framework in industrial organisation economics used to analyse markets and industries. Its central idea is that there is a causal relationship (Figure 1) flowing from an industry's structure to the conduct of firms within that industry, which in turn determines its overall performance. As seen in " The organization of urban public transport systems in western metropolitan areas" by (Costa, 1996), it is a policy oriented model that adapts well to transport industries.

By examining how market Structure - defined by organizational models such as vertical separation, the nature of competition, and barriers to entry - directly influences firm Conduct in areas like pricing and investment, this study can causally link policy choices to tangible Performance outcomes, such as operational efficiency, service quality, and financial sustainability.

Figure 1 - The structure-conduct-performance model (Tan, 2014)

MARKET STRUCTURE

The 'Structure' component of the SCP paradigm provides the analytical foundation for understanding the competitive dynamics of any industry. It delineates the relatively permanent characteristics of a market that exert a determinative influence on the behaviour of firms and, consequently, on overall market performance (Cantos-Sánchez *et al.*, 2023). In the context of the global railway sector, market structure is particularly complex, shaped by a legacy of state ownership, intrinsic economic characteristics such as natural monopoly, and decades of policy-driven reforms (Issina *et al.*, 2023) (Deville e Verduyn, 2012). This section will deconstruct the key elements of railway market structure that will be used throughout this thesis to compare international systems and derive lessons for the

Portuguese context. These elements are: market concentration, barriers to entry, the degree of vertical and horizontal integration, and product differentiation.

MARKET CONCENTRATION

Market concentration refers to the number and size distribution of firms operating within a market. It is the most direct indicator of the potential for competition. Historically, the railway industry's structure was the epitome of high concentration: the archetypal state-owned, vertically integrated monopoly, where a single entity controlled all aspects of the network and services. The liberalisation process, particularly in Europe, has been a direct policy intervention aimed at de-concentrating this monopolistic structure by enabling the entry of new operators (Solina *et al.*, 2021). However, the railway sector does not naturally tend towards perfect competition. The significant capital intensity and economies of scale mean that even liberalised markets typically evolve into an oligopoly - a market dominated by a few large firms - rather than a fragmented market with many small players (Crozet, 2017, Crozet *et al.*, 2014).

The number and size of firms (figure 2) describes the level of market concentration. Is it a monopoly (one firm), an oligopoly (a few dominant firms), or a competitive market (many firms).

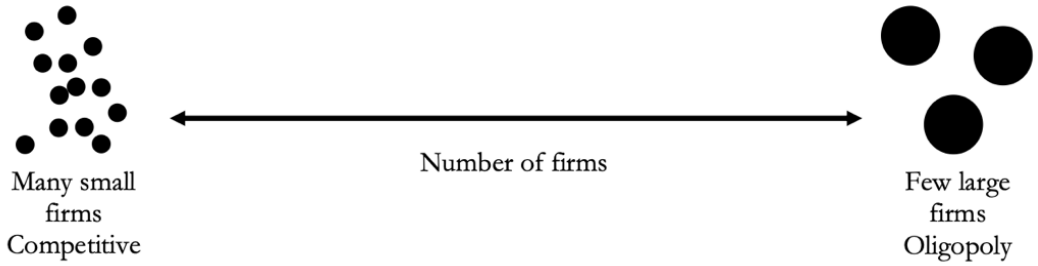

Figure 2 - Market structure and concentration (Coiacetto, 2009)

A highly concentrated market, even with a few competitors, may still exhibit monopolistic tendencies, while a market with a vibrant set of smaller challengers may be more competitive (Kvizda e Spetik, 2023)

BARRIERS TO ENTRY

Barriers to entry are obstacles that hinder or prevent new firms from entering a market, thereby protecting the market power of existing firms. The railway sector is defined by exceptionally high barriers to entry, which is the primary justification for its historical monopolistic structure.

The most significant barrier in the traditional railway model is the natural monopoly of the infrastructure (Nash e Rivera-Trujillo, 2004). This is the tracks, signals, and stations. The enormous sunk costs and economies of scale associated with building and maintaining this infrastructure make it economically inefficient and practically impossible for a competitor to duplicate (Affeldt, 2024) (Campos e Sánchez, 1999). Policy reforms like vertical separation are designed to neutralize this barrier by granting access to the single network (Nash e Rivera-Trujillo, 2004).

Some other examples are:

- High Capital Cost: Even without needing to build tracks, new entrants face substantial capital costs for acquiring or leasing rolling stock, establishing maintenance depots, and investing in ticketing and operational systems (Crozet *et al.*, 2014).
- Regulatory and Safety Hurdles: Gaining an operating license and safety certification is a complex, costly, and time-consuming process governed by stringent national and international regulations (Crozet, 2017). This ensures safety but also represents a significant hurdle for new entrants.
- Incumbent Advantages: Incumbents often benefit from established brand recognition, deep institutional knowledge, skilled workforces, and crucial "grandfather rights" that can give them priority when allocating scarce track capacity (Kirchner e Services, 2011).

Vertical and Horizontal Integration

The degree of integration is arguably the most debated structural characteristic in railway organization.

Vertical Integration refers to the control of multiple stages of the value chain by a single firm. In railways, this means the same entity manages both the infrastructure (upstream) and the train operations (downstream)(Cantos-Sánchez *et al.*, 2023). Proponents argue this structure improves operational coordination, reduces transaction costs, and is more efficient for dense, mixed-traffic networks (Affeldt, 2024).

By opposition, a Vertical Separate model places infrastructure management and train operation in legally and institutionally distinct entities to promote neutral and non-discriminatory access for multiple operators (Perennes, 2017).

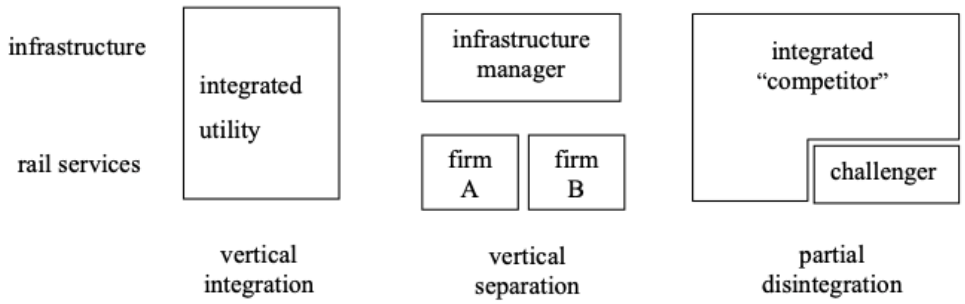

Figure 3 - Alternative vertical organizations (Ivaldi e Seabright, 2003)

Within this spectrum (figure 4), several models exist:

- Full Integration: A single entity controls everything (rare in Europe now, but common historically).
- (Organizational Separation): An often-common compromise between the two emerges as a Holding Company Model. A single parent company exists on top of separate infrastructure and operating companies, attempting to balance coordination benefits with transparent accounting (e.g., Germany's Deutsche Bahn AG) (Affeldt, 2024).

- Full Institutional Separation: The infrastructure manager is completely independent of all train operators (e.g., Sweden).

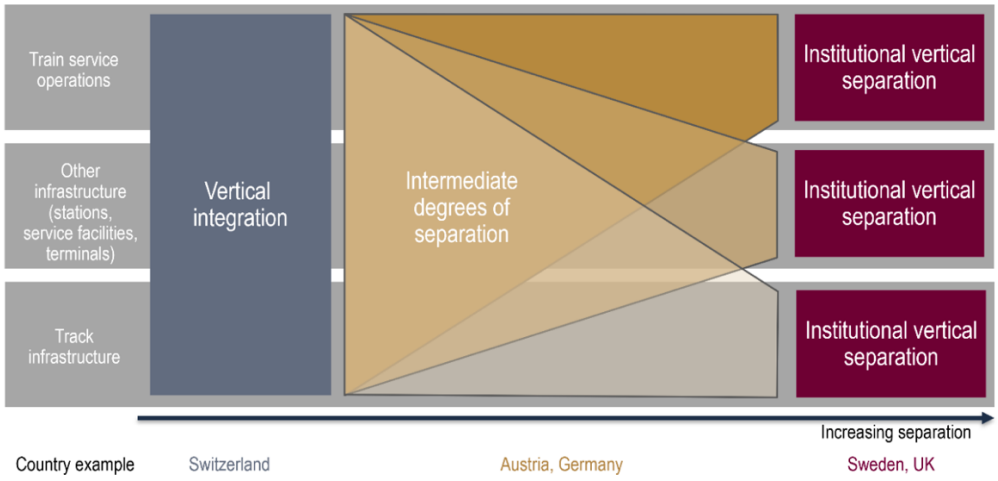

Figure 4 - Forms of vertical integration and separation (Affeldt, 2024)

Horizontal Structure refers to the number of firms at a single level of the value chain. Horizontal integration implies a monopoly operator for a given service, while horizontal separation means multiple operators are competing on the network.

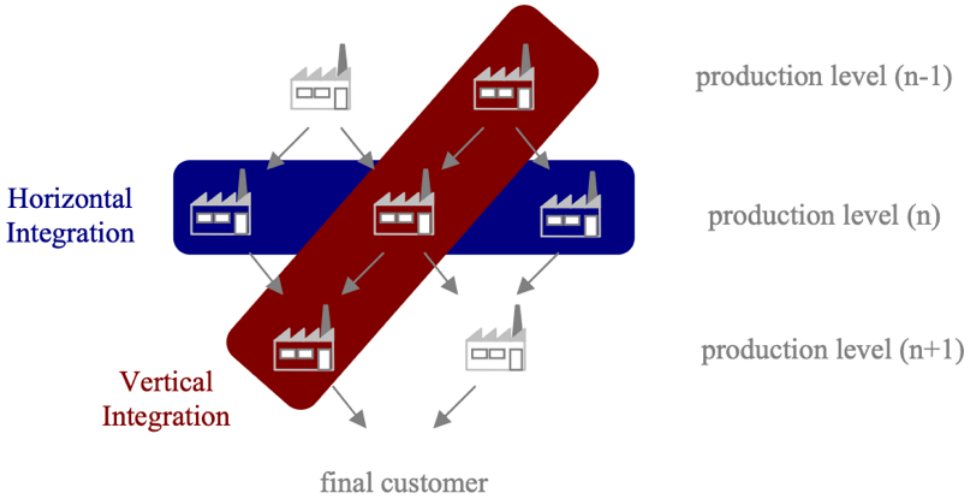

Figure 5 - Vertical and Horizontal Integration (Reis, 2004)

Using these two fundamental dimensions (the Vertical axis and the Horizontal axis) the market can combine these attributes in the following structures (Figure 6).

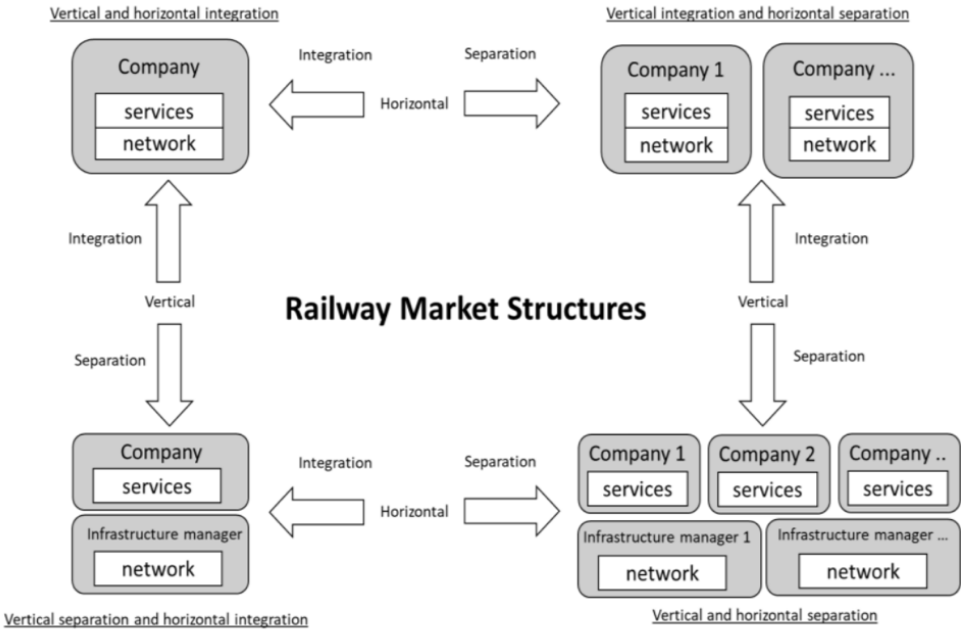

Figure 6 - Overview of the main railway market structures (Ait-Ali, 2020)

Product Differentiation

Product differentiation refers to the degree to which firms' products or services are perceived as distinct by consumers. In many urban and regional public transport systems, product differentiation is considered low, as the core service is largely homogeneous (Costa, 1996). However, in a liberalised railway market, differentiation can become a key competitive dimension.

Differentiation can occur across several axes. Regarding the service level, distinctions can be made between high-speed, intercity, regional, and commuter services, each catering to different customer needs (Amos, 2009). The quality of the service and the amenities offered is a prime differentiator as operators can compete by offering different levels of comfort, onboard services (e.g., Wi-Fi, catering), and customer service, as seen in the high-speed rail industry (Li e Lin, 2020).

In duopoly (A type of oligopoly where two firms have dominant or exclusive control over a market) or oligopoly markets, services may be perceived as distinct even if they serve the same route. The degree of differentiation determines the intensity of price competition; where services are seen as nearly homogeneous, competition is fiercest, whereas highly differentiated services allow operators to carve out near-monopolistic market segments (Cantos-Sánchez *et al.*, 2023). A market with low product differentiation tends to result in intense price competition. Conversely, significant differentiation allows operators to build brand loyalty and compete on quality, potentially softening direct price rivalry.

Classic market structures

The organization of any economic sector, including railways, can be better understood through the lens of classical market structures. These structures (Table 1) - ranging from perfect competition to monopoly - describe how firms interact within a market, the degree of competition, and the nature of barriers to entry. In the railway sector, market structures are particularly relevant because of the industry's inherent

characteristics, such as high fixed costs, natural monopoly tendencies in infrastructure, and varying levels of liberalization across countries. Understanding these market structures provides a foundation for analysing how different nations organize their railway systems, whether through vertically separated models, horizontally integrated operators, or combinations that reflect historical, regulatory, and economic factors. below summarizes the key features of these four market structures, highlighting their differences in firm size, product characteristics, barriers to entry, and both vertical and horizontal integration tendencies.

Table 1 - Four types of market structures, adapted from (Coiacetto, 2009)

Market Structure	Perfect Competition	Contestable market	Oligopoly	Monopoly
Number and size of firms	Many small	Many medium	A few large	One large
Product characteristic	Homogeneous	Differentiated	Homogeneous or slightly differentiated	Unique
Barriers to entry	None	Some	Significant	Significant
Vertical Structure	Separated	Separated	Can be both	Integrated
Horizontal Structure	Separated	Separated	Usually separated	Integrated

Market Conduct

The 'Conduct' component of the SCP paradigm acts as the crucial bridge between the static market architecture and its dynamic outcomes. It encompasses the spectrum of strategies, behaviours, and decisions that firms undertake within the constraints and opportunities defined by the market structure (IBRD, 2017). While structure sets the 'rules of the game,' conduct describes how the 'game is played.' In the railway sector, conduct is not merely a matter of commercial discretion; it is profoundly shaped by the industry's legacy, its capital intensity, and the pervasive regulatory oversight that governs its operation (IBRD, 2017). This section explores the key dimensions of firm conduct in railways: pricing strategies, investment and innovation behaviour, and the propensity for strategic alliances or collusive practices.

Pricing Strategies and Tariff Setting

Pricing is one of the most direct and visible forms of firm conduct. In the railway industry, pricing is a multifaceted activity that extends beyond simple ticket prices and includes the critical element of infrastructure access charges. The market structure dictates the degree of freedom an operator has in setting its prices.

In Monopolistic Structures operators, facing no direct competition, have significant discretion in its pricing conduct. The primary principle becomes "pricing to the market, not to costs," meaning the operator can charge what different market segments are willing to bear, a practice known as price discrimination (IBRD, 2017). While theoretically efficient for recovering high fixed costs, this conduct can be politically contentious, as users may object to perceived inequities in treatment (S.Thompson,

1997). Regulatory oversight often steps in to limit this power, but the underlying conduct remains profit-maximisation through price differentiation.

In Competitive Structures (Oligopoly/Open Access), the introduction of competition fundamentally alters pricing conduct. Incumbent operators may react to the entry of new competitors by adjusting prices and capacity to defend their market share (Affeldt, 2024). New entrants, in turn, often use aggressive pricing as a key strategy to attract customers from the incumbent (Avenali *et al.*, 2023). This competitive pressure can lead to lower average fares for consumers. However, firms in an oligopoly are also acutely aware of their interdependence, which can lead to strategic, non-aggressive pricing to avoid mutually destructive price wars.

A unique aspect of railway conduct, particularly in vertically separated markets, is the pricing of track access (Eisenkopf *et al.*, 2006). The infrastructure manager's conduct in setting these charges - whether based on marginal cost, fully allocated cost, or Ramsey pricing principles - directly impacts the viability and competitiveness of all train operators. This pricing conduct is almost always subject to intense regulatory scrutiny to ensure fairness and prevent the abuse of monopoly power over the network infrastructure (Asmari e Ricci, 2025) (Link, 2012). The extensive literature on railway infrastructure pricing and access charge mechanisms, while highly relevant to market organization, falls beyond the scope of this analysis. This thesis acknowledges the importance of pricing policies but concentrates on the structural and regulatory frameworks within which these mechanisms operate.

Management strategy

The above-mentioned pricing decisions are the most obvious manifestation of the management strategy of a company. It represents the central focus of management decisions (Costa, 1996). In most cases, as the ones seen in table 1 (apart from the perfect competition one), the objective is to maximise the number of passengers each company carries and so to produce more services with the same resources, representing an improvement in productive capacity or efficiency. In the perfect competition model though, there is substantial vulnerability and so the objective is solely to achieve profitability (Costa, 1996). They concentrate in financially viable routes, with management strategies focused on recovering short-run marginal cost rather than full cost coverage.

Pricing Goals

Pricing objectives represent the goals pursued through pricing policies and vary significantly across different market structures. In monopolistic markets, pricing may serve broader macroeconomic objectives, such as modal shift, carbon reduction or to relieve urban congestion. Under regulated market structures with single or multiple operators, regulatory authorities typically establish cost recovery targets as primary pricing objectives. In deregulated markets, pricing strategies focus on profit maximization (Costa, 1996).

Pricing Policies

Pricing policies define the relationship between production costs and pricing mechanisms, directly linking to management strategy. When the objective is to maximize passenger volume, operators adopt a network expansion strategy that relies on cross-subsidization, where revenues from profitable routes support unprofitable services, supplemented by government subsidies. In contrast, under regulated models, pricing policies aim to maximize profit within regulatory constraints (Costa, 1996).

Pricing Procedures

Pricing procedures encompass the tactical implementation of pricing strategies, commonly employing various forms of price discrimination to optimize revenue and market penetration (Costa, 1996). Second-degree price discrimination through quantity discounts is typically implemented via differentiated ticket products, such as single-ride tickets versus monthly passes that offer discounts to frequent users. Third-degree price discrimination targets specific consumer segments based on demographic characteristics like age or occupation, offering differentiated pricing to students, seniors, or professional groups. In competitive markets, these pricing procedures are complemented by innovation in service delivery, as operators invest in digital ticketing systems, real-time passenger information, and enhanced customer service standards to differentiate their offerings. Such investments in brand development and customer experience serve to build market loyalty and reduce price sensitivity, enabling operators to maintain pricing flexibility while improving service quality.

Investment, innovation, and service quality

A firm's conduct regarding investment and innovation reveals its long-term strategic orientation. These decisions determine the future quality, efficiency, and competitiveness of the railway system.

In a competitive environment, firms are incentivised to invest in modern rolling stock, enhance on-board amenities, and improve service quality to attract and retain customers (Pittman, 2011). Conversely, a protected monopolist may exhibit conduct characterised by under-investment, as the lack of competitive threat diminishes the urgency to innovate or modernise (Campos e Sánchez, 1999). The structure of vertical separation introduces complexity to investment conduct. The infrastructure manager may have incentives that are misaligned with train operators; for example, an operator may desire investment in increased capacity, while the infrastructure manager prioritises maintenance and operational stability, leading to potential under-investment in network expansion from the operator's perspective (Affeldt, 2024).

Competition forces firms to be more responsive to market demands (OECD, 2002). This includes innovating in areas such as digital ticketing, real-time information systems, and developing new services tailored to specific customer needs (e.g., business travellers, tourists) (Pagliara *et al.*, 2024). Without competitive pressure, an incumbent's conduct may be sluggish, perpetuating outdated practices and failing to adapt to evolving customer expectations (Campos e Sánchez, 1999).

Strategic Alliances and Collusive behaviour

This dimension of conduct concerns how firms interact with each other. In a market like modern rail, these interactions can range from beneficial cooperation to harmful collusion.

The desired conduct from a policy perspective is the Head-to-head competition, where firms actively compete on price and quality, leading to benefits for consumers (Bošković e Bugarinović, 2015).

In railway operators alliances are often formed to provide seamless cross-border services (e.g., the Thalys system) or to coordinate schedules and ticketing, which can enhance the overall value proposition for passengers (Alexandersson e Hultén, 2009). These cooperative arrangements are a form of conduct that can strengthen rail's position against other transport modes, such as air travel.

A typical phenomenon of the transport sector is the predatory pricing. It is an aggressive and often illegal competitive tactic where a dominant incumbent drastically cuts prices, potentially below cost, to drive

a new entrant out of the market with the intention of raising prices again once the threat is eliminated (Bošković e Bugarinović, 2015). While often claimed, proving predatory conduct can be difficult. For instance, an analysis of the Czech market suggested that the incumbent's price drops were more likely a legitimate, albeit vigorous, competitive response rather than predatory behaviour (Kurosaki, 2008).

Finally, the small number of players in an oligopolistic railway market creates a risk of collusion, where firms tacitly or explicitly coordinate to limit competition, for instance, by fixing prices or dividing markets (Stojadinović et al., 2019). This conduct undermines the very purpose of liberalisation. The design of market mechanisms, such as auctions for track capacity, must be carefully considered to mitigate the risk of cartels. For example, certain auction types may inadvertently facilitate collusion, whereas others are designed to make it more difficult, demonstrating how structure can directly influence this negative form of conduct (Stojadinović et al., 2019). Regulators and competition authorities must therefore be vigilant in monitoring firm conduct to detect and penalise anti-competitive agreements (Crozet et al., 2014).

INFLUENCE OF TRAIN DENSITY ON VERTICAL STRUCTURE

In the extensive and often ideological debate surrounding railway organisation, the concept of train density has emerged as a critical, empirically-grounded variable that can help guide policy away from "one-size-fits-all" solutions towards context-specific, evidence-based models (Affeldt, 2024). Train density, a measure of infrastructure capacity utilisation, is more than a simple metric; it serves as a powerful proxy for the operational complexity and coordination intensity of a railway network (Affeldt, 2024) As this sub-chapter will argue, the academic literature shows with remarkable consistency that the optimal vertical structure of a railway - whether integrated or separated - is fundamentally contingent upon the density of the traffic it carries (Affeldt, 2024). Ignoring this factor can lead to the imposition of structurally inefficient models, resulting in higher costs and sub-optimal performance.

High freight density introduces different coordination complexities (e.g., managing slower, heavier trains) than a high passenger density. Cross-country comparisons (figure 7) reveal enormous heterogeneity in train density across Europe, with nations like Switzerland, the Netherlands, and Germany exhibiting some of the highest densities, while others operate far less intensively used networks.

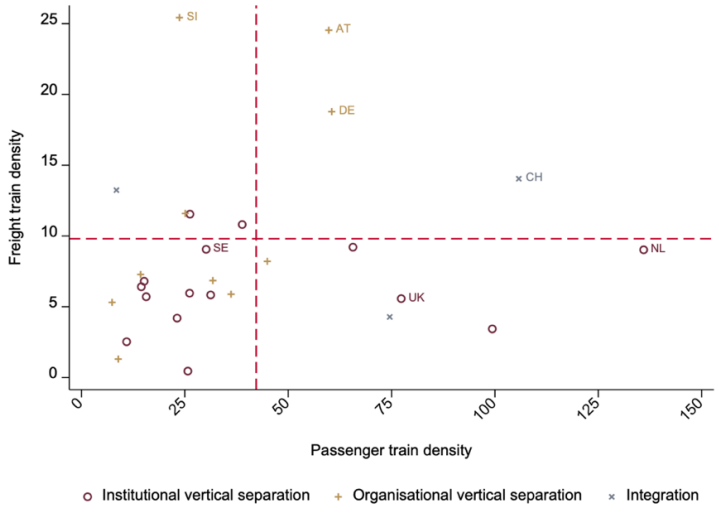

Figure 7 - Heterogeneity of trains density in 2021 (Affeldt, 2024)

The most significant contribution of the economic literature on this topic is the finding that the cost differential between vertically separated and integrated railways is not constant but depends directly on train density (Affeldt, 2024, Mizutani, 2020). The consensus from multiple empirical and theoretical studies can be summarised as follows:

At low levels of train density, a vertically separated structure tends to be more cost-efficient (Affeldt, 2024). In such environments, coordination needs are minimal, and the benefits of specialisation and potential transparency in a separated model can outweigh the low transaction costs.

At high levels of train density, a vertically integrated organisational structure becomes more cost-efficient and ultimately minimises total system costs (Affeldt, 2024).

This relationship was robustly demonstrated in seminal empirical work by Mizutani and Uranishi (2013), who found that while vertical separation has a cost-reducing effect in isolation, its interaction with train density is strongly cost-increasing (Mizutani e Uranishi, 2013). Later theoretical work by Mizutani (2020) confirmed these empirical findings using a parameter-based mathematical model, solidifying the conclusion that as density crosses a certain threshold, the cost-minimising structure shifts from separation to integration (Mizutani, 2020).

Understanding why train density has this effect requires moving beyond statistical correlation to the underlying economic and operational mechanisms. The most critical mechanism are coordination and transaction costs. High-density networks are characterised by a high degree of interdependence and potential for conflict between different services competing for scarce track capacity (Affeldt, 2024). As the network becomes more congested, the tasks of timetabling, real-time traffic control, maintenance scheduling, and disruption management become exponentially more complex (Mizutani, 2020). In a vertically separated system, each of these interactions represents a transaction between distinct entities (infrastructure manager and multiple operators), leading to significant misalignment and transaction costs (Mizutani, 2020). An integrated operator, by contrast, can internalise these complexities, optimising the system as a whole and making trade-offs more efficiently within a single organisation. The "system-wide view" or Systemgedanke becomes far more valuable as network complexity increases (Affeldt, 2024).

Secondly, railways exhibit strong economies of density, meaning that the unit cost of operations decreases as more traffic is run over the same fixed infrastructure (Bitzan e Karanki, 2022). While this applies under any structure, the coordination failures inherent in separation at high densities can erode these economies. Poor timetabling or inefficient disruption management can lead to lower effective capacity, preventing the full realisation of density economies that an integrated operator might achieve (Velde et al., 2012).

One target aspect of any network is resilience. High-density networks are inherently less resilient; a single incident can cause cascading delays across the system. Managing this requires a holistic and agile approach to operations. A vertically integrated structure may be better positioned to manage these disruptions efficiently, as communication lines are shorter and strategic command-and-control is unified (Affeldt, 2024). The fragmentation of responsibility in a separated system can slow down response times and lead to sub-optimal recovery strategies.

In figure 8, Mizutani shows the cost function of 3 organization structures. The evidence surrounding train density provides one of the clearest and most powerful lessons in modern railway policy: organisational structure cannot be designed in a vacuum. The decision between vertical integration and separation is not an ideological choice but a pragmatic one that must be grounded in the physical and

operational realities of the network. It must consider the mix of traffic, the technical quality of its infrastructure, and its regulatory capacity.

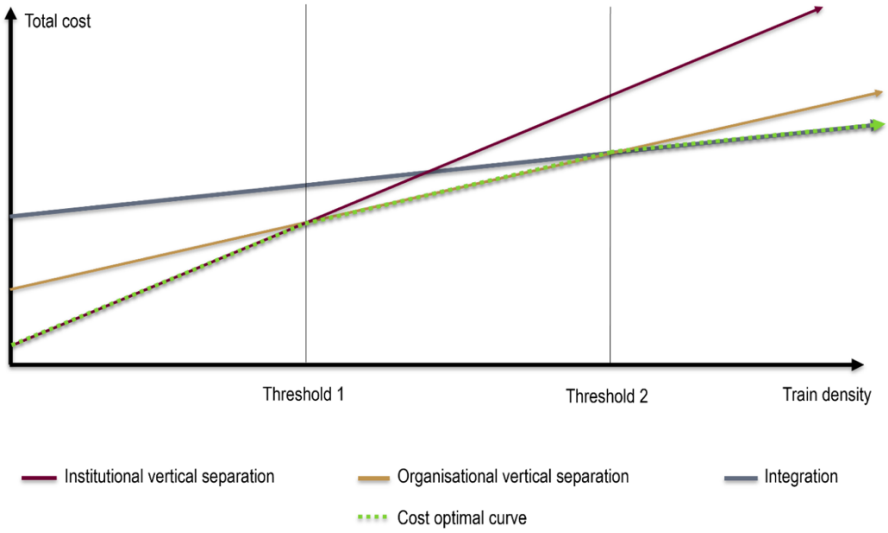

Figure 8 - Optimal ownership structure (Affeldt, 2024) based on (Mizutani, 2020)

COMPETITION FOR THE MARKET VS COMPETITION IN THE MARKET

The restructuring of European railway markets over the past three decades has been dominated by a central policy dichotomy: the choice between fostering competition for the market and enabling competition in the market (Feuerstein et al., 2018, Knorr e Eisenkopf, 2022). These two paradigms represent fundamentally different philosophies for introducing competitive pressures into an industry historically defined by its natural monopoly characteristics (Jensen, 1998). The former paradigm, rooted in the theories of Demsetz and Vickrey, replaces a permanent monopoly with a series of temporary ones, awarded through a competitive process (Knorr e Eisenkopf, 2022). The latter, often termed 'open access', seeks to replicate the dynamics of a conventional competitive market by allowing multiple operators to compete directly on the same infrastructure (Gutiérrez-Hita et al., 2022).

This chapter provides an analysis of these two models of competition. It moves beyond theoretical definitions to examine their practical application in the European railway sector, drawing on a wide range of case studies and empirical evidence. The analysis will dissect the objectives, mechanisms, advantages, and significant challenges associated with each model, ultimately synthesising the findings to understand their respective roles and the complex dynamics that emerge when they coexist. The choice between, or the blending of, these models is not merely a technical decision; it is a critical policy lever that profoundly shapes the efficiency, cost, service quality, and financial sustainability of the entire railway system (Laroche e Lamatkhanova, 2022).

COMPETITION FOR THE MARKET

Competition for the market, most commonly implemented through competitive tendering or franchising, is a regulatory model designed to harness market forces without necessitating head-to-head competition on the tracks(ECMT, 2005) (Wheat et al., 2018). In this system, a public authority specifies a bundle of services - often unprofitable but socially necessary regional or local routes - and invites private operators

to bid for the exclusive right to operate them for a defined period (Affeldt, 2024). The contract is typically awarded to the bidder who can provide the specified service at the lowest required subsidy (a 'net cost' contract) or the lowest total cost (a 'gross cost' contract)(Alexandersson e Hultén, 2009).

The primary objective of this model is to improve the productive efficiency of services that require public financial support (Affeldt, 2024). By creating a contestable market for the operating rights, it incentivises potential operators to minimise costs and innovate in their service delivery models to submit the most competitive bid (Knorr e Eisenkopf, 2022). This approach has been widely adopted for regional passenger services in countries like Germany, Sweden, and the Netherlands, and for the entire passenger network in Great Britain (until 2021) (Fitzová, 2017) (Alexandersson e Hultén, 2009) (European University Institute: Robert Schuman Centre for Advanced et al., 2016).

Evidence from several countries suggests that competitive tendering can be effective in controlling and reducing the costs of subsidised services. Studies have pointed to significant efficiency gains and cost reductions in the initial phases of franchising as private operators bring new management practices to formerly state-run services (Johnson e Nash, 2012).

Despite its theoretical appeal, the practical implementation of competition for the market is fraught with significant challenges. Designing, awarding, and monitoring franchise contracts is an immensely complex and costly task for public authorities (Alexandersson e Hultén, 2009). The contracts must be detailed enough to specify service quality, fares, and investment obligations, yet flexible enough to adapt to changing circumstances (ECMT, 2005).

There is also the risk of strategic bidding and franchise failure. The bidding process is susceptible to the "winner's curse," where an operator submits an overly optimistic or unsustainably low bid to win the contract, only to face financial distress or bankruptcy later (Alexandersson e Hultén, 2009). The failure of a franchisee can cause massive service disruption and requires costly government intervention (Fröidh e Byström, 2013, Wheat et al., 2018).

Contracts, oftentimes short-term franchises, lasting 7-15 years, can create disincentives for operators to make significant, long-term investments in areas like rolling stock or station improvements, as they may not be able to recoup the costs before the contract expires (Johnson e Nash, 2012). Over time, the number of credible bidders for franchises can dwindle, reducing the competitive intensity of the tendering process and potentially leading to higher costs for the public authority (Alexandersson e Hultén, 2009).

COMPETITION IN THE MARKET

Competition in the market, or open access, allows multiple licensed railway undertakings to compete directly against each other on the same routes, setting their own prices, frequencies, and service standards (Feuerstein et al., 2018, Gutiérrez-Hita et al., 2022). This model is typically applied to commercially viable services, primarily long-distance and high-speed passenger routes, where operators are expected to be profitable without public subsidy (Perennes, 2017). The European Union's Fourth Railway Package has firmly established open access as the default regime for commercial passenger services across member states(Gutiérrez-Hita e Ruiz-Rua, 2019) (Casullo, 2016).

The primary goals of open access are to drive down prices, increase service quality and frequency, and stimulate innovation through direct competitive pressure (Feuerstein et al., 2018) (Knorr e Eisenkopf, 2022). The empirical evidence from countries that have embraced this model reports that the entry of new operators consistently leads to significant fare reductions. In Italy, the competition between incumbent Trenitalia and new entrant NTV led to price drops of up to 40% on some routes (Laroche e Lamatkhanova, 2022) (Bougette et al., 2021). Similar effects were observed in the Czech Republic,

where intense competition on the Prague-Ostrava line caused prices to fall by over 40% (Tomes, 2022), and in Sweden on the Stockholm-Gothenburg line (Olarte Bacares et al., 2019) (Broman e Eliasson, 2019).

Frequency and service levels are also impacted. Competition invariably leads to an increase in the number of services offered as operators vie for market share, resulting in greater choice and convenience for passengers (Laroche e Lamatkhanova, 2022) (European University Institute: Robert Schuman Centre for Advanced et al., 2016). The overall quality of services improves as new entrants often act as catalysts for innovation, introducing higher-quality rolling stock, superior onboard amenities (like free Wi-Fi), and more customer-centric service models. This forces incumbents to abandon complacent practices and improve their own offerings to remain competitive (Bougette et al., 2021).

While the consumer benefits of open access are clear, the model presents its own set of profound challenges that threaten system-wide efficiency and financial stability. As seen in the market structure segment, by fragmenting services among multiple operators, open access can lead to a loss of economies of scale and density. This can increase the overall system cost compared to a single, optimised operator, an argument first robustly articulated by Preston et al. (1999) and echoed in subsequent research (Jensen, 1998) (Casullo, 2016).

Perhaps the most significant criticism to competition in the market is ”cherry-picking” and network integrity. Open access operators have a strong commercial incentive to "cherry-pick" - that is, to operate only on the most profitable routes and at the most lucrative times (the "cream"), while avoiding less profitable services (Król et al., 2019). This can undermine the financial viability of an incumbent's or franchisee's broader network, which may rely on cross-subsidies from profitable routes to support essential but loss-making lines (Wheat et al., 2018). The presence of multiple operators also increases the complexity of timetabling and real-time traffic management for the infrastructure manager, potentially leading to coordination failures and inefficient use of scarce track capacity (Perennes, 2014).

Coexistence of both types of competition

In most liberalised European railway systems, the two models do not exist in isolation but operate in parallel, creating a hybrid and often tense competitive environment. Typically, socially necessary regional services are tendered under a competition for the market framework, while commercial long-distance services operate under competition in the market (Alexandersson e Hultén, 2009).

This coexistence creates a critical point of friction: the potential for open access operators to cherry-pick profitable services from an incumbent that also holds a public service obligation or a franchise. The UK provides the most salient case study of this dilemma. Open access operators on the East Coast Main Line compete directly with the franchised operator. While this competition has delivered lower fares and innovative services for passengers on that corridor, it also siphons off revenue that the government would have otherwise received from the franchisee, potentially increasing the net cost to the taxpayer for the franchised network as a whole (Wheat *et al.*, 2018).

This highlights the central policy trade-off: the tangible benefits of open access competition on specific routes versus the potential erosion of network-wide financial stability and the integrity of the public service contract model. Resolving this tension requires sophisticated regulatory oversight, including carefully designed track access charges and a clear framework for defining and protecting public service obligations (Król *et al.*, 2019).

PUBLIC-PRIVATE PARTNERSHIPS

Governments have increasingly turned to Public-Private Partnerships (PPPs) as a core instrument for railway development and reform (Dutta, 2022). The rationale driving this global trend is both pragmatic and strategic. At its most fundamental level, the PPP model is seen as a solution to a chronic problem: the immense and often insurmountable public funding gap for capital-intensive infrastructure projects (Roy e Mitra, 2024). Faced with fiscal constraints and competing budgetary demands, governments view the private sector as a source of more abundant, albeit more costly, capital that can accelerate project delivery and modernise ageing networks (Vendramini et al., 2020).

Beyond mere financing, the turn to PPPs is predicated on the belief that private sector involvement can inject much-needed commercial discipline, operational efficiency, and innovation into traditionally staid, state-run railway enterprises (Turgut et al., 2016). Proponents argue that private partners, motivated by profit, are better at identifying market opportunities, managing costs, and delivering services that are more responsive to customer needs (IBRD, 2017). This belief has underpinned a wide array of reform efforts, from the concessioning of entire national networks in Africa and Latin America to the introduction of privately financed high-speed rail lines in Europe (Olievschi e Bank, 2013).

PPPs encompasses a broad spectrum of contractual arrangements that vary significantly in scope, duration, and risk allocation (IBRD, 2017). The most limited form of PPP is contracting and outsourcing, where state-owned railways contract out specific non-core activities, such as maintenance, station cleaning, catering, or IT services, to private firms through competitive bidding (Vendramini et al., 2020). This model aims to achieve cost savings and efficiency gains on discrete tasks while the state retains full operational control of the core railway business (IBRD, 2017). A step further, service management contracts, involve the government outsourcing the entire management of a railway system or service to a private operator for a fee, while retaining ownership of the assets and assuming most of the commercial risk (Vendramini et al., 2020).

By far the more comprehensive form of PPP, concession contracts are widely used in railway restructuring across Africa and Latin America (Kopicki et al., 1995). Under a concession, a private operator (the concessionaire) is granted the long-term right (e.g., 25-50 years) to operate, manage, and often invest in a specific railway network (Laurino et al., 2015). The concessionaire typically assumes significant commercial risk, with its revenue derived directly from passenger fares and freight tariffs. This model has been the cornerstone of reforms aiming to revitalise failing state-owned railways, as seen in less developed countries.

Partnership and Design-Build-Finance-Maintain (DBFM) Models: These models are more common for new infrastructure projects, particularly in Europe. The French experience with High-Speed Rail (HSR) provides a clear illustration of two distinct variants (IBRD, 2017):

The Partnership Model: The private partner finances, designs, and builds the infrastructure, and is then paid a regular 'availability fee' by the public authority (e.g., SNCF Réseau(figure 9)) based on the infrastructure's performance and availability. Critically, the public sector retains all the traffic and revenue risk.

The Concession Model (for new build): Similar to the above, but the private partner's remuneration is directly linked to the traffic volumes and revenue generated by the new line. Here, the private sector assumes a significant portion of the traffic risk, creating a stronger incentive for the project's commercial success.

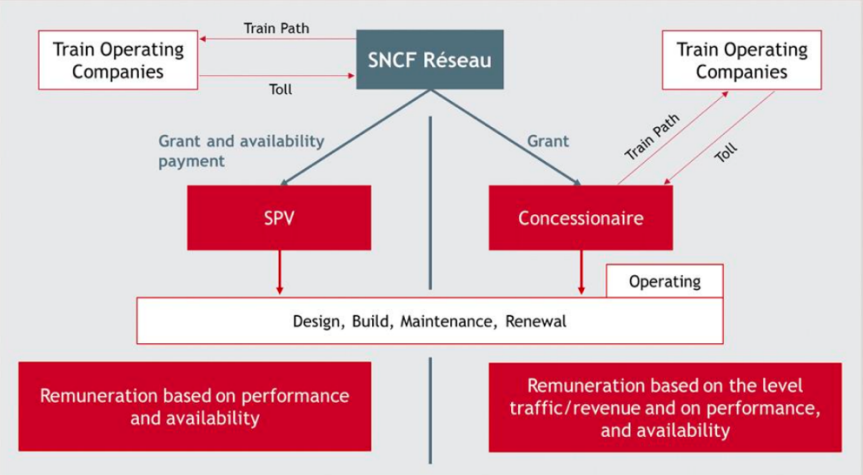

Figure 9 - French PPP Mechanisms (IBRD, 2017)

PUBLIC SERVICE OBLIGATIONS

At the core of modern railway policy lies a fundamental and enduring tension: the railway is simultaneously expected to function as a competitive, commercially-driven enterprise while also fulfilling its historical role as an instrument of social and economic policy (Dyrhauge, 2022) (Laurino *et al.*, 2015). Historically, under state monopoly structures, this tension was resolved implicitly. Governments would simply mandate that the national railway operate unprofitable but socially vital services - such as lines in remote rural areas, off-peak commuter services, or discounted fares for students and pensioners - with the costs being opaquely covered through internal cross-subsidies from profitable freight or passenger routes, or through general deficit funding (IBRD, 2017). This approach, while politically convenient, created a system that lacked transparency, distorted market signals, and severely undermined the managerial and financial accountability of the railway undertaking (Campos e Sánchez, 1999).

The global shift towards railway liberalisation and commercialisation necessitated a new, more explicit mechanism to manage this duality. This mechanism is the **Public Service Obligation (PSO)**, a concept that has become the cornerstone of regulated railway markets, particularly within the European Union (Nash e Matthews, 2002) (Guillen, 2022). This sub-chapter will dissect the concept of the PSO, analyse its implementation through contractual frameworks, and critically evaluate the significant challenges that persist in its application.

A Public Service Obligation represents the formalisation of a government's desire for transport services that the market, left to its own devices, would not provide. The European Commission has provided the most widely adopted definition, which characterises a PSO as “a requirement defined or determined by a competent authority in order to ensure public passenger transport services in the general interest that an operator, if it were considering its own commercial interests, would not assume or would not assume to the same extent or under the same conditions without reward” (IBRD, 2017) (Guillen, 2022).

This definition is crucial because it shifts the paradigm from an assumed burden on the railway to a specified service purchased by the state (Nash e Matthews, 2002). There are three principal categories of PSOs applied to passenger railways:

- The Obligation to Operate: This is the most common form, requiring an operator to provide services on specific routes (e.g., low-density branch lines) or at particular times (e.g., late-night

or weekend services) that would otherwise be cancelled due to low demand and commercial unviability (IBRD, 2017).

- The Obligation on Tariffs: This involves the government imposing fare structures that are below commercial levels, such as capping fare increases below the rate of inflation or mandating uniform national pricing, thereby preventing the operator from engaging in profit-maximising price discrimination (IBRD, 2017).
- The Obligation of Concession Fares: This requires the operator to offer discounted travel to specific social groups, such as students, pensioners, military personnel, or persons with disabilities (IBRD, 2017).

By explicitly defining these requirements, the PSO framework unbundles social objectives from commercial operations, allowing each to be assessed and funded on its own merits (Campos e Sánchez, 1999).

3
History of Railway market organization

EARLY MODELS OF RAILWAY DEVELOPMENT

The railway was not born from a grand state plan but from the crucible of the Industrial Revolution, fuelled by private capital and entrepreneurial ambition (Chen et al., 2010). In the early 19th century, particularly in Great Britain, railways emerged as a transformative technology, dramatically reducing travel times and freight costs compared to the canal and road networks that preceded them (Waters, 2007). The earliest lines were conceived and built by private companies, often with the specific goal of connecting industrial centres, mines, and ports to facilitate the movement of goods like coal, coffee, and tea (Kumara e Bandara, 2021) (Ait Ali e Eliasson, 2022). This initial phase of development can be described as one of laissez-faire capitalism, where governments adopted a largely permissive stance, allowing private investors to identify opportunities, raise capital, and construct networks with minimal state interference (Ait-Ali, 2020).

This model of private-led development was not unique to Britain. It was replicated across the world, including in the United States, where a multitude of private companies competed fiercely to lay tracks across the vast continent, creating what was arguably the world's most dynamic and extensive railway network, primarily focused on freight transport (Turgut et al., 2016). This era was characterised by what has been termed "railway mania" - a period of intense investment, speculative bubbles, and rapid, often chaotic, network expansion driven by the promise of immense profits (Ait Ali e Eliasson, 2022).

The initial phase of unfettered competition soon gave way to a new economic reality. It became increasingly apparent that the railway industry possessed strong natural monopoly characteristics (Alexandersson e Rigas, 2013) (Bordie et al., 2014) (Nash e Rivera-Trujillo, 2004). The enormous sunk costs required to build railway infrastructure - the tracks, signals, tunnels, and bridges - meant that it was highly inefficient to have multiple, parallel railway lines competing on the same route (Alexandersson e Rigas, 2013) (Nikitinas e Dailydka, 2016). Once one company had built a line between two cities, it effectively held a monopoly over rail transport on that corridor.

This realisation had two profound consequences for the organisation of the market:

- Consolidation and Integration: The intense competition of the "railway mania" was inherently unstable. Weaker companies went bankrupt or were acquired by stronger rivals, leading to a natural process of consolidation (Eisenkopf et al., 2006). Over time, large, vertically integrated railway companies emerged, controlling both the infrastructure and the operation of trains within specific geographical territories. This vertically integrated monopoly became the dominant organisational model, not by design, but as the logical economic outcome of the

industry's cost structure (Issina et al., 2023) (Campos e Sánchez, 1999) (Nash e Rivera-Trujillo, 2004).

- The Rationale for Public Intervention: The immense market power held by these new railway monopolies created a strong public demand for government intervention. Shippers and passengers became "captive" to the railway and vulnerable to exploitative pricing and poor service (Waters, 2007). This prompted the development of the earliest forms of transport regulation, with governments stepping in to control tariffs, mandate service standards, and ensure fair access, marking the end of the purely laissez-faire era (Willig, 1999) (Estache et al., 2001).

As the 19th century progressed and railways became indispensable arteries of national commerce and military strategy, governments across the world adopted more active roles, leading to the development of two divergent organisational paths.

PATH 1: NATIONALISATION AND THE STATE-OWNED MONOPOLY

In most of Europe and in many colonial territories, the response to the natural monopoly problem was nationalisation. Governments either took over failing private companies or created new state-owned railway enterprises to manage the entire national network as a single, vertically integrated entity (AIT ALI E ELIASSON, 2022) (AIT-ALI, 2020) (EISENKOPF *ET AL.*, 2006). France, for instance, consolidated its fragmented private networks into the state-owned SNCF (MONAMI, 2000). In British India, the colonial government established a vast state-run railway system, viewing it as a critical tool for administrative control, military mobility, and economic exploitation (KUMARA E BANDARA, 2021) (NAYAK, 2021).

This model was predicated on the belief that since the railway was a strategic national asset and a natural monopoly, it should be owned and operated directly by the state in the public interest (CAMPOS E SÁNCHEZ, 1999) (BORDIE *ET AL.*, 2014). This structure, the state-owned, vertically integrated monopoly, would become the dominant model for railways globally for the better part of the 20th century (ISSINA *ET AL.*, 2023) (THOMPSON, 2003). It promised unified planning, standardised technology, and the ability to operate services based on social need rather than pure commercial logic. However, as became apparent in later decades, it also contained the seeds of inefficiency, political interference, and a lack of customer focus (VESKOVIĆ *ET AL.*, 2011) (IBRD, 2017).

PATH 2: THE NORTH AMERICAN MODEL OF REGULATED PRIVATE COMPETITION

In contrast, the United States and Canada pursued a different path. While acknowledging the need for regulation to curb monopoly abuses, they largely retained a system of privately owned, vertically integrated railway companies (THOMPSON E KOHON, 2012) (NASH E RIVERA-TRUJILLO, 2004). The key difference was that the vast geography of North America allowed for a degree of intramodal competition that was not possible in the smaller, more densely populated countries of Europe (PITTMAN, 2011).

In this model, multiple large railway companies (like Union Pacific and BNSF in the U.S., or CN and CP in Canada) competed with each other, not typically over parallel tracks on the same route, but through "systems competition." They controlled vast, distinct networks that often served the same major cities or industrial regions, providing shippers with a choice between competing rail systems (PITTMAN, 2011) (THOMPSON E KOHON, 2012). This system was, and remains, heavily regulated by bodies like the Surface Transportation Board (STB) in the U.S. to manage mergers, resolve disputes, and protect captive

shippers, but the fundamental principle of private ownership and system-level competition has endured (AIT-ALI E ELIASSON, 2019).

ERA OF NATIONALIZATION AND VERTICAL INTEGRATION

The period spanning the early to mid-20th century marked a profound and widespread shift in the organisation of railway markets across the globe. The model of fragmented, privately owned railways, which had characterised the industry's genesis, gave way to an era dominated by nationalisation and vertical integration (Laurino et al., 2015) (Eisenkopf et al., 2006) (IBRD, 2017). This was not a random occurrence but a deliberate policy response to a confluence of economic, political, and social pressures that made the old system increasingly untenable (Kopicki et al., 1995).

As mentioned in 3.1, the primary driver was the recognition of the railway's status as a strategic national asset. Governments came to view the rail network as indispensable for military mobilisation, national security, and economic development, a perception solidified by the experience of two World Wars (Willig, 1999) (Pittman, 2011). The fragmented and sometimes competing interests of private companies were seen as incompatible with the need for a unified, nationally coordinated transport system (IBRD, 2017). Furthermore, many of the early private railway companies, which had been born during the speculative "railway mania," began to face severe financial difficulties (Ait-Ali e Eliasson, 2019) (Turgut et al., 2016). As traffic declined due to the rise of road transport and operational costs increased, these private firms often became reliant on state subsidies to survive, making state takeover seem like a logical and fiscally responsible next step (IBRD, 2017).

This led to a wave of nationalisations across Europe and beyond. In countries like France, a multitude of private lines were consolidated into the single state-owned entity, SNCF (Kurosaki, 2008). In Great Britain, the "Big Four" private railway companies were nationalised in 1948 to form British Rail, a vertically integrated public corporation responsible for the entire network (Abbott e Cohen, 2017). This pattern was replicated throughout the world, establishing the state-owned, vertically integrated monopoly as the standard organisational model for railways for decades to come (Eisenkopf et al., 2006) (Brose, 2015).

This dominant model was defined by a specific set of organisational and operational characteristics such as a single entity controlled all aspects of the railway system. This included ownership and maintenance of the infrastructure (tracks, signals, stations) as well as the operation of all train services (both passenger and freight) (Ait Ali e Eliasson, 2022, Bouf et al., 2005). This structure was justified by the belief that it maximised coordination efficiencies and allowed for integrated planning of the entire network. The inherent economies of scope between track and train operations were seen as a compelling reason to keep these functions unified within one organisation (Amos, 2009).

The railway was typically organised as a public corporation or a government department, making it directly accountable to the state rather than to private shareholders (Ait-Ali e Eliasson, 2019) (Kopicki et al., 1995). This structure gave the government immense influence over railway policy, allowing it to dictate fares, service levels, and investment priorities to meet political objectives (Velde et al., 2012) while conserving a monopoly status. The national railway held a legal monopoly over all rail transport services within the country. Competition from other railway operators was non-existent, and the primary competitive pressure came from other modes of transport, such as road and, later, air (Willig, 1999) (Grushevska et al., 2016).

It was expected to operate socially necessary but unprofitable lines, offer concessionary fares to specific social groups, and maintain a high level of employment, often at the expense of commercial efficiency.

These public service obligations were rarely formalised or transparently funded; instead, their costs were buried within the railway's overall operational deficit (Ait Ali e Eliasson, 2022).

For a time, this model appeared to serve its purpose. It provided stable, unified, and comprehensive rail services across national territories. The integrated structure allowed for standardised technology and facilitated large-scale, centrally planned infrastructure projects. It also ensured that railways continued to fulfil a vital social function, providing connectivity to remote regions and affordable transport for millions (Bouf *et al.*, 2005).

However, the state monopoly model contained deep-seated structural flaws that would become increasingly apparent over time. Separated from market signals and shielded from competitive pressure, these monolithic organisations became prone to significant inefficiencies (Affeldt, 2024).

With their deficits covered by the state treasury, state railways had little incentive to control costs, innovate, or respond to changing customer demands (IBRD, 2017) and so lacked commercial focus. Management focus shifted from satisfying customers to navigating political directives and bureaucratic processes. The close relationship with the state made the railway a tool of political patronage. Decisions on route closures, station staffing, and even fare levels were often made for political reasons rather than on sound operational or economic grounds.

Labour unions held significant power within state railways, often resisting productivity improvements and changes to work rules, which led to overstaffing and bloated operating costs (IBRD, 2017). This operational inefficiency linked to the chronic underinvestment led to a gradual deterioration of the railway system, further eroding its competitiveness against other modes of transport (Velde *et al.*, 2012). While governments were willing to cover operational deficits, they were often reluctant to provide the massive capital investment required to modernise ageing infrastructure and rolling stock.

THE GOLDEN AGE OF STATE-OWNED RAILWAYS (1945-1980)

Following the widespread wave of nationalisations, the vertically integrated state railway entered what can be retrospectively viewed as its golden age, a period from the end of the Second World War until roughly the 1960s and early 1970s. During this time, the state monolith was not seen as a problematic or inefficient structure but as a resounding success and an indispensable engine of national progress and modernity (Kopicki et al., 1995). This era of confidence was built on the railway's central role in post-war reconstruction, its demonstrated technological prowess, and its near-total dominance of the land transport market, a position that temporarily masked the model's underlying structural weaknesses (Kurosaki, 2008) (Solina e Abramović, 2022).

In the crucible of post-war recovery, the centralised, command-and-control nature of the state-owned railway proved uniquely effective. These organisations were instrumental in rebuilding shattered economies, providing the mass transport of raw materials, industrial goods, and people necessary to fuel national reconstruction efforts. In Japan, for instance, the newly formed Japanese National Railways (JNR) was not only profitable in its early years but played a pivotal role in the nation's extraordinary post-war economic miracle, effectively functioning as a key instrument of state-led development policy (Kurosaki, 2008). This performance cemented the perception of the national railway as a vital strategic asset, justifying its privileged position and direct state control. The integrated structure allowed for unified planning and the efficient execution of large-scale, national-priority projects that would have been impossible for fragmented private entities to undertake.

This period was also one of significant technological advancement, further burnishing the reputation of state-run systems. Freed from the short-term profit motives of private investors, national railways

embarked on ambitious modernisation programmes. The most notable of these was the wholesale conversion from steam to more efficient and reliable diesel and electric traction, a massive capital-intensive undertaking that state monoliths were well-positioned to execute (Kopicki et al., 1995). This technological leap forward delivered substantial gains in productivity and service quality, reinforcing the image of the state railway as a forward-looking, modern enterprise at the forefront of engineering excellence.

Crucially, the financial health of these organisations was underpinned by their dominant market position. For much of this era, railways faced limited and underdeveloped intermodal competition (Krmac e Djordjevic, 2018) (Thompson, 2003). National highway systems were still in their infancy, making road haulage a secondary player for long-distance freight, while air travel remained a luxury reserved for a small elite (Campos e Sánchez, 1999) (Amos, 2009). In this environment, the railway was the undisputed king of land transport, allowing state operators to maintain high traffic volumes and, in some cases, even achieve operational profitability without significant subsidies (Kurosaki, 2008). Their status as a natural monopoly was not just a theoretical concept but a tangible market reality, allowing them to benefit from significant economies of scale and scope.

However, the very success of this golden age sowed the seeds of its eventual and inexorable decline. The model's effectiveness was contingent on a specific set of historical and economic conditions that were rapidly changing. The same governments that owned the railways were simultaneously making massive public investments in the construction of national highway networks, thereby creating and subsidising the railway's most formidable competitor (IBRD, 2017). As road transport for both freight and passengers became faster, more flexible, and more cost-effective, it began to aggressively erode the railway's market share (Bordie et al., 2014) (Campos e Sánchez, 1999). Furthermore, the monolithic, bureaucratic structure of the state railway, so effective for centrally planned reconstruction, proved woefully ill-equipped to adapt to this new competitive reality. It was slow to innovate in response to changing customer demands, such as the need for door-to-door service, and was constrained by its public service obligations and rigid labour practices (White, 1998) . The implicit political bargain - whereby the state supported the railway in return for the provision of social services - began to break down as revenues fell and deficits mounted, marking the end of the golden age and ushering in a period of crisis that would ultimately trigger the next great wave of reform (Thompson, 2003).

CRISIS AND THE SEEDS OF REFORM (1980-1990)

The golden age of the state-owned railway proved to be a fleeting epoch. By the late 1960s and extending through the 1970s and 1980s, the very foundations of the vertically integrated state monolith began to crumble, ushering in a protracted period of crisis that would ultimately create the powerful imperative for radical reform (Monsalve, 2012) (Cantos et al., 2010). The same model that had been hailed as an engine of post-war recovery was now increasingly viewed as an inefficient, financially unsustainable anachronism, ill-suited to a rapidly changing transport market (Kurosaki, 2008). This decline was not the result of a single event, but a "perfect storm" of intensifying intermodal competition, internal structural decay, and a fundamental breakdown of the political and economic compact that had long sustained the national railway (Gómez-Ibáñez e de Rus, 2006) (OECD, 2002).

The most potent external force driving this crisis was the relentless rise of road transport (Esposito et al., 2020, Kurosaki, 2018). Massive public investment in national and trans-national highway networks had created a formidable competitor that the railways were structurally ill-equipped to counter (Crozet, 2017). For freight, the trucking industry offered a flexibility and door-to-door service that the rigid, hub-and-spoke model of the railway could not match, capturing an ever-larger share of the lucrative general

merchandise market (Huang et al., 2019). For passengers, the proliferation of the private automobile offered a convenience and personal freedom that eroded the railway's base for shorter journeys, while the advent of affordable air travel began to challenge its dominance over long-distance routes (Cantos et al., 2010) (Tomeš, 2017). This two-fronted assault led to a precipitous and sustained decline in the railway's modal share for both passengers and freight across the developed world, hollowing out the revenue base that had once supported the entire system (Monsalve, 2012) (Cantos et al., 2010).

Internally, the monolithic state railways proved incapable of adapting to this new competitive landscape (Kurosaki, 2008). Decades of operating as protected monopolies had fostered a culture focused on operational metrics - running trains and producing tonne-kilometres - rather than on customer needs, service quality, or commercial innovation (Gómez-Ibáñez e de Rus, 2006). Management was often more attuned to the political directives of its government ministry than to the signals of the market (Kogueda et al., 2025). Compounding this were powerful labour unions that frequently resisted necessary productivity improvements and modernisation efforts, contributing to bloated workforces and unsustainable operating costs (Gómez-Ibáñez e de Rus, 2006). This internal paralysis meant that as the market changed, the railways stood still, becoming progressively less competitive and more financially precarious (Kurosaki, 2008).

The financial consequences were catastrophic. The implicit political bargain of the golden age - whereby governments would support the railway in return for the provision of social services - had unravelled (Gómez-Ibáñez e de Rus, 2006). As revenues plummeted, the cost of maintaining extensive, underutilised networks and fulfilling unfunded public service mandates skyrocketed (Ait-Ali, 2020) (Kogueda et al., 2025). Railways across the world plunged into a state of chronic and ever-deepening deficit (Vesković et al., 2011). In the United Kingdom, British Rail's operating surpluses vanished in the mid-1950s, leading to decades of mounting losses 17 (Yvrande-Billon e Menard, 2005). In Japan, the once-profitable JNR accumulated a staggering debt of 25 trillion yen by the 1980s (Kurosaki, 2008). This fiscal haemorrhage transformed the national railway from a symbol of pride into a major drain on the public purse, making it a prime target for treasury officials and reform-minded politicians seeking to curb state spending (Monsalve, 2012).

This confluence of competitive pressure, internal inefficiency, and fiscal crisis created the fertile ground in which the seeds of reform were sown. The old model was clearly broken. The initial responses were often defensive and piecemeal, such as the infamous Beeching cuts in the UK, which sought to restore profitability by radically shrinking the network (Yvrande-Billon e Menard, 2005). However, it soon became clear that mere downsizing was insufficient. A growing consensus emerged among policymakers, economists, and international bodies like the World Bank that a more fundamental, structural overhaul was required (Estache et al., 2001). This new thinking, heavily influenced by the broader neoliberal turn towards deregulation and privatisation in other network industries like telecommunications and energy, began to question the very tenets of the state-owned, vertically integrated model (Pittman, 2009) (Pittman et al., 2007). It was from this crucible of crisis that the modern reform agenda - centred on vertical separation, competition, and private sector participation - would be forged, setting the stage for the most profound reorganisation of the railway sector in a century.

4

International models of railway sector organization

EUROPEAN LIBERALIZATION SCHEME

The deep-seated crisis of the state-owned railway monoliths across Europe did not lead to a chaotic collapse but rather catalysed a coordinated and profoundly ambitious political project: the creation of a Single European Railway Area (Brose, 2015) (Di Foggia e Arrigo, 2013) (Stiftung, 2021). Faced with declining modal shares, spiralling public subsidies, and a patchwork of technically and operationally incompatible national networks, the European Commission embarked on a multi-decade legislative journey to fundamentally reorganise the continent railways (Ruiz-Rua e Palacin, 2012) (Zeybek, 2018) (Jarzembowski, 2006). This European liberalisation scheme was not a single event but a gradual, evolutionary process, pursued through a series of directives and regulations collectively known as the "Railway Packages" (Solina *et al.*, 2021) (Nash *et al.*, 2019) (Guillen, 2022). Its overarching goal was to replace the fragmented system of national monopolies with an integrated, competitive, and efficient trans-European market, shifting the sector's governing logic from state administration to market-based competition (Deville e Verduyn, 2012) (Solina e Abramović, 2022).

The philosophical cornerstone of the entire European reform project, first laid down in the seminal Directive 91/440/EEC, was the principle of unbundling infrastructure management from transport operations (Dyrhauge, 2022) (Finger e Messulam, 2015b) (Perennes, 2017). This vertical separation, even if only at an accounting level initially, was deemed the essential prerequisite for creating a level playing field (figure 11). The logic was that a vertically integrated incumbent would always have the incentive and the ability to discriminate against new entrants seeking to use its tracks, thereby stifling the very competition the reforms sought to create (Beria *et al.*, 2012) (Lang *et al.*, 2013). By separating the two functions, the infrastructure could be treated as a neutral platform to which all licensed railway undertakings - whether state-owned or private, domestic or foreign - could gain fair and non-discriminatory access (Beria *et al.*, 2012) (Di Foggia e Arrigo, 2013). This directive, while criticised in its early years as a "toothless tiger" for its flexible interpretation, successfully shattered the ideological dominance of the integrated monolith and established the foundational principles for all subsequent reforms (Dyrhauge, 2022).

Building upon this foundation, the European Union pursued a staged and methodical opening of the market through the successive Railway Packages, each one deepening the liberalisation process (figure 10). The **First Railway Package** (2001) put concrete mechanisms behind the initial principles, mandating clearer accounting separation, establishing frameworks for non-discriminatory track access charging and capacity allocation, and, most significantly, opening the international rail freight market to competition (Di Foggia e Arrigo, 2013) (Finger e Messulam, 2015a) (Szczygieł). This was a critical

first step, targeting the sector where the railways' declining competitiveness against road haulage was most acute (Jarzembowski, 2006) (Crozet, 2017).

The **Second Railway Package** (2004) accelerated this process by opening the domestic rail freight markets and establishing the European Railway Agency (ERA) (Brose, 2015) (Guillen, 2022) (Bougette *et al.*, 2021). The creation of the ERA acknowledged a crucial reality: market access is meaningless without technical compatibility. The ERA was tasked with the immense challenge of driving interoperability - harmonising the disparate national technical standards, safety rules, and signalling systems (like the push for a common European Rail Traffic Management System, or ERTMS) that remained formidable non-tariff barriers to entry for cross-border operators (Brose, 2015) (Laroche *et al.*, 2017).

Having largely opened the freight sector, the EU turned its attention to the more politically sensitive passenger market. The **Third Railway Package** (2007) opened international passenger services to competition, including rights of cabotage, allowing an international operator to pick up and drop off domestic passengers along its route (Lang *et al.*, 2013) (Bougette *et al.*, 2021) (Vesković *et al.*, 2011). Finally, the **Fourth Railway Package** (adopted in 2016) represented the culmination of the entire liberalisation project (Nash *et al.*, 2019) (Company). Its "market pillar" mandated the full opening of domestic commercial passenger markets to open access competition from 2020 and established competitive tendering as the standard procedure for awarding Public Service Contracts from 2023, aiming to eliminate the practice of direct awards to incumbents (Jarzembowski, 2006) (Gutiérrez-Hita e Ruiz-Rua, 2019).

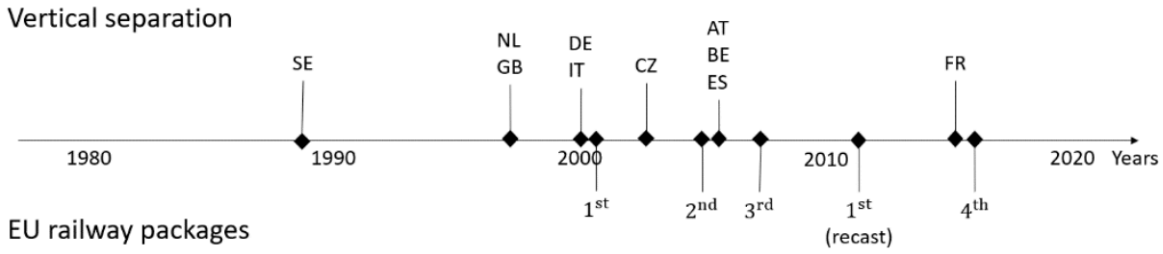

Figure 10 - Timeline of vertical separation and EU railway packages (Ait-Ali, 2020)

Underpinning this entire legislative edifice is the establishment of strong, independent National Regulatory Authorities (NRAs) in each Member State (De Francesco e Castro, 2016). The success of the single market hinges on the existence of a neutral referee empowered to oversee the market, approve track access charges, allocate train paths fairly, handle complaints, and prevent anti-competitive behaviour by dominant incumbents (Solina et al., 2021) (Lerida-Navarro et al., 2019) (Bougna e Crozet, 2016). The development and strengthening of these regulatory bodies has been a slow and often contested process, but they are now recognised as an indispensable component of the liberalised European railway model (De Francesco e Castro, 2016). The European liberalisation scheme, therefore, cannot be understood as a singular model, but rather as a comprehensive and evolving framework designed to engineer a market where one did not previously exist. It has transformed the European railway landscape from a collection of isolated national fiefdoms into a complex, interconnected, and increasingly competitive system, creating the context within which every national railway, including that of Portugal, must now operate.

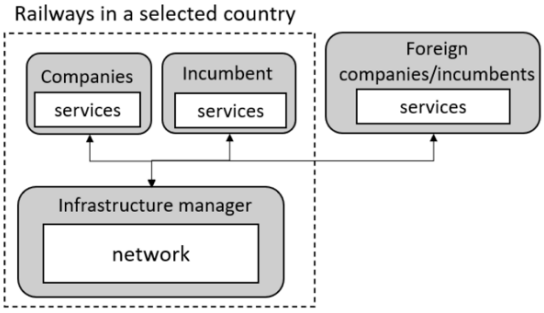

Figure 11 - Example of a deregulated market structure in Europe (Ait-Ali, 2020)

Table 2 - Evolution of the European railway landscape from pre-1990 to post-2010, adapted from (Brose, 2015)

	Previous era (untill 1990)	Transition era (1990-2050)	New era (2010)
Organizational Structure	Vertically integrated	Voluntary unbundling	Mandatory unbundling
Regulatory policy and legislation	National	National with supra-national transport policy and directives	National with EU directives (railway packages)
Drivers	Public service	Public service, productivity and finantial sustainability	Public service, productivity, finantial sustainability, environmental concerns
Market structure	Monopoly	Monopolistic (infrastructure) and market segments	Monopolistic (infrastructure) and market segments
Market Opening	Closed with limited international traffic	Ah hoc opening of domestic markets	Freight open Mandatory opening of passenger market
Ownership	Public ownership	Mostly state-owned	State-owned (infrastructure) Some private rail companies
Regulatory arrangments	None (ministry)	None (ministry)	Independent railway authority
Scale	Regional and National	National to International	Increasingly International

GERMANY

The German approach to railway reform stands as one of the most significant and debated models within the European liberalisation framework. It represents a distinctive "middle way" that attempts to reconcile the EU's mandate for market opening and vertical separation with the perceived operational benefits of an integrated system (Nikitinas e Dailydka, 2016) (Kumara e Bandara, 2021) (Affeldt, 2024). Unlike

the full institutional separation seen in Sweden or the initial radical privatisation in the UK, Germany opted for an organisational separation within a holding company structure, a model that has since been influential across Europe, including in countries like Austria and Italy (Deville e Verduyn, 2012) (Affeldt, 2024) (Beria *et al.*, 2012). Understanding the German experience - its successes, its persistent challenges, and its ongoing evolution - is therefore crucial for any country, including Portugal, seeking to navigate the complex trade-offs of modern railway organisation.

The impetus for Germany's Bahnreform (Railway Reform) of 1994 was primarily domestic, predating some of the more prescriptive EU directives but aligned with their spirit (Deville e Verduyn, 2012). The country was facing a fiscal and operational crisis of monumental proportions. The reunification of Germany had saddled the state with two deeply indebted and inefficient railways: West Germany's Deutsche Bundesbahn (DB) and East Germany's Deutsche Reichsbahn (DR), which together had accumulated staggering losses (ERFA, 2022) (Deville e Verduyn, 2012) (Brose, 2015). The reform had two principal, intertwined goals: to relieve the immense burden on the federal budget and to revitalise rail transport to make it more competitive with other modes (Affeldt, 2024).

The cornerstone of the reform was the merger of the two old railways into a new, single entity, Deutsche Bahn AG (DB AG), legally constituted as a private joint-stock company but with the federal government as its sole shareholder (ERFA, 2022) (Deville e Verduyn, 2012) (Nikitinas e Dailydka, 2016). Crucially, the reform implemented an organisational, rather than institutional, vertical separation (Kumara e Bandara, 2021). The infrastructure and transport service functions were unbundled into separate subsidiaries under the umbrella of the DB AG holding company. This created distinct entities responsible for infrastructure management (DB Netz AG), passenger stations (DB Station & Service AG), long-distance passenger services (DB Fernverkehr AG), regional passenger services (DB Regio AG), and freight (now DB Cargo AG) (Affeldt, 2024) (Deville e Verduyn, 2012) (Nikitinas e Dailydka, 2016).

This "holding model" was designed to achieve the best of both worlds. On the one hand, the legal and accounting separation of the subsidiaries was intended to ensure the transparency and non-discriminatory network access required by EU law, creating the conditions for on-track competition (Deville e Verduyn, 2012) (Nikitinas e Dailydka, 2016). The reform immediately granted open access to both freight and passenger operators, making Germany one of the earliest and most extensively liberalised markets in Europe (Brose, 2015) (Affeldt, 2024). On the other hand, keeping these entities within a single holding company was intended to preserve the strategic and operational coordination benefits of an integrated system, allowing for a unified approach to planning, investment, and innovation - a concept often referred to as Systemgedanke or "system-thinking" (Kumara e Bandara, 2021) (Affeldt, 2024).

The results of this reform have been demonstrably positive in many respects. The introduction of competition has been a notable success, with Germany now having one of the most dynamic rail markets in Europe, hosting over 350 licensed railway undertakings (Nikitinas e Dailydka, 2016) (Kirchner e Services, 2011). New entrants and "challengers" have captured a significant share of the market, particularly in rail freight, where they now account for over half of the traffic, and in regional passenger transport, where competitive tendering for Public Service Contracts has become the norm (Lalive e Schmutzler, 2008) (Affeldt, 2024) (ERFA, 2022). This surge in competition has been credited with driving efficiency gains, fostering innovation, and contributing to a significant increase in both passenger and freight traffic volumes since the reform (Kumara e Bandara, 2021) (Affeldt, 2024).

However, the German model is not without its significant and persistent challenges, most of which stem from the inherent tension of its hybrid structure. The central criticism levelled against the holding model

is that the supposed independence of the infrastructure manager, DB Netz, is compromised by its position within a group dominated by the incumbent operator, DB AG (Szekely, 2009) (Nikitinas e Dailydka, 2016). Competing operators have long argued that this structure creates a conflict of interest, alleging that DB Netz can subtly favour its sister transport companies through the design of track access charges, the timetabling process, and investment planning (Deville e Verduyn, 2012) (Nikitinas e Dailydka, 2016). Despite the presence of a strong independent regulator, the Bundesnetzagentur (BNetzA), suspicions of discriminatory practices persist, creating what many competitors view as an unlevel playing field (Nikitinas e Dailydka, 2016) (Affeldt, 2024). The European Court of Justice has weighed in on this very issue, affirming the legality of the holding model but stressing the stringent independence requirements needed to make it compliant with EU law (Nikitinas e Dailydka, 2016).

Furthermore, while the reform initially succeeded in reducing the direct burden on the federal budget, it has more recently been criticised for leading to chronic underinvestment in the network (Affeldt, 2024). The focus on commercial performance and profitability within DB AG led to a period of cost-cutting that saw the network shrink by nearly 6,000 km while traffic volumes soared, creating a highly congested and increasingly fragile system (Affeldt, 2024). A significant investment backlog, estimated at around €90 billion by 2021, has resulted in declining punctuality and service quality, prompting a recent policy shift by the German government towards massive reinvestment and a renewed focus on infrastructure renewal, epitomised by the creation of the new non-profit infrastructure entity, DB InfraGO (Affeldt, 2024).

The German model offers a compelling but complex case study. It demonstrates that organisational separation within a holding company can successfully foster a vibrant and competitive railway market while retaining some of the coordination benefits of integration (Kirchner e Services, 2011, Nikitinas e Dailydka, 2016). However, it also highlights the profound challenges of managing the inherent conflicts of interest and ensuring sufficient long-term investment in infrastructure within such a structure. For Portugal and other nations, the German experience serves as a powerful lesson that there is no perfect model, only a series of trade-offs. It underscores the critical importance of a strong, independent regulator and a steadfast, long-term government commitment to infrastructure funding as non-negotiable prerequisites for the success of any reform path.

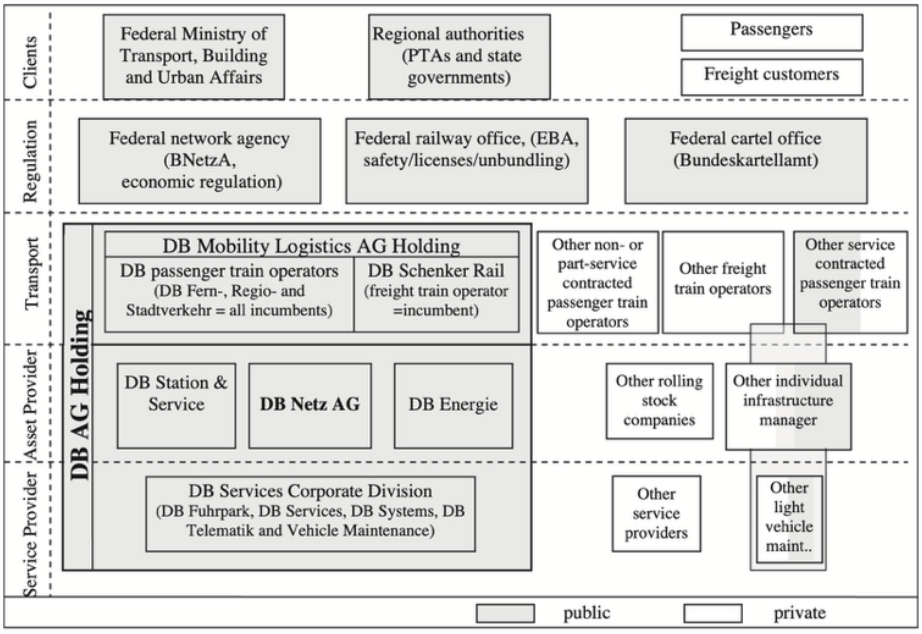

Figure 12 - The German rail system (Link, 2012)

ITALY

The Italian railway reform experience presents a unique and compelling case study within the European landscape, distinguished by its early adoption of open access competition in the high-speed rail (HSR) sector (Beria *et al.*, 2016) (Desmaris e Croccolo, 2018) (Bergantino *et al.*, 2015). While initially following a reform path similar to Germany's holding company model, Italy's subsequent development into the first and most extensive European market with direct, head-on competition between two major HSR operators makes it a vital laboratory for understanding the impacts of liberalisation (Cascetta e Coppola, 2015) (Desmaris e Croccolo, 2018) (Bergantino *et al.*, 2015). The lessons from Italy's journey - characterised by ambitious entrepreneurship, fierce rivalry, regulatory intervention, and significant market growth - are of profound relevance to any nation, including Portugal, contemplating the future structure of its own railway market.

Like many of its European neighbours, Italy's reform process began in the 1990s, driven by the need to address the inefficiencies and fiscal drain of its traditional state monopoly and to comply with emerging EU directives (Bergantino *et al.*, 2015) (ERFA, 2022) (Kirchner e Services, 2011). The state-owned Ferrovie dello Stato (FS) was restructured, following the German model, into a holding company, Ferrovie dello Stato Italiane (FSI), with separate subsidiaries for infrastructure management (Rete Ferroviaria Italiana, RFI) and transport operations (Trenitalia) (Beria *et al.*, 2016) (Cascetta e Coppola, 2015) (Desmaris e Croccolo, 2018) (Laurino *et al.*, 2015). This created the necessary legal and organisational separation to allow for third-party access to the network, as mandated by European law (Bergantino *et al.*, 2015) (ECMT, 2005). For many years, however, this structural change did not translate into significant on-track competition in the passenger market, a situation common across much of Europe (Beria *et al.*, 2016) (Cascetta e Coppola, 2015) (Desmaris e Croccolo, 2018).

The transformative moment for the Italian market arrived in April 2012 with the launch of Nuovo Trasporto Viaggiatori (NTV), a privately owned open-access operator that began competing directly with the incumbent Trenitalia on the lucrative Milan-Rome HSR corridor under the brand name "Italo" (Beria *et al.*, 2016) (Desmaris e Croccolo, 2018) (Bergantino *et al.*, 2018). This was a landmark event in European railway history (Bergantino *et al.*, 2015). While other countries had seen limited competition on niche routes or through franchising, Italy became the first to witness sustained, large-scale, head-on competition between two full-service HSR providers on its core national network (Cascetta e Coppola, 2015) (Desmaris e Croccolo, 2018) (Bergantino *et al.*, 2015).

NTV entered the market with an ambitious and innovative strategy. It made a massive initial investment of over one billion euros, primarily in a fleet of 25 modern Alstom AGV trains, signalling a long-term commitment to the market (Desmaris e Croccolo, 2018). Its business model drew inspiration from the low-cost airline sector, focusing on minimising fixed costs through digital distribution, outsourcing non-core tasks like maintenance and catering, and implementing innovative, incentive-based remuneration for its staff (Desmaris e Croccolo, 2018). Italo also differentiated its service by offering distinct travel classes (Smart, Prima, Club Executive) and amenities like free Wi-Fi, aiming to capture market share through a combination of competitive pricing and superior service quality (Desmaris e Croccolo, 2018).

The impact of NTV's entry on the Italian HSR market has been profound and widely studied, yielding several key findings. First, it triggered a dramatic increase in service supply and network utilisation. Far from retreating, the incumbent Trenitalia responded aggressively to the new competition, increasing its own service frequencies by over 30% on the Rome-Milan route (Bergantino *et al.*, 2015) (Affeldt, 2024). This, combined with NTV's new services, led to a more than 50% increase in overall capacity on key corridors, providing passengers with significantly more choice and convenience (Bergantino *et al.*, 2015) (Beria *et al.*, 2019).

Second, the competition led to a significant reduction in average fares. Studies have estimated that the entry of NTV prompted an overall decrease in HSR prices of around 35%, driven by Trenitalia's reaction and the availability of more promotional and advance-purchase fares from both operators (Beria *et al.*, 2019). While Trenitalia generally maintained a price premium over its new rival, the competitive pressure prevented it from exercising monopoly pricing power (Bergantino *et al.*, 2015) (Beria *et al.*, 2019) (Affeldt, 2024).

Third, the rivalry has spurred a dynamic intermodal competition with airlines, particularly on the Rome-Milan route. The improved service frequency, reduced travel times (enabled by the completion of the HSR infrastructure), and lower fares caused a massive modal shift. The rail market share on this corridor surged from 36% before NTV's entry to 68% in 2012, while the airline's share plummeted from 51% to 26% (Bergantino *et al.*, 2015). This demonstrates that effective on-track competition can act as a powerful tool to enhance the railway's competitiveness against other modes (Bergantino *et al.*, 2015) (Bergantino *et al.*, 2018).

However, the Italian experience has not been without friction and regulatory challenges. NTV's entry was accompanied by numerous complaints to the Italian competition authority (AGCM) and the transport regulator (ART), alleging discriminatory behaviour by the FSI group (Beria *et al.*, 2016) (Bergantino *et al.*, 2015). These complaints ranged from claims of unfair track access charges and slot allocation by RFI to accusations of predatory pricing by Trenitalia (Beria *et al.*, 2016) (Bergantino *et al.*, 2015) . While the AGCM ultimately cleared Trenitalia of predatory pricing, these disputes underscore the critical role of a strong, independent regulator in mediating conflicts and ensuring a level playing field in a market with a powerful, state-owned incumbent (Beria *et al.*, 2016) (Desmaris e Croccolo, 2018). The establishment of the Autorità di Regolazione dei Trasporti (ART) in 2013 was a crucial step in strengthening this regulatory oversight (Beria *et al.*, 2016) (Desmaris e Croccolo, 2018).

The Italian model offers a powerful testament to the potential benefits of open access competition in invigorating a railway market. It demonstrates that a well-capitalised and innovative new entrant can successfully challenge a state-owned incumbent, leading to increased supply, lower prices, greater consumer choice, and a stronger competitive position for the rail sector as a whole. For Portugal, the Italian case highlights the importance of a completed, high-quality infrastructure as a prerequisite for such competition and reinforces the indispensable need for a robust and proactive regulatory authority to manage the complex dynamics between new entrants and established incumbents.

United Kingdom

The United Kingdom's experience with railway reform represents the most radical and ideologically driven departure from the state-owned monopoly model seen anywhere in the world (Boodoo, 2002) (Solina *et al.*, 2021). In the mid-1990s, the British government embarked on a comprehensive privatisation and vertical separation of its national railway, British Rail (BR), a process that went far beyond the requirements of emerging European Union directives (Szekely, 2009) (Crozet, 2017) (Louis, 2004). This bold experiment, which sought to introduce market forces into nearly every facet of the railway system, has created a complex and constantly evolving landscape. Its journey - marked by initial turmoil, significant traffic growth, spiralling public costs, and ongoing structural adjustments - offers a profound and often cautionary set of lessons for any nation, including Portugal, seeking to understand the extreme end of the railway reform spectrum (Kumara e Bandara, 2021) (Deville e Verduyn, 2012).

The intellectual foundation for the British privatisation was a belief that competition, both for the market and in the market, was the key to reversing decades of perceived inefficiency and underperformance

under state ownership. The chosen model was one of complete fragmentation. In a process that took place between 1994 and 1997, the vertically integrated British Rail was broken up into more than one hundred separate private companies (Comission, 2019). The core of this new structure consisted of three distinct types of entities:

- Railtrack: A single, privately owned, for-profit company was created to own and manage the entirety of the national rail infrastructure, including tracks, signals, and stations. Railtrack's revenue was to come from access charges levied on the train operators.
- Rolling Stock Companies (ROSCOs): The entirety of British Rail's fleet of trains was sold to three private leasing companies. These ROSCOs would then lease the rolling stock to the train operators, creating a competitive market for train provision.
- Train Operating Companies (TOCs): The right to operate passenger services was divided into 25 regional and intercity franchises. These franchises were awarded to private companies through a competitive bidding process, typically for periods of 7 to 15 years. The freight operations of British Rail were sold off entirely as separate, commercially independent businesses.

This model was unique in its totality. While other countries pursued gradual liberalisation, the UK attempted a "big bang" transformation, replacing a public monopoly with a web of private contracts and market relationships, all overseen by newly created regulatory bodies like the Office of the Rail Regulator (ORR) and the Office of Passenger Rail Franchising (OPRAF).

The outcomes of this radical experiment have been complex and highly contested. On one hand, the post-privatisation era has witnessed a remarkable renaissance in rail usage. Passenger numbers have more than doubled since the mid-1990s, reversing a long-term decline and making the UK's railway one of the fastest-growing in Europe (Boodoo, 2002). Rail freight has also seen significant growth, capturing a greater share of the market from road transport. Proponents of the reform attribute this growth to the private sector's commercial focus, investment in new services, and responsiveness to passenger demand (Boodoo, 2002).

On the other hand, the model has been plagued by severe and persistent problems. The complete vertical separation between Railtrack and the multitude of TOCs created significant coordination failures and a misalignment of incentives (IRG-Rail, 2024) (Crozet, 2017). The complex contractual interface between the infrastructure manager and the operators proved cumbersome and adversarial (Deville e Verduyn, 2012). Railtrack, under pressure to deliver returns to its shareholders, was accused of underinvesting in maintenance and renewal, prioritising short-term profits over long-term network resilience (IRG-Rail, 2024). This culminated in a series of fatal accidents, most notably at Hatfield in 2000, which shattered public and political confidence in the privatised infrastructure model (Crozet, 2017).

The financial consequences have also been challenging. Contrary to the initial political objective of reducing the burden on the taxpayer, the cost of running the railway has soared (Louis, 2004). The privatised system has required significantly more public subsidy than British Rail did in its final years, calling into question the efficiency gains of the reform (Boodoo, 2002). In 2002, the financially collapsed Railtrack was effectively re-nationalised and replaced by Network Rail, a not-for-profit company owned by the state, marking a major reversal of the original privatisation policy.

Today, the UK system remains a complex hybrid. While passenger services continue to be operated by private TOCs under competitively awarded franchises (a model of competition for the market), true open-access competition in the market remains very limited (Louis, 2004). The structure continues to

evolve, with ongoing debates about reintegrating track and train operations at a regional level to overcome the coordination problems inherent in the initial fragmented design.

Sweden

No international comparison of railway organisation would be complete without a thorough analysis of Sweden, the nation widely regarded as the original pioneer of the modern European reform movement (Solina *et al.*, 2021) (Ait Ali e Eliasson, 2022) (Brose, 2015). Long before the European Union's first directives mandated change, Sweden embarked on a pragmatic and revolutionary reorganisation of its railway sector, driven not by ideology but by a pressing domestic fiscal crisis (Alexandersson e Rigas, 2013) (Kumara e Bandara, 2021) (Alexandersson e Hultén, 2008). The model it created, centred on a clean institutional vertical separation between infrastructure and operations, has served as a foundational blueprint for the EU's liberalisation scheme and offers a wealth of lessons on the long-term evolution of a deregulated railway market (ERFA, 2022) (Nash e Rivera-Trujillo, 2004). For Portugal, which also adopted a model of full vertical separation, the nearly four-decade Swedish journey provides an invaluable roadmap of the potential benefits, persistent challenges, and necessary evolutionary steps of such a structure.

The catalyst for Sweden's Bahnreform was the deteriorating financial situation of the state-owned monopoly, Statens Järnvägar (SJ), which by the 1980s required ever-increasing subsidies to maintain a network it could no longer afford to reinvest in (Alexandersson e Rigas, 2013) (Kumara e Bandara, 2021). The landmark Transport Policy Act of 1988 introduced a simple but radical concept: the railway should be organised like the road network (Alexandersson e Hultén, 2008). The state would take full responsibility for providing and maintaining the "road" (the railway infrastructure), while train operators would act as the "vehicles," paying to use the tracks. This led to the creation of two separate entities: Banverket, a new state authority to own and manage the infrastructure, and a restructured SJ to function purely as a train operating company (Cantos *et al.*, 2010) (Kumara e Bandara, 2021). This clean institutional split was the first of its kind in Europe and pre-dated the EU's Directive 91/440 by three years (ERFA, 2022).

A crucial and defining feature of the Swedish reform was what has been termed the "accidental deregulation" (Alexandersson e Rigas, 2013) (Alexandersson e Hultén, 2009) (Fröidh e Byström, 2013). The 1988 Act did not explicitly aim to create on-track competition (Alexandersson e Rigas, 2013) (Alexandersson e Hultén, 2008). However, in a concurrent move to save unprofitable regional lines from closure, the Act decentralised the financial and administrative responsibility for these services to regional County Public Transport Authorities (CPTAs) (Alexandersson e Rigas, 2013) (Alexandersson e Hultén, 2008) (Alexandersson e Hultén, 2009). Having been given the funding, the rolling stock, and a mandate to procure services, and with prior positive experience from tendering bus services, it became natural for these CPTAs to also put their regional rail services out to competitive tender (Alexandersson e Rigas, 2013) (Alexandersson e Hultén, 2008). This opened the door for the first new entrant, a private bus company named BK Buss (through its subsidiary BK Tåg), to win a contract in 1989 and begin operating in 1990, breaking SJ's decades-long monopoly (Alexandersson e Rigas, 2013).

From this unplanned beginning, the Swedish model evolved and deepened. Recognising the efficiency gains from tendering, the practice was expanded to cover inter-regional subsidised services in 1993 (Alexandersson e Rigas, 2013). In 2001, the system underwent a further horizontal disintegration, as the old SJ monolith was broken up into several specialised, state-owned companies: SJ AB for passenger services, Green Cargo for freight, Jernhusen for railway real estate, and EuroMaint for vehicle maintenance, among others (Alexandersson e Rigas, 2013) (Kumara e Bandara, 2021). This step was

crucial for creating a more transparent market of distinct players, preventing cross-subsidisation and ensuring that common facilities were available to all operators on non-discriminatory terms. Finally, mirroring the EU's own trajectory, the market was fully liberalised with the opening of freight services to open access competition in 1996, followed by a step-wise opening of all passenger services between 2009 and 2012 (Alexandersson e Rigas, 2013).

The results of this long-term reform have been significant. The model has been credited with a substantial increase in passenger traffic, which grew by over 70% in the two decades following the initial reform, while labour productivity also rose dramatically as traffic increased and employment in the sector was rationalised (Kurosaki e Alexandersson, 2018). The use of competitive tendering has generally been successful in controlling and often reducing the public subsidies required for regional services (Affeldt, 2024). The market is now mature, with a diverse range of public and private operators competing both for the market (in tendered services) and, to a lesser extent, in the market (on open access commercial routes) (Alexandersson e Rigas, 2013) (Kirchner e Services, 2011).

However, the Swedish experience is not an unqualified success story, and it highlights several enduring challenges of a fully separated model. First, the clean separation has created significant coordination challenges and transaction costs between the infrastructure manager (now Trafikverket) and the numerous operators (Alexandersson *et al.*, 2023) (Alexandersson e Rigas, 2013). Aligning long-term infrastructure planning with the commercial needs of operators, and managing day-to-day track access and maintenance scheduling in a congested network, has proven complex and costly (Affeldt, 2024). Second, the system is highly dependent on public funding. Track access charges are intentionally set low - well below full cost recovery levels - to keep rail competitive with other modes, meaning the infrastructure manager relies heavily on direct state funding for investment and maintenance (Brose, 2015). While this policy choice has boosted traffic, it makes the system's long-term health vulnerable to the shifting political priorities of the state budget (Alexandersson e Rigas, 2013).

For Portugal, the Swedish model offers several critical lessons. It demonstrates that full vertical separation can be a viable and effective foundation for a competitive and growing railway market. It highlights the power of competitive tendering as a tool for managing public service contracts efficiently. Most importantly, it reveals that reform is not a single event but a long-term process of evolution and adaptation. The Swedish experience underscores the absolute necessity of a strong, independent regulator (Transportstyrelsen) and a stable, long-term commitment to public funding for infrastructure to make a separated system work effectively and sustainably over the long run (Alexandersson e Rigas, 2013) (Affeldt, 2024).

AUSTRALIA AND NEW ZEALAND

The railway reform experiences of Australia and New Zealand offer a particularly compelling and contrasting case study. Driven by a shared political and economic philosophy of market liberalisation that swept through both nations in the late 20th century, they embarked on ambitious privatisation programmes that were among the most extensive in the world (Williams *et al.*, 2005). Yet, despite their common starting point, the divergent paths they took - and the profoundly different outcomes they achieved - provide a crucial set of lessons on the complexities of privatisation, the critical importance of freight, and the enduring role of the state as the ultimate guarantor of a national railway network.

Australia's journey began from a position of deep structural fragmentation. For most of its history, the Australian railway industry was not a single system but a collection of independent, state-based, and vertically integrated government monopolies (IBRD, 2017). These networks were built to serve colonial

(and later, state) priorities, primarily linking the interior to coastal ports, with little consideration for creating a national network (Williams *et al.*, 2005). This legacy was most evident in the infamous "break of gauge" problem, with three different track gauges common across the country, creating a system that was inherently inefficient for interstate transport (IBRD, 2017). By the late 1980s, these state railways were struggling to compete with an increasingly efficient road transport sector, setting the stage for radical reform (Williams *et al.*, 2005).

The Australian reform strategy, propelled by a national competition policy in the 1990s, was multifaceted but centred on two key pillars: the privatisation of freight operations and the vertical separation of infrastructure (IBRD, 2017). Unlike the UK's "big bang," the process was more staggered, with state and federal governments progressively selling off their freight businesses (such as Australian National, Westrail Freight, and FreightCorp) to private operators between 1997 and 2002 (Williams *et al.*, 2005). Concurrently, open access was introduced, and new state-owned track authorities were created, most notably the Australian Rail Track Corporation (ARTC), which was established to manage the interstate standard-gauge network and ensure non-discriminatory access for all operators (Williams *et al.*, 2005) (IBRD, 2017).

The results of the Australian reforms have been widely regarded as a qualified success, particularly for the freight sector. Privatisation spurred a much-needed consolidation of the industry, as a myriad of state-based entities were absorbed into a few major national carriers, such as Pacific National and Australian Railroad Group (Williams *et al.*, 2005). This created significant economies of scale and allowed rail to compete aggressively for a greater role in the national logistics market, integrating seamlessly into broader supply chains managed by logistics and shipping companies (Williams *et al.*, 2005). Today, Australia's unique structure is a highly heterogeneous mix of public infrastructure owners and private freight operators, a model that has proven durable and commercially dynamic (Vendramini *et al.*, 2020) (Laurino *et al.*, 2015). However, the reforms have not been a panacea; privatisation could not overcome the inherently poor economics of some low-density regional lines, where governments inevitably remain the funder of last resort (Williams *et al.*, 2005).

In stark contrast, New Zealand pursued a more absolute and ideologically pure form of privatisation. After a period of aggressive, state-led corporatisation and efficiency drives in the 1980s, the government decided in 1993 to sell the entire railway system - New Zealand Rail Ltd - as a single, vertically integrated entity (Williams *et al.*, 2005). The entire operation, including freight, passenger services, the vital inter-island ferries, and all infrastructure assets (via a long-term lease of the land), was sold in a competitive trade sale to a consortium led by the US railroad Wisconsin Central. To maximise the sale price, the conditions imposed on the new owner were minimal, with no explicit access provisions, creating a private monopoly that faced competition only from road and sea transport (Williams *et al.*, 2005).

Initially, the privatisation appeared to be a resounding success. The new company, rebranded as Tranz Rail, continued to improve productivity, volumes, and revenues in its first few years (Williams *et al.*, 2005). However, this success proved to be a mirage. The private owners were widely accused of pursuing short-term profits at the expense of long-term sustainability, drastically underinvesting in the network and running down assets to a critical state (Williams *et al.*, 2005). This strategy led to what is often termed the "investment doom loop": a reluctance to invest in long-lived, specialised assets without long-term customer contracts, which in turn erodes service quality and drives customers away (Williams *et al.*, 2005). By the early 2000s, the infrastructure had deteriorated so significantly that the government was forced to intervene, first buying back the national network in 2004 and ultimately re-nationalising the entire rail operation in 2008, creating the current state-owned enterprise, KiwiRail (Vendramini *et al.*, 2020) (Lerida-Navarro *et al.*, 2019) (Merkert e Hensher, 2014).

Together, these two Oceania experiences offer a powerful set of lessons for Portugal. Australia demonstrates that a focus on privatising freight operations, combined with open access and a strong public role in infrastructure ownership, can create a vibrant and competitive market, especially where rail is integrated into larger logistics chains. New Zealand, conversely, serves as the ultimate cautionary tale. It vividly illustrates the profound risk of private under-investment in long-life infrastructure assets and underscores the non-negotiable need for government to retain strategic "step-in rights," because when a privatised railway fails, the state is almost always the owner of last resort (Williams *et al.*, 2005). The dramatic boom-and-bust cycle of Tranz Rail is perhaps the clearest evidence in the developed world that privatisation does not solve the fundamental economic challenges of running a railway.

JAPAN

The Japanese experience with railway reform presents a compelling and fundamentally different paradigm to the liberalisation models pursued across Europe and much of the Anglosphere (Mizutani e Nakamura, 2004). Driven by the catastrophic failure of its state-owned monopoly, Japan National Railways (JNR), the nation undertook a radical restructuring in 1987 that deliberately rejected the path of vertical separation that would later become European orthodoxy (Mizutani e Uranishi, 2013) (Boodoo, 2002) (Imahashi, 2000). Instead, it created a unique system founded on the principles of horizontal separation and vertical integration, a model whose remarkable success in revitalising passenger rail offers a powerful counter-narrative and a trove of invaluable lessons for Portugal (Perera e Shaja, 2023) (Boodoo, 2002).

To comprehend the logic of the Japanese reform, one must first grasp the scale of the crisis that preceded it. By the mid-1980s, JNR was a textbook case of a dysfunctional state-owned enterprise (Kurosaki, 2018) (Kurosaki, 2013) (Mizutani e Nakamura, 2004). It was crippled by staggering debts equivalent to the national debts of several developing countries, plagued by antagonistic and highly politicised labour relations, and constrained by deep-rooted political interference that forced it to build and operate unprofitable lines for electoral gain (Thompson, 2003) (Perera e Shaja, 2023). The organisation had become too large and bureaucratic to manage effectively, leading to a precipitous decline in its market share against road transport and a culture that was largely unresponsive to customer needs (Thompson, 2003) (Boodoo, 2002).

The solution, enacted in 1987, was not to unbundle infrastructure from operations, but to break up the unwieldy national monopoly itself (Thompson, 2003) (Perera e Shaja, 2023) (Kopicki *et al.*, 1995) (Kumara e Bandara, 2021). The core of the reform was the horizontal subdivision of JNR into six new regional passenger companies - JR Hokkaido, JR East, JR Central, JR West, JR Shikoku, and JR Kyushu - and a single, nationwide freight company, JR Freight (Perera e Shaja, 2023) (Kurosaki e OKUDA, 2013). Each of the new passenger "JRs" was established as a vertically integrated company, retaining full ownership and responsibility for both the infrastructure and the train operations within its defined geographical territory (Boodoo, 2002) (Huang *et al.*, 2019) (Kurosaki e OKUDA, 2013). This decision was a conscious departure from the emerging European trend and was deeply rooted in the Japanese context. It drew on the long and successful history of vertically integrated private railway companies that had prospered by developing extensive non-rail businesses, such as real estate and retail, which required control over the infrastructure (Van de Velde, 2013) (Imahashi, 2000). Furthermore, it was believed that vertical integration would avoid the significant coordination problems and transaction costs that were anticipated to arise from separating infrastructure from operations, particularly in a high-density network (Mizutani e Uranishi, 2013) (Van de Velde, 2013).

A second critical element was the strategic decision to insulate the new, commercially focused JR companies from the crippling legacy of the past (Thompson, 2003). This was achieved through the creation of the JNR Settlement Corporation, an intermediary government agency that absorbed the vast majority of JNR's long-term debt and its enormous surplus workforce (Thompson, 2003). This masterstroke allowed the new JRs to begin with clean balance sheets and a rationalised number of employees, freed from the historical burdens that had sunk their predecessor (Kopicki *et al.*, 1995). The privatisation process itself was gradual and pragmatic. Only the most profitable companies on the main island of Honshu (JR East, JR West, and JR Central) have been fully sold to the public through stock offerings, while the less profitable "Three-Island" companies and JR Freight remain under government ownership, supported by a Management Stabilisation Fund to ensure their viability (Thompson, 2003) (Kurosaki e OKUDA, 2013) (Kumara e Bandara, 2021).

The results of the JNR reform have been nothing short of transformative. Freed from political interference and empowered by a new commercial mandate, the JR companies spurred a dramatic increase in passenger traffic, reversing decades of decline (Kurosaki e OKUDA, 2013). Labour productivity soared by over 60% in the immediate aftermath of the reform (Thompson, 2003). The system as a whole transitioned from being a colossal drain on the national treasury to a net contributor through taxes paid by the profitable new companies (Thompson, 2003). This success was not solely structural; it was driven by a profound managerial and cultural shift. The new JRs fostered a relentless focus on customer needs, operational precision, and safety - a philosophy of continuous improvement, or kaizen, that has become a hallmark of the Japanese system (Van de Velde, 2013). This is evident in everything from their world-renowned punctuality, often measured in seconds rather than minutes, to their development of stations as vibrant commercial hubs, integrating retail, housing, and entertainment with transport - a synergistic model that vertical integration makes possible (Van de Velde, 2013).

For Portugal, the Japanese experience demonstrates that vertical integration is not an inherently flawed model, and can, in fact, be highly efficient in a high-density passenger market where the alignment of incentives between track and train is critical (Mizutani e Uranishi, 2013). It suggests that for an overly large and centralised state monopoly, a bold horizontal separation into smaller, more manageable regional entities can be a more effective path to revitalisation than simply unbundling its functions. Crucially, it highlights the importance of a clean break from legacy debts and liabilities as a prerequisite for the success of any newly created commercial entity. Finally, Japan provides a powerful example of how railways can thrive by becoming more than just transport providers, diversifying into related businesses to create new revenue streams and anchor themselves as central players in urban and regional development (Van de Velde, 2013) (Mizutani e Nakamura, 2004). This holistic, integrated, and commercially dynamic approach stands as a vital and compelling alternative for consideration in the future evolution of the Portuguese railway sector.

CANADA

The Canadian railway system offers a distinct and highly instructive model, one shaped not by the European Union's passenger-focused directives but by the unique geography and economic drivers of North America (Vendramini *et al.*, 2020) (Waters, 2007). Its evolution - from a competitive duopoly of public and private entities to a fully privatised, freight-dominant landscape - provides an essential counterpoint to the European experience. For Portugal, which has already privatised its freight operator and continues to grapple with the appropriate role of the state in its national railway, the Canadian journey offers critical lessons in the power of commercial discipline, the benefits of managerial

autonomy, and the complex process of successful privatisation (Vendramini *et al.*, 2020) (Kopicki *et al.*, 1995).

Historically, the Canadian railway industry was defined by a unique structural feature: a direct, head-to-head competition between a state-owned enterprise and a private corporation (Waters, 2007) (Kopicki *et al.*, 1995). On one side stood the Canadian Pacific Railway (CP), a powerful, privately-owned company forged in the 19th century to unite the nation. On the other was the Canadian National Railway (CN), a company created by the government between 1917 and 1923 through the consolidation of several bankrupt private railroads whose failure threatened the country's transport network (Vendramini *et al.*, 2020) (Kopicki *et al.*, 1995). For decades, these two giants competed across the vast expanse of Canada, creating a dynamic that was fundamentally different from the state monopolies prevalent in Europe.

A crucial lesson from this period is that state ownership is not an inherent barrier to efficiency, provided the right competitive conditions and managerial autonomy exist (Waters, 2007). Seminal economic studies from the pre-privatisation era, which compared the performance of CN and CP, found that the publicly owned CN often rivalled and sometimes even exceeded the productivity of its private competitor (Waters, 2007). This was attributed to the fact that CN was largely managed as a commercial entity with a high degree of autonomy, forced by the constant pressure from CP to innovate and control costs (Waters, 2007). This historical fact offers a powerful nuance to the standard narrative of inefficient state-owned enterprises and suggests that competition and commercial management are arguably more important drivers of performance than ownership per se.

Like its neighbour, the United States, Canada recognised early on that heavy-handed economic regulation was stifling the industry's ability to compete with the burgeoning road transport sector (Waters, 2007). The National Transportation Act of 1967, predating the famous US Staggers Act, began a process of deregulation by granting railways greater freedom in setting rates and negotiating contracts with shippers, allowing them to operate more commercially (Waters, 2007). This was further deepened by the 1987 National Transportation Act, which made it easier to abandon uneconomic branch lines and enhanced competitive access for shippers, pushing the railways further down the path of commercialisation (Kopicki *et al.*, 1995).

Despite these reforms and CN's relative efficiency, by the 1990s the global trend towards privatisation and the persistent need for state subsidies to cover losses - particularly on passenger services - led to the decision to fully privatise CN (Vendramini *et al.*, 2020) (Kopicki *et al.*, 1995). The privatisation of 1995 was a carefully planned affair, executed through a share-issue privatisation that transformed CN into a publicly traded company with multiple shareholders (Vendramini *et al.*, 2020). The results were immediate and dramatic. Freed from the constraints of the public purse and with direct access to capital markets, CN's capital expenditures surged by 33% in the first five years, and its debt-to-asset ratio significantly improved (Vendramini *et al.*, 2020).

The modern Canadian model is thus one defined by two major, vertically integrated, privately-owned, and highly efficient freight railways that dominate the national landscape (Vendramini *et al.*, 2020). Passenger services are a secondary concern, largely operated by a separate state-owned corporation, VIA Rail, which functions much like Amtrak in the US, paying access fees to run its trains over the freight companies' privately-owned tracks (Huang *et al.*, 2019) (Thompson e Kohon, 2012). The Canadian experience demonstrates that, for freight, the vertically integrated structure has proven exceptionally effective, allowing for tight coordination between infrastructure investment and operational needs, which is essential for running long, heavy, and efficient freight trains (Huang *et al.*, 2019).

For Portugal, the Canadian model offers several critical insights. First, it powerfully illustrates the benefits of instilling a commercial, competitive culture within a state-owned operator before considering privatisation, as was the case with CN. Second, it showcases a successful model for privatising a major state railway, highlighting the importance of a well-planned share issue to create a company with a broad ownership base and access to private capital (Vendramini *et al.*, 2020). Finally, and perhaps most importantly, it presents a clear and successful blueprint for a freight-dominant railway. For a country like Portugal, with major ports like Sines and a desire to increase the modal share of rail freight, the Canadian focus on operational efficiency, commercial freedom, and vertical integration in the freight sector provides a compelling and highly relevant example of how to build a world-class rail logistics system (Tomeš, 2017) (Nikitinas e Dailydka, 2016).

5
Portuguese context

Having extensively examined the diverse organisational models adopted across the world we now turn our focus inward to the specific case of Portugal. The history of the Portuguese railway sector offers a compelling narrative that is both representative of the broader European reform experience and marked by its own unique and instructive institutional choices (Kirchner e Services, 2011) (Cruz e Sarmento, 2017). Understanding this specific trajectory - from a traditional state monopoly, through a period of classic European-style vertical separation, to its more recent and unconventional horizontal merger of road and rail infrastructure - is the essential prerequisite for deriving meaningful and contextually relevant lessons for its future development.

For much of the 20th century, the Portuguese railway system mirrored the dominant European model: a vertically integrated state monolith, Comboios de Portugal (CP), which was responsible for both the operation of trains and the management of the national infrastructure (Kirchner e Services, 2011) (ERFA, 2022). Like its counterparts across the continent, this structure eventually succumbed to the pressures of mounting financial deficits and increasing competition from a rapidly expanding road network, creating a powerful impetus for fundamental reform by the 1990s (Cruz e Sarmento, 2017).

The catalyst for change was the twin force of domestic fiscal pressure and the overarching influence of the European Union's emerging liberalisation agenda (Laabsch e Sanner, 2012). In 1997, Portugal embarked on its own reform path, adopting a model of full institutional vertical separation that was, at the time, aligned with the more radical European approaches, such as that seen in Sweden. Through Decreto-Lei no 104/97, the state monolith was unbundled. The incumbent, CP, was redefined as a train operating company responsible for passenger and freight services, while a new, independent, state-owned company, Rede Ferroviária Nacional (REFER), was created to act as the national infrastructure manager. This foundational split was intended to create a transparent and non-discriminatory environment, laying the groundwork for the introduction of on-track competition as mandated by the EU (Kirchner e Services, 2011).

The subsequent decade saw a deepening of this legislative framework, meticulously transposing the EU's Railway Packages into national law. Decreto-Lei no 270/2003, later re-enacted and amended, solidified the legal structure, guaranteeing open access to the network and establishing the regulatory framework for access charges and capacity allocation (Kirchner e Services, 2011). Following the standard European progression, the market was opened first to freight competition, with Directive 2004/51/EC enabling both domestic and foreign operators to access the Portuguese network (Monsalve, 2012). This was later followed by the opening of international passenger services, in line with Directive 2007/58/EC, though Portugal, like many Member States, exercised its right to restrict cabotage, preventing international operators from competing on purely domestic legs of their journeys (Kirchner e Services, 2011).

This new legal structure did not remain a mere theoretical exercise; it catalysed the entry of new players into the market, fundamentally altering the competitive landscape. In the passenger sector, the most notable new entrant has been Fertagus, which, under a franchise agreement, began operating crucial suburban services across the River Tagus in the Lisbon metropolitan area, becoming the first and, for a long time, only external railway undertaking (RU) in the passenger market (Kirchner e Services, 2011). In the freight sector, the liberalisation had a more pronounced effect. New operators, most significantly Takargo, entered the market to compete with CP's freight division, CP Carga (Kirchner e Services, 2011). The state later advanced the reform by privatising its freight incumbent, which was acquired by the global shipping giant MSC in 2016 and rebranded as Medway, a move that has significantly influenced the shift in Portuguese rail freight from traditional bulk commodities towards rapidly growing intermodal traffic linked to the country's major ports at Sines and Leixões (ERFA, 2022).

However, the most distinctive and arguably most significant turn in Portugal's organisational history occurred in 2015. In a move that ran counter to the purely vertical focus of most railway reforms, the Portuguese government initiated a horizontal merger of its transport infrastructure managers. REFER, the rail infrastructure body, was merged with Estradas de Portugal, the national road agency, to create a single, multi-modal infrastructure company: Infraestruturas de Portugal (IP) (Cruz e Sarmento, 2017).

This decision was a pragmatic response to a unique set of national circumstances. For decades, Portugal had engaged in massive public and private investment in its road network, resulting in a system ranked among the best in the world for quality. The railway network, by contrast, had suffered from relative disinvestment, leading to a significant quality gap between the two modes (Cruz e Sarmento, 2017). Both legacy infrastructure companies were highly indebted and facing severe financial constraints. The rationale for the merger was therefore multifaceted: to capture operational synergies in areas like procurement and IT; to create a unified framework for transport planning to avoid overlapping and uncoordinated investments; and, most importantly, to transform the state's role from a builder of new infrastructure into a more efficient and financially sustainable manager of existing assets (Cruz e Sarmento, 2017).

Today, the Portuguese railway sector exists within this complex framework: a liberalised market with vertical separation between operations and infrastructure, but with that infrastructure now managed by a horizontally integrated road-rail entity. The market is overseen by a single transport regulator, the Autoridade da Mobilidade e dos Transportes (AMT), which actively polices the sector, evidenced by recent interventions concerning disputed access charges at the Port of Sines and its assessment of the economic equilibrium for new open-access entrants (Rail, 2025). Yet, challenges persist. The modal share for rail remains low for both passengers and freight, and the disparity in network quality continues to pose a significant challenge to increasing rail's competitiveness (Kirchner e Services, 2011). This intricate history - shaped by EU mandates, domestic policy choices, and unique structural innovations - provides the essential and rich context from which our final analysis and recommendations for the future of Portugal's railway sector will be drawn.

POSSIBLE PATHS

DO NOTHING

The first and perhaps most deceptively simple path forward for the Portuguese railway sector is that of inaction - to "do nothing." This approach does not imply a complete cessation of activity but rather a conscious policy decision to maintain the current organisational and regulatory status quo without further significant structural reform. This would mean preserving the existing model of full vertical

separation between operations and infrastructure, with the latter remaining embedded within the unique horizontally integrated road-rail entity, Infraestruturas de Portugal (IP). It would entail continuing to operate within the established legal framework, transposing EU directives as they evolve, and relying on the existing regulatory powers of the Autoridade da Mobilidade e dos Transportes (AMT) to oversee the market (Velde *et al.*, 2012). On the surface, this path has the allure of stability, avoiding the significant disruption, cost, and political capital required for another major reorganisation, a lesson painfully learned from the tumultuous reform experiences in countries like the United Kingdom. Proponents might argue that the current structure, particularly the novel IP merger of 2015, is still relatively young and needs more time to mature and for its intended synergies to be fully realised without the distraction of further change (IBRD, 2017) (Affeldt, 2024).

However, a deeper analysis, informed by the international case studies and the inherent challenges of railway organisation detailed in the provided literature, reveals that this path of inaction is fraught with significant risks and represents a profound missed opportunity for Portugal. To "do nothing" is to implicitly accept and perpetuate the deep-seated structural challenges that continue to constrain the railway's potential. The most critical of these is the persistent misalignment of objectives between the infrastructure manager (IM) and the railway undertakings (RUs) that operate on its network (Velde *et al.*, 2012). This is a fundamental pathology of vertically separated systems worldwide (Nakamura e Sakai, 2020). The IM, in this case IP, is driven by the need to manage and maintain its network cost-effectively, while the RUs, such as CP and Medway, are driven by the need to run punctual, frequent, and commercially viable services. This divergence inevitably creates conflict over crucial operational matters, including the scheduling of maintenance windows, the design of timetables, and the prioritisation of investments (Velde *et al.*, 2012). A "do nothing" approach fails to proactively address these coordination costs, which manifest as reduced network capacity, missed market opportunities, and ultimately, a higher total cost for the railway system as a whole (Nakamura e Sakai, 2020).

Furthermore, maintaining the status quo risks cementing the historical disparity in quality and investment between Portugal's world-class road network and its rail counterpart (Kurosaki, 2008). While the horizontal integration within IP was intended to foster more coordinated intermodal planning, a passive approach could see this vision unrealised, with the two modes continuing to develop along separate, and unequal, paths (Affeldt, 2024). Without a proactive strategy to leverage the integrated structure to prioritise rail investment and enhance its competitiveness, the railway risks becoming increasingly marginalised, unable to effectively contribute to national goals of decarbonisation and relieving road congestion - goals where rail holds a significant intrinsic environmental advantage over road transport (Dutta, 2022).

The "do nothing" option fails to confront the institutional inertia that can afflict state-owned enterprises. While the market has been liberalised, key players like CP and IP remain state-owned, making them susceptible to the classic challenges of public corporations, including vague objectives, potential for political interference, and a lack of strong commercial incentives that can lead to operational inefficiencies and a failure to innovate (IBRD, 2017) (Kurosaki, 2008). A passive strategy foregoes the opportunity to introduce new governance models or performance incentives that could drive these entities to become more dynamic and customer focused. In essence, choosing inaction is a high-risk strategy of managed decline or, at best, stagnation. It is a decision to accept a suboptimal equilibrium, leaving the Portuguese railway sector unable to overcome its historical handicaps and preventing it from fulfilling its potential as a modern, competitive, and vital component of the nation's transport system.

INTRODUCING COMPETITION

A second and more proactive path for Portugal involves a deliberate strategy to deepen and intensify competition within its already liberalised railway market. This approach acknowledges that while the legal groundwork for competition has been laid, its full potential to drive efficiency, innovation, and customer value remains largely untapped (Bordie *et al.*, 2014). A strategy of managed competition would move beyond the current state, where a single private franchisee, Fertagus, operates in a specific niche and a single major private freight operator, Medway, competes with the incumbent's legacy operations (Merkert e Hensher, 2014). It would involve actively using the two primary mechanisms for fostering railway rivalry observed across Europe: competition for the market through competitive tendering, and competition in the market through open access (Fitzová, 2017) (Affeldt, 2024).

The first avenue, expanding **competition for the market**, would entail a fundamental shift in how Portugal's Public Service Obligation (PSO) passenger services are procured. Currently, these services, which form the backbone of the national network outside the main corridors, are operated by the state-owned incumbent, Comboios de Portugal (CP), through a direct award contract. Following the model adopted extensively in Sweden, Germany, and the United Kingdom, this path would involve breaking these services into logical, geographically or operationally coherent bundles and awarding them to operators through a competitive tendering process (Alexandersson e Hultén, 2008). This approach harnesses market forces not on the track itself, but in the bidding process to run the services. International experience suggests that this can lead to significant benefits, including reductions in the public subsidy required per passenger and pressure on operators to innovate in service delivery and cost management to win bids (Alexandersson e Hultén, 2009). The Swedish experience, for example, demonstrated that decentralising and tendering unprofitable regional lines often led to their revival and better coordination with local transport networks (Alexandersson e Hultén, 2008). However, this path is not without significant challenges. It demands a high level of regulatory capacity from the state, which must be able to specify complex franchise contracts in minute detail, defining service levels, timetables, rolling stock requirements, and fare structures to protect the public interest. The UK's difficult early experiences with franchising highlight the risks of poor contract design and the potential for franchisee failure, underscoring the need for careful and expert management of the tendering process (Kelemen-Erdős, 2011) (Jandová e Paleta, 2019).

The second, parallel avenue is to foster greater **competition in the market**, particularly on commercially viable routes. This 'open access' model would allow new, private operators to enter the market and run services in direct, head-on competition with the incumbent CP, funding their operations entirely from farebox revenue (Fitzová, 2017) (Knorr e Eisenkopf, 2022) (Affeldt, 2024). For Portugal, the most obvious and attractive candidate for such competition is the core Lisbon-Porto corridor, especially with the planned development of a dedicated high-speed line. The lessons from Italy are profoundly relevant here. The entry of the private operator NTV onto Italy's high-speed network did not simply win market share; it dramatically expanded the entire market, forcing the incumbent Trenitalia to lower fares, increase frequencies, and improve service quality, resulting in a massive modal shift from air to rail (Montero *et al.*, 2016) (Cascetta e Coppola, 2015). A similar outcome in Portugal could revolutionise intercity travel, enhance the railway's competitiveness against road and air, and deliver substantial benefits to consumers.

This path, however, carries its own set of significant risks that require proactive regulatory management. The foremost of these is the problem of "cherry-picking," where new entrants are naturally drawn only to the most profitable routes, leaving the incumbent to serve the less profitable or loss-making parts of the network without the benefit of cross-subsidies from its former cash-cow lines (Jandová e Paleta, 2019). This can place immense financial strain on the incumbent and, if not managed, could lead to a

degradation or withdrawal of services on other routes, as was observed in the Czech Republic (European University Institute: Robert Schuman Centre for Advanced *et al.*, 2016). Therefore, a successful open access policy is not a laissez-faire policy. It requires a strong and vigilant regulator - in this case, the AMT - to ensure that competition is fair and does not destabilise the wider network (Fitzová, 2017).

Ultimately, neither of these competitive paths can succeed in a vacuum. Their viability is contingent on a robust enabling framework. This requires, first and foremost, fair and non-discriminatory access to the essential facilities of the network - the tracks, stations, and maintenance depots managed by Infraestruturas de Portugal (OECD, 2002) (Nash, 2005). The design of track access charges becomes a critical regulatory lever; charges set too high will deter new entrants, while those set too low could compromise IP's ability to adequately fund network maintenance and renewal, a challenge that has plagued the German system (Kurosaki, 2008) (Nash e Rivera-Trujillo, 2004) (Laroche e Lamatkhanova, 2022). Second, the success of competition, particularly on the Lisbon-Porto corridor, is intrinsically linked to the quality of the infrastructure itself. The Italian HSR success story was built upon a new, world-class infrastructure that allowed for a step-change in speed and reliability (Knorr e Eisenkopf, 2022). For Portugal, this means the timely completion of the planned HSR line is not merely an infrastructure project but an essential prerequisite for unlocking the full benefits of market competition (Jandová e Paleta, 2019).

A path of managed competition offers Portugal the most promising route to a more efficient and customer-focused railway. This is not a binary choice between franchising and open access but rather the potential for a hybrid system, using competitive tendering to secure efficient delivery of socially necessary services and open access to drive innovation and value on the core commercial arteries. This path demands a sophisticated and proactive role for the state, not as a direct operator, but as a strategic architect and vigilant referee of a competitive market, ensuring that the rivalry it unleashes serves the long-term health and development of the entire national transport system.

Privatization of the national operator

A third and far more radical path for Portugal would be the outright privatisation of its national passenger operator, Comboios de Portugal (CP). This would represent a fundamental ideological shift, moving beyond the introduction of competition to a full transference of the incumbent's ownership from the public to the private sector. Such a move is predicated on the belief that only the full discipline of the private market - with its profit motive, exposure to risk, and commercial focus - can definitively break the cycle of inefficiency, political interference, and reliance on state finances that has often characterised state-owned railways (Mizutani e Nakamura, 2004) (Thompson, 2003) (Campos e Sánchez, 1999). The lessons from countries that have walked this path, including Japan, Canada, Australia, and the United Kingdom, offer a complex tapestry of profound successes and cautionary failures, providing an essential guide for evaluating this high-stakes option for the Portuguese context (Mizutani e Nakamura, 2004) (Williams *et al.*, 2005) (IBRD, 2017).

The core argument for privatising CP is to unleash its commercial potential by severing it from the constraints of state ownership (Thompson, 2003). A private operator, accountable to shareholders rather than a government ministry, would be incentivised to maximise efficiency, aggressively pursue new markets, innovate in its service offerings, and manage its costs with a rigour that is often difficult to achieve within a public sector culture (Thompson, 2003) (Campos, 2001). International experience suggests that private management often leads to significant improvements in productivity and a more customer-centric approach (Williams *et al.*, 2005) (Thompson, 2003). Furthermore, a privatised CP could access private capital markets to fund essential investments, such as the renewal of its rolling

stock fleet, without directly competing for scarce funds from the state budget - a crucial advantage in a country facing fiscal constraints (Kopicki *et al.*, 1995) (IBRD, 2017). The successful privatisation and subsequent commercial performance of Canadian National (CN) and the US freight railroad Conrail stand as powerful examples of how formerly state-owned entities can be transformed into highly efficient and profitable private enterprises (IBRD, 2017).

The process of privatisation itself offers several avenues, each with its own strategic implications. One route is a trade sale to a strategic investor, such as a major international transport group (Williams *et al.*, 2005). This can bring in valuable external expertise and operational best-practices. A second route, employed in the privatisations of CN and Japan's most successful successor companies (JR East, West, and Central), is an Initial Public Offering (IPO), selling shares to the public and institutional investors (Mizutani e Nakamura, 2004) (Kopicki *et al.*, 1995) (IBRD, 2017). The Japanese experience is particularly instructive, demonstrating a gradual, step-by-step privatisation process where the state holding company retained ownership until the new companies had proven their profitability and were attractive enough for a successful public stock offering (Mizutani e Nakamura, 2004). This phased approach suggests that a successful privatisation of CP would likely require a preparatory period of internal restructuring to make it a commercially viable and attractive asset for private investment.

However, this path is laden with profound risks and complex trade-offs that must be carefully navigated. The most fundamental challenge is reconciling the private sector's profit motive with the railway's role as a provider of a public service. A privatised CP would have a fiduciary duty to its shareholders, which could lead it to reduce or eliminate services on less profitable regional and rural lines, or to raise fares on its most popular routes to maximise revenue (Thompson, 2003). This could undermine national objectives of social cohesion and regional accessibility (Kopicki *et al.*, 1995) (Campos e Sánchez, 1999).

Consequently, the privatisation of an operator like CP cannot occur in a vacuum; it must be intricately woven into a robust framework of Public Service Obligation (PSO) contracts (Williams *et al.*, 2005) (Thompson, 2003). The state would no longer own the operator, but it would have to become a highly sophisticated purchaser of services, using competitively tendered franchise agreements or negotiated contracts to secure the provision of socially necessary but commercially unviable routes (Williams *et al.*, 2005). The British model of franchising passenger services to private operators is the quintessential example of this, but its history of franchisee failures and renegotiations serves as a stark warning of the contractual complexity and regulatory oversight required (ERFA, 2022).

Furthermore, privatisation in the absence of effective competition risks simply replacing a public monopoly with a less accountable private one (Estache *et al.*, 2001) (Kogueda *et al.*, 2025). A privatised CP could use its dominant market position to stifle new entrants and exploit consumers. Therefore, a successful privatisation strategy is contingent upon, and must be preceded by, the establishment of a truly competitive market and the empowerment of a strong, independent regulator like the AMT, which would need enhanced powers to police anti-competitive behaviour, regulate fares where necessary, and ensure fair network access (Estache *et al.*, 2001).

The experience of New Zealand offers the most potent cautionary tale. The initial privatisation of New Zealand Rail was hailed as a success, with traffic and profits increasing. However, this was not sustained; the private owner was accused of underinvesting in the network to extract profits, leading to a deterioration of the infrastructure to the point where the government was forced to take it back into public ownership (Williams *et al.*, 2005). This highlights a critical lesson: the short-term financial logic of a private operator may not align with the long-term investment horizons required for maintaining railway infrastructure and assets, a problem that demands vigilant regulatory oversight (Williams *et al.*, 2005).

The privatisation of Comboios de Portugal is a high-risk, high-reward strategy that should be approached with extreme caution. It offers the potential for a transformative injection of commercial discipline and private capital but introduces significant risks to service continuity and affordability, while demanding a far more sophisticated and powerful regulatory role for the state. For Portugal, it would mean trading the known challenges of managing a state-owned enterprise for the complex and arguably more difficult task of regulating a web of private contracts and market players. The decision hinges on a national judgment of whether the potential efficiencies to be gained are worth the immense challenge and inherent risks of placing a core public service in private hands.

Rolling stock leasing companies (ROSCOs) and Asset Separation

Beyond the fundamental vertical separation of infrastructure and operations, a more granular and highly consequential reform path lies in the separation of another critical asset: the rolling stock itself. This involves creating a market structure where the ownership of locomotives and carriages is unbundled from the responsibility of operating train services. The most prominent and influential model for achieving this is the creation of Rolling Stock Leasing Companies (ROSCOs), a mechanism that, while pioneered in the United Kingdom, offers profound and adaptable lessons for any nation, including Portugal, that seeks to deepen market competition and attract new investment into its railway sector (Louis, 2004) (Kopicki *et al.*, 1995) (Finger e Messulam, 2015a).

The core rationale for creating a ROSCO model stems from a fundamental economic mismatch inherent in a liberalised railway market, particularly one that uses franchising or concessions. Train operating contracts are typically awarded for relatively short periods - often 5 to 15 years - to allow for periodic competition and regulatory oversight. Rolling stock, however, is a very long-lived asset, with a typical economic life of 30 years or more (Louis, 2004) (IBRD, 2017). This creates a major barrier to entry: it is unreasonable and commercially unviable to expect a company bidding for a ten-year franchise to make a thirty-year investment in a fleet of new trains (Kopicki *et al.*, 1995). A dedicated leasing market, therefore, is not merely an optional extra but can be an essential enabler of competition, allowing new operators to enter the market by leasing their primary assets rather than purchasing them outright (Campos e Sánchez, 1999) (Finger e Messulam, 2015a).

The British privatisation of the 1990s provides the quintessential, if controversial, case study. As part of its radical restructuring, the government sold the entirety of British Rail's passenger fleet to three newly created, private ROSCOs: Porterbrook, Angel Trains, and Eversholt (Kurosaki, 2008) (White, 1998). These companies were then tasked with leasing this stock back to the 25 new private Train Operating Companies (TOCs) (Thompson, 2003) (Louis, 2004). The stated objective was to create a competitive and liquid market for rolling stock, facilitate the smooth transfer of assets between franchises at the end of a contract period, and allow specialist companies to focus on the efficient management and financing of these long-term assets (Kopicki *et al.*, 1995). In many respects, the model has been successful in these aims. It has facilitated a massive wave of private investment in new trains - the largest in British history - dramatically reducing the average age of the fleet and introducing modern technology (Louis, 2004).

However, the British experience also serves as a powerful cautionary tale about the model's potential pitfalls. The initial privatisation of the ROSCOs was widely criticised for selling public assets too cheaply, allowing the first wave of investors to make substantial and rapid profits when they sold the companies on, a political controversy that damaged public acceptance of the wider reform programme (Louis, 2004). Furthermore, rather than creating a truly vibrant and competitive market, the initial structure established a powerful oligopoly of just three firms, raising persistent concerns about their market power and the fairness of their leasing prices, which have been subject to scrutiny by the

competition authorities (Yvrande-Billon e Menard, 2005). There have also been critiques regarding technical misalignments, with accusations that the ROSCOs, in pursuing standardised, less specific assets to maximise their leasing potential, sometimes ordered rolling stock that was not optimally designed for the unique conditions of the British infrastructure (Louis, 2004).

The concept, however, is not exclusively British nor inherently private. In Sweden, a similar logic was applied to lower barriers to entry, but ownership of rolling stock was often transferred to public entities, such as regional transport authorities, which would then lease the assets to the winning bidder of a tendered service contract (Kurosaki, 2008). Other countries, like Germany and Australia, have seen the organic development of a rolling stock leasing industry in response to the demands of a liberalised market, where both new entrants and incumbents see value in leasing rather than owning assets (Kurosaki, 2008).

For Portugal, considering a ROSCO-style model opens a strategic pathway directly linked to the options of managed competition and privatisation. The current structure, where CP largely owns its own legacy fleet, presents a formidable hurdle for any potential competitor. A new operator wishing to bid for a regional franchise or launch an open-access service on the Lisbon-Porto corridor would be at a massive disadvantage if it first had to procure its own fleet of trains (Company).

Introducing a leasing model in Portugal could take several forms, learning directly from the British and Swedish experiences. One option would be to carve out CP's existing fleet into a new, state-owned ROSCO. This "Public ROSCO" could be mandated to offer rolling stock on fair and non-discriminatory terms to all licensed operators, including a restructured CP and any new private entrants. This would achieve the primary goal of lowering entry barriers without courting the political controversy of private profiteering that plagued the UK model. Such an entity could also be tasked with leading a national fleet renewal strategy, using its scale and public backing to access financing for new, modern trains on favourable terms, thus taking this significant investment burden off both the state budget and the operator's balance sheet (IBRD, 2017).

This path is not a panacea. It introduces another layer of contractual complexity into the railway system and would require vigilant regulation by the AMT to ensure the leasing terms offered by the new entity are genuinely fair and transparent (Louis, 2004) (Yvrande-Billon e Menard, 2005). However, it represents a pragmatic and powerful tool. By separating the ownership of trains from their operation, Portugal could create the necessary conditions for a more dynamic and competitive railway market, accelerating investment in modern rolling stock and making the prospect of new services - whether franchised or open access - a far more tangible and achievable reality.

6
Conclusion

PRINCIPAL CONCLUSIONS

Having critically examined the varied models of railway organization around the globe - spanning vertically integrated systems, fully liberalised markets, hybrid holding structures, and fragmented privatized regimes - it is clear that no universal solution can be applied blindly across national contexts. However, some principles consistently emerge from international experience. First, structure matters: whether a system is vertically integrated or separated has profound implications for efficiency, coordination, pricing behaviour, and investment. Yet structure is not destiny. What defines success is how the structure is implemented, governed, and adapted to context-specific realities such as traffic density, regulatory capacity, and fiscal constraints.

Portugal's adoption of institutional vertical separation and compliance with EU directives has modernised the sector's legal framework, but it remains a largely symbolic liberalisation with little competitive traction. The continued dominance of Comboios de Portugal (CP) in the passenger sector and the monopolistic position of Infraestruturas de Portugal in infrastructure management reflect a quasi-monopolistic-market where formal separation has not produced meaningful contestability or service differentiation. The reform of CP Carga and its transformation into Medway shows that, under the right conditions, privatisation can enhance efficiency, particularly in freight. Yet the broader system suffers from underinvestment, limited modal share, and misaligned incentives between infrastructure management and operations.

Critically, the empirical literature on train density and vertical structure demonstrates that Portugal - given its moderate-to-low density and limited congestion (except on the northern line) - could benefit from a well-designed, vertically separated model, if regulatory and institutional coordination are strengthened. The country's horizontal merger of road and rail infrastructure managers remains a bold but underutilized reform, whose potential to achieve intermodal integration and funding parity has not been fully realised.

FUTURE DEVELOPMENTS

Looking forward, Portugal has several strategic paths it can pursue. First, it must move from structural reform to functional transformation. This means actively introducing competition in public service obligations through competitive tendering and enabling open access on high-potential corridors like Lisbon-Porto, particularly with the upcoming high-speed line. The Italian experience offers a compelling blueprint here, where head-on competition in high-speed rail significantly improved service quality, affordability, and modal shift.

To support new entrants, Portugal should consider establishing a rolling stock leasing company - public, private, or hybrid - to reduce one of the most formidable barriers to competition. This would align with models in the UK and Sweden, where ROSCOs facilitated dynamic market entry and helped diversify service offerings.

Moreover, regulatory reinforcement is indispensable. The Autoridade da Mobilidade e dos Transportes (AMT) must be equipped not just with formal authority but with technical resources, autonomy, and a clear mandate to oversee track access charges, monitor potential discrimination by incumbents, and safeguard the economic equilibrium of public service contracts.

Finally, Portugal must integrate its rail strategy into a broader transport and decarbonisation agenda. The railway's future lies not only in internal efficiency but in its role as a backbone of sustainable mobility, logistics chains, and territorial cohesion. This demands long-term, multi-sectoral investment planning aligned with climate targets and EU funding frameworks.

LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

While this dissertation draws extensively on international case studies and economic theory, it faces inherent limitations. First, the comparative approach necessarily abstracts from important cultural, political, and legal differences that affect policy outcomes. For example, Japan's vertical integration success cannot be replicated without understanding its embedded culture of operational excellence and urban density, just as Germany's holding model functions within a context of strong federal regulation and long-standing industrial competence.

Second, the Portuguese context is evolving, and the data landscape - particularly on the operational performance and financial sustainability of key entities like IP and CP - is often opaque or fragmented. This limits the ability to make fully data-driven comparisons or cost-benefit analyses of alternative organizational models.

Lastly, some recommendations, such as the introduction of a rolling stock leasing market or full open access on core routes, presume a level of political will and administrative capacity that may not exist in the short term. The implementation of structural reform, especially in a state-centric system, is not a technocratic act but a political negotiation - an element that lies beyond the analytical reach of this dissertation but is crucial to any real-world change.

In sum, Portugal's railway future cannot be built on inertia or ideology. It requires strategic learning from abroad, courageous policy experimentation at home, and a sustained commitment to embedding rail within a national vision of sustainable, competitive, and inclusive mobility. The lessons are clear. What remains is the will to apply them.

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