
What is the scale of public subsidies received by rail passenger operators in Europe, and how has this public support evolved across different European countries between 2016 and 2022 ?

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WHAT IS THE SCALE OF PUBLIC SUBSIDIES RECEIVED BY RAIL PASSENGER OPERATORS IN EUROPE, AND HOW HAS THIS PUBLIC SUPPORT EVOLVED ACROSS DIFFERENT EUROPEAN COUNTRIES BETWEEN 2016 AND 2022 ?

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2 List of abbreviations / Glossary

AT Austria

BE Belgium

BG Bulgaria

HR Croatia

CZ Czech Republic

DK Denmark

EE Estonia

ERA European Union Agency for Railways

EU European Union

FI Finland

FR France

DE Germany

GR Greece

HU Hungary

IE Ireland

IT Italy

LV Latvia

LT Lithuania

LU Luxembourg

NL Netherlands

PL Poland

PSO Public Service Obligation

PT Portugal

RO Romania

SK Slovakia

SI Slovenia

TAC Track Access Charge

ES Spain

SE Sweden

UK United Kingdom

3 Introduction

The European railway market is undergoing a significant transformation towards full liberalization. Since the enactment of the First Railway Package by the European Parliament and the Council in 2001, the process of liberalizing the rail market has been gradual but steady across European countries. This comprehensive approach began with the liberalization of freight transport within the European Union and has since extended to passenger services. The Third Railway Package initiated the liberalization of international passenger transport, while the Fourth Railway Package addressed the national liberalization of passenger transport. Despite these advancements, the implementation of these directives and regulations varies significantly among European countries, with some nations having fully adopted the new frameworks and others encountering challenges in doing so.

Within the national passenger transport sector, services are categorized into two classes: commercial lines, which operate without the need for subsidies, and public service lines, which rely on financial support from the public sector. Each of these classes has its own model of competition. Commercial lines operate under an open-access model, allowing multiple operators to compete on the same tracks. In contrast, public service lines are subject to franchising or direct attribution models, where specific operators are granted the exclusive right to operate particular routes, often in exchange for subsidies to ensure service provision.

This thesis seeks to explore the extent of public subsidies received by passenger rail operators across Europe and to examine the evolution of this financial support in different European countries. The primary objective is to calculate the subsidy per passenger-kilometer, a standardized metric for evaluating the output and efficiency of rail services, in various European contexts. By employing this metric, the research aims to provide a comprehensive understanding of the financial support allocated to the rail passenger transport sector and its implications for the performance and competitiveness of passenger rail operators over time.

The research question guiding this thesis is: What is the scale of public subsidies received by rail passenger operators in Europe, and how has this public support evolved across different European countries between 2016 and 2022? This question aims to address not only the quantitative aspect of subsidies but also their qualitative impact on the rail market. Through a detailed analysis, this study will contribute to the ongoing discourse on the effectiveness of public subsidies in enhancing the rail sector's efficiency and competitiveness in Europe.

To address this research question and effectively structure this thesis, the following outline will be adopted: a literature review will firstly be presented, summarizing various conclusions on public support for passenger railway operators. Next, the organization of the railway sector in Europe will be detailed to provide a comprehensive understanding of the current situation. This will be followed by an explanation of the estimation of the data and of the methodology. Subsequently, the findings for each European country and group, as defined by the methodology, will be discussed. Finally, the thesis will conclude with a summary of the key insights and implications of the research.

4 Literature review

The provision of public support to the passenger railway market has not been a subject of extensive scholarly inquires and policy analysis. As European countries strive to enhance the efficiency, accessibility, and sustainability of their railway networks, understanding the dynamics and impacts of public subsidies becomes increasingly crucial. This literature review aims to synthesize existing research on public support mechanisms for passenger railways, examining the various forms of subsidies, their allocation methods, and their outcomes on market performance. By exploring theoretical frameworks, empirical studies, and policy evaluations, this review provides a comprehensive overview of the current knowledge landscape. This context will facilitate a deeper understanding of how public support influences the competitiveness and service quality of passenger railway operators, setting the stage for the subsequent empirical analysis presented in this thesis.

To begin this literature review, it is essential to note that the liberalisation of the rail market has reshaped the way in which the public state distributes its support. The railway market highly depends on public subsidies (Crozet et al. (2023)). Every European country injects a considerable amount of public money into their national railway industries, mentioned Crössmann and Mause (2015). Still, according to Crössmann and Mause (2015), railway subsidies constituted approximately 40 percent of the total subsidies provided by EU member states in 2008, representing a significant allocation of public funds. Passenger public transport services have become a matter of public interest due to citizens' direct concerns and their indirect economic implications. Thus, authorities are tasked with establishing equitable legal frameworks that facilitate the subsidization and management of public transport services (Stojić et al. (2018)).

European countries do not provide public support in the same way. Gautier and Salem (2016) appraised that it is necessary to consider the diverse methods of offering public support when undertaking comparisons and analyses, as these approaches vary across European countries. For instance, the public support could be implicitly given, as in the United Kingdom before. Indeed, Bowman (2015) outlined the various challenges faced by the United Kingdom government in distributing public support to rail operators. An illustrative instance is the financing setback experienced by RailTrack, a private rail infrastructure company. Reliant on track access charges paid by train operating companies, their funding proved insufficient, leading RailTrack to declare bankruptcy within just two years. Consequently, Bowman (2015) underscores the necessity of public support for non-profitable companies, and even if rail companies are profitable, this profitability is largely supported by subsidies allocated to rail activities (Crössmann and Mause (2015)).

Nash et al. (2019) observed a trend toward reduced subsidies attributable to market liberalization. Bowman (2015) also demonstrated a decline in the subsidy provided to train operating companies as a percentage of passenger revenue in the United Kingdom. This trend could indicate either a movement towards reducing subsidies and achieving financial sustainability within the railway sector, or a decrease in the overall subsidies allocated to railway undertakings. According to Crozet et al. (2023), a decrease in subsidies per passenger-kilometer would indicate increased usage of services and reflect efficient allocation of funds to provide these services. Additionally, Nash et al. (2016) indicated that the subsidy per train-kilometer has decreased in Germany, the United Kingdom, and Sweden, a trend attributed to the liberalization of the market. Conversely, in France, the subsidy per train-kilometer has increased. Along the same line, Malay and Van Keirsbilck (2019)

noted that public subsidies allocated to the railway market have increased either as a result of liberalization or concurrently with it. Therefore, the effects of liberalization are uncertain, as are its implications for the allocation of subsidies.

In European legislation, public service obligation, or PSO, refers to a contract awarded by a competent authority (national, regional, or local) to a railway operator. This contract grants the operator a monopoly to provide specific public transport services for a designated period (Stanojević et al. (2021)). Stojić et al. (2018) emphasized that PSO systems serve as a model for financing unprofitable transport services of common interest within a geographic area. Ninety percent of services are operated under public service obligation contracts, making this the predominant practice in the market (CNMC (2019); Nash (2008)). Gleave (2016) also noted that two-thirds of all rail travel occurs on services contracted under PSO agreements. Berawi and Miraj (2023) underscored the significance of continuous government support through PSOs. The extent of this support varies among European countries. Thus, the prevalence of numerous PSO contracts in the market will result in heightened competition for these contracts, according to Nash et al. (2016).

There are two methods for awarding PSO contracts: through tender procedures or direct awards. Even if the regulation does not specify the optimal method for implementation (CER (2011)), the public tender procedure is preferable to direct awards or attributions (Gleave (2016); Harker et al. (2013)). Stanojević et al. (2021) mentioned that the tender procedure suggests a willingness to foster competition in the railway market and alleviate public finances, despite potential political unpopularity and challenges for the national railway operator. CNMC (2019) observed that the competitive tendering of PSO services has resulted in a reduction in subsidies provided to railway undertakings. These savings have been noted in countries such as Sweden and Germany. In contrast, direct awards reflect a reluctance to introduce competition, often resulting in lower service quality for passengers and ongoing financial pressure on public funds. Nevertheless, according to Dolinayova and Domyeny (2022), it can not be confirmed that public tenders significantly enhance the efficiency of public spending compared to direct awards; this conclusion resulted from their study done in the Czech Republic, Poland, Hungary, and Slovakia. Stanojević et al. (2021) also observed that the majority of European countries have chosen to directly award PSO contracts, which tends to restrict the entry of new rail passenger transport companies into this market. According to Montero-Pascual et al. (2021), a criticism of these two methods is that they should be based more on key performance indicators and rigorous financial analysis rather than on requests or speculative bids.

Furthermore, as previously noted, a significant portion of the railway market is comprised of operators engaged in PSO contracts, which involve the receipt of subsidies known as PSO compensation. According to the Rail Guidelines on Market Monitoring from IRG Rail (2016), the paper of Stojić et al. (2018) and the Regulation 1370/2007 of European Parliament and Council of the European Union (2007), PSO compensation refers to financial benefits provided, directly or indirectly, by a competent authority from public funds to support the operation of rail services under a designated public service obligation during a specified reporting period. Based on the Seventh Monitoring Report from European Commission (2021), PSO compensation continues to be a significant source of revenue for railway undertakings in most member states. These compensations depend on the costs borne by the railway for operating the PSO service, as stated by Dolinayova and Domyeny (2022). For direct awards, Article 6.1 of Regulation 1370/2007 states that compensation shall be calculated

in accordance with the rules specified in the Annex to the Regulation. In contrast, for competitive tenders, compensation is determined by the winning operator's bid, with the competitive tendering process presumed to prevent overcompensation. Based on Regulation 1191/69, governments are obligated to ensure equitable treatment of PSO services and bear the financial responsibilities associated with these contracts (CER (2011)). According to Harker et al. (2013), substituting upfront subsidies with compensation based on the difference between revenue and costs post-event may encourage more suitable methods of fulfilling public service needs in the railway market. Harker et al. (2013) also added that compensation for commercially non-viable tracks is seen as a solution to ensuring continuity of services in the railway market.

Public service obligation contracts can involve two distinct methods of compensation: net contracts or gross contracts (CER (2011); Gleave (2016); Stojić et al. (2018)). In "net contracts", revenue from ticket sales forms part of the payment to service providers by public authorities. Commonly used in the EU, these contracts effectively incentivize passenger rail operators to increase passenger numbers and enhance customer satisfaction. They are viewed as suitable for delineating responsibilities between public authorities and operators, even though potentially limiting innovation and service quality improvements. Conversely, "gross contracts" involve all ticket revenue going to public authorities, who subsequently pay operators for transport services. This approach is chosen when authorities prefer full responsibility for passengers transport, often incorporating economic incentives for railway operators. According to Gleave (2016), the compensation method should encourage effective management by the operator and ensure the provision of services at a sufficiently high standard.

However, Harker et al. (2013) emphasized that compensation could become a detrimental tool against competition if these compensation schemes strengthen the position of the domestic incumbent and act as disincentives for newcomers. Additionally, the costs presented for PSO compensation are sometimes intentionally exaggerated (Nicolaidis (2014)). Therefore, the authority responsible for granting the compensation must accurately identify eligible costs to ensure a proper calculation of the compensation. This also ensures that railway undertakings do not regard this compensation as an additional source of revenue. To address these problems, Montero-Pascual et al. (2021) proposed that an independent authority should be responsible for determining the exact amount of PSO compensation to prevent overcompensation, particularly in cases of direct awards, as it is already the case in Austria, for instance. Harker et al. (2013), Gleave (2016), and Montero-Pascual et al. (2021) all caution against the risk of overcompensation in the allocation of PSO compensation.

Based on Berawi and Miraj (2023), governmental subsidies are necessary to sustain railway services across member states, regardless of the organizational model adopted. However, the allocation of subsidies remains significantly influenced by political considerations, a point emphasized by Bowman (2015) that warrants careful consideration. For example, in the Netherlands, when the government reduced subsidies provided to passenger railway companies, this resulted in increased fares for passengers (Dionori et al. (2011)). According to the study by Crössmann and Mause (2015), subsidy levels are systematically lower in countries governed by left-wing parties and higher in those governed by bourgeois parties, which is somewhat surprising. Also, according to Crozet et al. (2023), railways across all European countries have received substantial public subsidies, leading to commercial revenues becoming relatively marginal in the budgets of public transport for a period

of time. Despite policymakers' good intentions for subsidizing the industry, economists contend that many of these public cash injections may have adverse incentive effects, potentially fostering a dependency or 'mentality' towards subsidies (Crössmann and Mause (2015)).

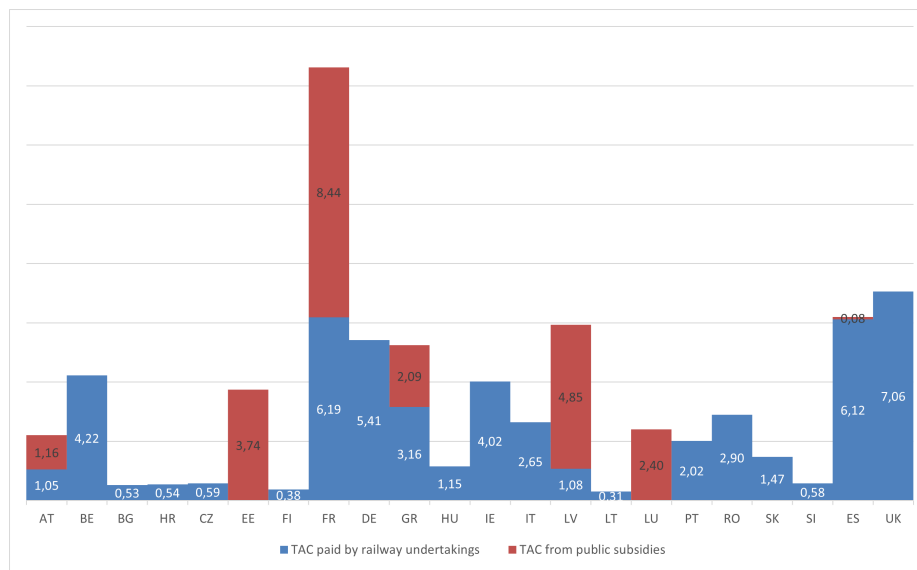
In addition, Stojić et al. (2018) emphasized that public transport, including passenger rail transport, plays a significant role in regional development, necessitating subsidies to ensure its sustainable development. According to Nash et al. (2016), the regionalization of rail services significantly contributes to the growth of rail traffic. Beria et al. (2012) further highlight that all European countries perceive regional transport as a social service warranting subsidies for various reasons, including social and environmental considerations. Moreover, Nash (2008) observed that in some European countries, such as France and Germany, subsidies are now provided by regional authorities, indicating a shift towards regionalized public support for passenger rail operators. According to Cresci (2024), seventy percent of regional passenger transport services in France were subsidized in 2023. This trend towards the regionalization of subsidies can be attributed to the lower profitability of regional rail lines, which are more frequently subject to PSO contracts (CNMC (2019)). However, Nash et al. (2019) noted that the lack of competition in the French regional market has resulted in increased subsidies. Moreover, Nash et al. (2016) also observed that the modest growth in French regional traffic between 2000 and 2011, attributed to regionalization, correlated with an increase in public subsidies. In addition, Gleave (2016) emphasized that regional subsidies are sometimes insufficient, necessitating additional support from the federal state. Thus, as mentioned by Crozet et al. (2023), more public subsidies in the railway market do not necessarily guarantee an increase in traffic.

Moreover, Montero-Pascual et al. (2021) suggested that PSO compensation should cover not only the operating costs but also the depreciation of rolling stock and the costs of access to infrastructure. In many instances, the rolling stock is owned by the railway undertaking providing the services, as noted by CER (2011). Gautier (2004) observed that new rail operators often lack their own rolling stock and therefore must lease it from specialized companies. This arrangement incurs significant costs and means that the new passenger rail operators do not own the rolling stock. According to Beria et al. (2012) and Nash et al. (2019), the ownership of rolling stock often serves as a barrier to the entry of newcomers due to several factors: the low standardization of passenger rolling stock, lengthy procurement times, extended amortization periods, and the sovereign guarantee of national railway debts, which increases financial costs. Non-discriminatory access to rolling stock is key to enabling competition according to Montero-Pascual et al. (2021). Nash et al. (2019) observed that rolling stock can be included in the subsidies provided to railway undertakings as part of fulfilling a PSO contract. In addition, when the financing of rolling stock is incorporated into a PSO contract, it typically remains tied to the services rather than the company, unless the contract duration coincides with the amortization period of the specific rolling stock involved (CER (2011)). This could be an important factor to consider when conducting further comparisons.

Another factor to consider is the amount of track access charges. According to Schöne and Kunz-Kaltenhäuser (2022), track access charges are the fees paid to the rail infrastructure manager for the use of the railway infrastructure. These track access charges are paid by railway undertakings. However, since 2021, several European countries have chosen to subsidize track access charges for both passenger and freight services due to pandemic-related measures. This has been implemented through mechanisms such as TAC reimbursements or reductions, which have been applied

differently to passenger and freight services (IRG Rail (2023); IRG Rail (2024)). These TAC reimbursements or reductions appear to have been excluded from PSO compensation because non-PSO services have also benefited from this subsidization. Nevertheless, it is noteworthy that government subsidies can influence track access charges in both the short and long term (Schöne and Kunz-Kaltenhäuser (2022)). Figure 1 provides an overview of the various track access charges paid for PSO services in Europe in 2022, with no data available for Denmark, Sweden, the Netherlands, and Poland. It can be observed that Luxembourg and Estonia have fully subsidized all TACs, and a high level of subsidies is also evident in France (IRG Rail (2024)).

Figure 1: Track access charges paid per train-kilometer for PSO services in 2022 (in Euro)



Source: IRG Rail 2024

In the end, identifying these subsidies and public support can be seen as a challenge. Dolinayova and Domyeny (2022) discussed the limitations of data on PSO services and emphasized the necessity of conducting comparisons with other European countries. Moreover, this literature review showed that researchers used more descriptive statistics than econometric regressions; this can be seen in various papers (Gautier and Salem (2016) and Nash et al. (2019) as examples). This literature review also highlights a gap regarding the impact of public support on the realization of liberalization in passenger rail services. The different ways of providing, their impact, and the amount of public support are points that need thorough analysis. Crössmann and Mause (2015) highlighted that the public subsidization of railways has been overlooked in the literature. In light of the insights provided by this literature review on public subsidies in the passenger railway market, this thesis aims to contribute significantly to a topic that, despite its critical importance, remains underexplored.

5 Organisation of The Railway Sector in Europe

To fully grasp the objectives of this thesis, it is essential to examine the current state of the railway sector within the European Union. The railway market has undergone significant transformations in recent years, resulting in a fundamentally altered landscape. This section will begin by reviewing the various Railway Packages issued by the European Union, which have played a pivotal role in shaping the current market structure. Following this, we will delve into the principles of vertical and horizontal separation within the railway industry, providing a detailed understanding of these concepts. Finally, we will explain the public service obligation compensation, an essential aspect for the analysis and findings presented in this thesis.

5.1 Railway Packages

To contextualize the following research, it is essential to revisit the background of railway liberalization. The liberalization of the railway market has faced significant challenges and remains incomplete in some European countries. In order to set up this liberalization of the railway market, the European Union has issued different regulations and directives through four Railway Packages during these last few years. Each Railway Package aimed at targeting different sides of the rail sector. According to Nash (2008), these reforms and regulations aimed to enhance efficiency and competitiveness in the European railway market. Let us examine and review the contents of each package.

The First Railway Package, issued in 2001, laid the foundational framework for transforming the European railway market through several directives (Directive 2001/12/EC, Directive 2001/13/EC, Directive 2001/14/EC, and Directive 2001/16/EC). According to the website of European Commission (2024a), these new proposals were introduced in July 1998 with the exclusive objective of enhancing the effectiveness of existing legislation. Subsequently, on 26 February 2001, the Council formally adopted these directives, collectively known as the "Rail Infrastructure Package."

According to CNMC (2019), the primary goals outlined in this first package encompassed a range of significant aspects aimed at modernizing and liberalizing the railway sector. One of the key objectives was to prioritize efficiency by empowering infrastructure managers, thereby decentralizing control and promoting more effective management practices. Additionally, the package sought to initiate substantial changes in international freight transportation through liberalization measures, facilitating greater competition and market access across national borders. Another crucial element was the extension of national licenses to a European level, fostering a more integrated and cohesive railway network across the EU. The directives also emphasized the importance of interoperability, aiming to ensure seamless connectivity and standardized systems across member states, which is vital for efficient cross-border railway operations. The package also addressed issues such as capacity allocation, access charges and security protocols. These measures were designed to create a fair and transparent framework for the use of railway infrastructure, ensuring that all market participants could compete on an equal footing and that safety standards were maintained at a high level (Ait Ali and Eliasson (2022))

The Second Railway Package, proposed by the European Commission in January 2002, aimed to address several critical areas within the railway sector according to the website of European Commission (2024b). The primary objectives of this package, which comprised a series of Directives,

included enhancing railway safety, improving interoperability with a particular emphasis on high-speed services, and opening the freight market at both international and national levels. Directive 2004/49/EC focused on railway safety, establishing comprehensive safety standards and protocols to be adhered to across all European Union member states. CNMC (2019), Ait Ali and Eliasson (2022) summarize these Directives. Directive 2004/50/EC dealt with interoperability, particularly targeting high-speed rail services, to ensure seamless and efficient cross-border railway operations. Directive 2004/51/EC laid the groundwork for the liberalization of the freight market, mandating the opening of the international freight market by 2006 and the national freight markets by 2007 within each European country

The Second Railway Package was officially adopted in 2004 and also included Regulation 881/2004, which established the European Union Agency for Railways. The ERA, headquartered in Valenciennes, France, is tasked with overseeing railway safety and interoperability across the EU. According to the policy of European Union Agency for Railways (2019), the agency's responsibilities include developing common safety standards, promoting interoperability, and providing regulatory oversight to ensure a safe and integrated European railway network.

In 2007, the European Commission adopted the Third Railway Package, a significant step toward establishing a cohesive European internal railway market. As stated by the website of European Commission (2024c), this package aimed to promote competitive open access, enhance regulatory frameworks on safety, and protect passenger rights. The Third Railway Package comprised two Directives and two Regulations, each addressing key areas of railway market liberalization and standardization.

In accordance with CNMC (2019), Ait Ali and Eliasson (2022), Directive 2007/58/EC facilitated open access competition for international passenger services, with the Commission targeting first January 2010, as the deadline for full implementation. This Directive was pivotal in ensuring that international passenger services could operate under competitive conditions, fostering a more integrated and efficient European railway network. Directive 2007/59/EC standardized the licensing process for European train drivers, enabling them to operate across national borders within the EU. This harmonization was crucial for enhancing the interoperability of the European railway system, allowing train drivers to work seamlessly across different countries. Regulation 2007/1371/EC focused on strengthening the rights of rail passengers, ensuring that their rights were protected and that they received fair treatment and compensation in the event of service disruptions or issues. This regulation underscored the importance of passenger protection within the broader framework of railway market liberalization.

Finally, Regulation 2007/1370/EC represents a crucial component of this thesis. According to CER (2011), Regulation 2007/1370/EC played a pivotal role in advancing the liberalization of the European railway market by introducing open access competition for subsidized passenger services. This regulatory framework aimed to incentivize service providers to deliver high-quality and efficient transportation services. A significant aspect of this Regulation is its provision of a comprehensive definition of public passenger services, identifying them as services of general economic interest provided to the public on a non-discriminatory and continuous basis.

Moreover, the Regulation grants member states the autonomy to determine which types of passenger services should be included in public service contracts, according to Gleave (2016). This

flexibility allows each country to decide whether to apply these contracts to local, regional, or long-distance traffic, based on their specific transportation needs and priorities.

As reported by CER (2011), Article 1 of the Regulation further stipulates that competent authorities must compensate public service operators for the costs incurred in fulfilling these public service contracts. This compensation mechanism ensures that operators can sustainably provide the mandated services without incurring financial losses, thereby maintaining the quality and reliability of public passenger services across the European Union.

Lastly, the Fourth Railway Package, issued in 2016, aims to revitalize national rail passenger transport by enhancing its competitiveness with other modes of transportation, as mentioned by CNMC (2019). This comprehensive package was developed through two parallel pillars: the market pillar and the technical pillar.

Based on CNMC (2019), Ait Ali and Eliasson (2022), the technical pillar encompasses the provisions of Directive 2016/797/EU on interoperability, Directive 2016/798/EU on safety, and Regulation 2016/796 establishing the European Union Agency for Railways; which plays a crucial role in overseeing and implementing the technical and safety aspects of these directives, thus ensuring a coherent approach to rail transport across the EU. Together, these legal instruments form the legislative and regulatory framework aimed at harmonizing technical and safety standards across the European railway network. This harmonization facilitates the free movement of trains and ensures a high level of operational safety and efficiency.

The market pillar introduces Directive 2016/2370/EU, Regulation 2016/2337, and Regulation 2016/2338, forming a comprehensive legislative and regulatory framework aimed at liberalizing the railway market within the European Union, as stated by CNMC (2019) and Ait Ali and Eliasson (2022). This framework completes the gradual market opening initiated by the First Railway Package discussed above. Important measures include the liberalization of the rail passenger transport market and the provision for rail companies to access the rail infrastructures of all member states by 2020. Furthermore, the market pillar establishes rules to improve the impartiality of rail infrastructure governance, prevent discriminatory practices, and set up the mandatory tendering of railway public service obligations contracts starting in 2023. These measures are designed to foster competition, improve service quality, increase consumer choice, and ensure equitable access to railway infrastructure, thereby promoting a more efficient and customer-oriented railway sector. In summary, based on Guillen (2022), this market pillar generates new challenges for the passenger railway market, particularly concerning public service contracts.

These initial three packages have been effectively implemented across the entire European Union. Nevertheless, it is noteworthy to consider that liberalization can be unsuccessful. For example, Gautier and Salem (2016) argues that the freight liberalization in Belgium involving SNCB has proven to be unsuccessful. This prompts us to question whether a similar outcome might occur with the liberalization of national passenger transport. However, the liberalization of rail passenger services has been successful in some European countries, evidenced by an increase in users, as observed by Nash et al. (2019). Consequently, implementing the opening of national passenger transport is proving to be a challenge in various European countries with different potential effects that may arise.

5.2 Vertical and Horizontal Separation

Thanks to liberalization, the railway market has undergone vertical separation between the infrastructure company and the rail operator, whether in passenger transport or freight transport. As reported by Perennes (2017), this vertical separation was a significant objective for the European Commission since the 1990s. At that time, most network industries were state-owned, vertically integrated monopolies. This separation marked a crucial step toward the current state of liberalization.

There are some difficulties in assessing the effects and impacts of this vertical separation. According to Nash et al. (2019) and Dionori et al. (2011), there is no clear consensus on whether this vertical separation has increased or decreased costs. Certainly, they observe that vertical separation may lead to increased costs for heavily utilized lines, whereas it could result in cost reductions for less-utilized ones. In terms of efficiency and productivity, Cantos et al. (2010) demonstrated that the combination of vertical separation and the entry of new operators in the railway market positively impacts efficiency and productivity. However, he argues that these effects would be more pronounced with both vertical and horizontal separation. Additionally, vertical separation is theoretically intended to ensure transparent and non-discriminatory interactions between railway undertakings and the infrastructure manager, as mentioned by Dionori et al. (2011). Despite this, Dionori et al. (2011) noted that, in practice, various countries face challenges due to differing degrees of vertical separation. Gautier (2004) also noted that competitors in Germany have criticized the infrastructure manager, Deutsche Bahn, for allegedly favoring the historical incumbent in the allocation of tracks. Nevertheless, Nash (2008) concluded that the separation between infrastructure and operations has facilitated a more successful entry of competition into the market. Numerous other effects and impacts can be noted, highlighting both the strengths and weaknesses of this separation. However, it is also essential to consider horizontal separation.

Furthermore, horizontal separation is a core element of this liberalisation. This entails a division among distinct rail service providers with comparable interests, roles, and responsibilities. It implies the potential presence of multiple railway undertakings on the lines, fostering competition or the provision of complementary services. This horizontal competition is a competition either for the market, competition between rail passenger operators in order to have a public service contracts, or in the market, competition between rail passenger operators on the same line; generally the profitable-one (CER (2011); Perennes (2017); CNMC (2019)). As mentioned by CER (2011), these two models of competition are not mutually exclusive, but are complementary ways of introducing competition into the rail passenger transport market.

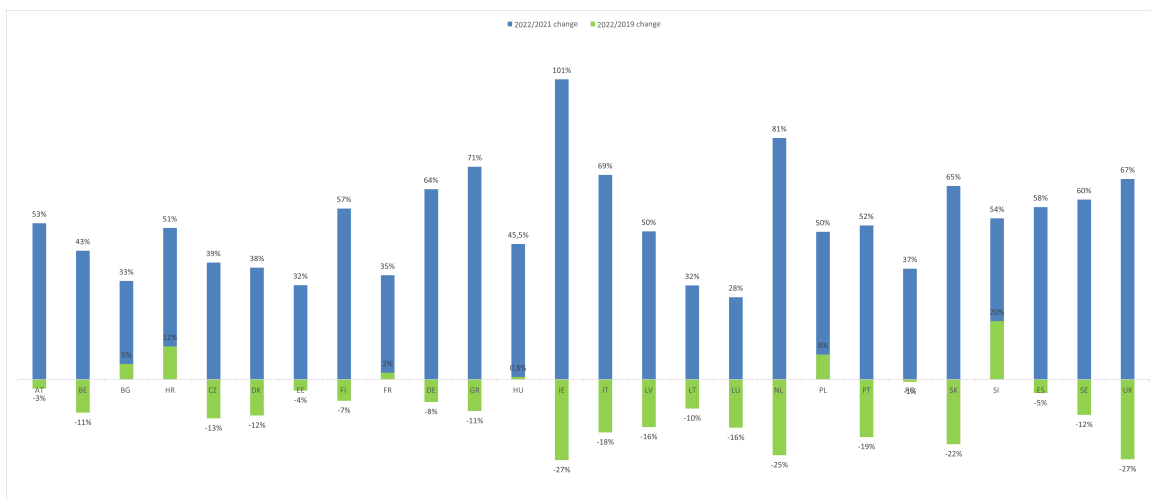
The introduction of competition among various passenger rail operators has distinct impacts. Driessen et al. (2006) argued that competition for the market drives greater efficiency compared to competition within the market. However, this contradicts Gathon and Pestieau (1995), who presented an opposing view. CER (2011) indicates that this competition is expected to enhance service quality and reduce costs. This is consistent with the findings of Nash et al. (2019), which highlight significant cost reductions resulting from horizontal separation. According to Gautier (2004), this horizontal separation implies, naturally, more competition on profitable lines and ultimately leads to a reduction in subsidies for these lines. This aligns with the findings of Nash et al. (2019). For instance, this reduction can be observed in Germany, thanks to their high level of horizontal separation, and also in Sweden where subsidies have been reduced by 20-30%

The non-profitable lines, the subsidized lines, should have been in competition through competitive tendering by 2023, according to Nash et al. (2016) and Malay and Van Keirsbilck (2019). However, Nash et al. (2016) highlighted a significant issue in the European rail passenger market: the majority of European rail passenger services are unprofitable. This situation results in increased competition for the market and, consequently, for the public service contracts. Moreover, the working document of IRG Rail (2024) reveals that in 2022, eleven European countries had only one passenger railway operator, indicating a lack of market competition. The sole passenger railway operator was the domestic incumbent, which is the railway undertaking from the same country and generally also the historical incumbent (IRG Rail (2016)). CNMC (2019) also indicates that the incumbent operator may retain regulatory advantages that must be eliminated to ensure fair competition.

This introduction of competition in the railway market incentivizes people to travel by train; more competition in a market leads to a reduction in ticket prices. As noted by Cresci (2024), the liberalization of the passenger railway market has led to a 20-30% reduction in ticket prices. Malay and Van Keirsbilck (2019) also added that the modal share of trains has increased globally since liberalization.

Indeed, the majority of countries reported a rise in passenger traffic in 2022 compared to the preceding year. The overall increase across all countries under observation amounted to 52%, according to the report by IRG Rail (2024). However, this figure should be interpreted with caution due to the impact of the COVID-19 crisis, which caused significant declines in passenger traffic within the European Union in 2020. This lingering effect is evident as many countries have not yet returned to pre-pandemic levels of 2019. Overall, total passenger-kilometers remain 10% below the levels recorded in 2019. Figure 2 provides a summary of the percentage changes in passenger-kilometers for each European country between 2022 and 2021, as well as between 2022 and 2019.

Figure 2: Rail passenger traffic evolution (in passenger-kilometer)



Source: IRG-Rail 2024

In conclusion, the separation of vertical and horizontal operations in the rail industry has profound implications for market dynamics, cost efficiency, and service quality. As demonstrated earlier, these separations have also led to increased rail usage by passengers. Ultimately, the strategic implementation of both horizontal and vertical separation is crucial for optimizing the benefits of competition in the rail industry, balancing the need for efficiency with the imperative of maintaining comprehensive service coverage across profitable and non-profitable routes.

5.3 Public Service Obligation Compensation

As discussed in the literature review, passenger railway operators fulfilling a PSO contract receive compensation. This compensation amount serves as a key indicator of public spending on public service obligations and varies due to different characteristics. The compensation is directly tied to the costs incurred by railway operators in providing PSO services. According to the PSO contract, economically justified costs are reimbursed from the state budget. When determining the compensation amount for the verifiable loss incurred in delivering services under a PSO contract, it is crucial that the compensation does not exceed the net financial impact, corresponding to the sum of positive and negative effects. This is in accordance with Regulation 2007/1370/EC of the European Parliament and of the Council.

Regulation 2007/1370/EC delineates precise conditions that exempt public service compensations from being categorized as state aid under EU competition law. These conditions, commonly referred to as the Altmark criteria, are detailed by Gleave (2016), CER (2011), and Harker et al. (2013). According to these sources, the Altmark criteria consist of four cumulative conditions:

- The recipient undertaking must genuinely have public service obligations to qualify for compensation, and these obligations must be clearly defined;
- The parameters for calculating the compensation must be established in advance in an objective and transparent manner. This ensures that the compensation does not confer an economic advantage on the recipient undertaking that may favor it over competing undertakings;
- The compensation must not exceed the amount necessary to cover all or part of the costs incurred in the discharge of public service obligations, considering the relevant receipts and allowing for a reasonable profit in fulfilling those obligations;
- In cases where the contract is awarded outside of a competitive tendering procedure, the level of compensation must be determined by comparing it with an analysis of the costs that a typical, well-run transport undertaking would incur.

The Altmark criteria were designed to establish a clear and transparent framework for compensating public service obligations within the transportation sector. The Altmark ruling asserts that conducting a public tender procedure is the preferred approach for determining compensation. However, it does not exclude the possibility of direct awards (Gleave (2016)). As noted by Dolinayova and Domeny (2022) and Nicolaidis (2014), the general calculation of these compensations for the public service obligations contracts in the railway market can be expressed as follows:

$$C = EC - R + P$$

In this context, C denotes the public service obligation compensation that should be allocated to an operator, EC represents the eligible costs necessary to fulfill the PSO contract, R signifies the revenue generated from the transport services, and P denotes a reasonable profit for the passenger railway undertakings. It is crucial to emphasize that the equation provided is a general formula for calculating PSO compensation, which can vary significantly across European countries. For instance, some countries may incorporate a reasonable profit component into their PSO contracts, such as Denmark and Estonia, while others do not, such as Bulgaria and Croatia.

Furthermore, the methodology for calculating overall costs varies among European countries. Table 1 provides an overview of the factors considered in the cost calculation for PSO compensation. The table includes the European countries for which relevant data were available. In the context of this table, a cross (X) signifies that the specified cost is included in the overall cost calculation.

Table 1: Costs considered for the calculation of the compensation

Countries	AT	BG	HR	CZ	DK	GR	HU	IE	LV	PL	PT	RO	SK	SI	SE
Staff	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Energy	X	X	X	X	X			X	X	X	X	X	X	X	X
Infrastructure charge	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Maintenance/repair	X	X			X	X	X	X	X	X	X	X	X	X	X
Rolling stock	X	X		X	X	X			X	X	X	X			
Installations	X	X	X	X	X	X		X	X	X		X			
Debt payment	X	X					X	X	X					X	
Marketing costs	X													X	
Shunting				X	X	X	X				X				
VAT						X					X				
Railway police				X							X				

Source: CER (2011)

As observed in Table 1, PSO contracts account for different cost components when determining compensation. A commonality across all these contracts is the inclusion of staff costs and infrastructure charges in the cost calculations. The differences between European countries in their methodologies are noteworthy. For instance, Austria and Slovenia include marketing costs in their cost calculations. Additionally, it is observed that nine out of fifteen analyzed countries consider costs associated with rolling stock, including depreciation and amortization. Thus, costs taken into account in the calculation can be very different between European countries.

In summary, PSO compensation is allocated to operators fulfilling PSO contracts, which are intended for non-profitable lines. Within the context of this thesis, PSO compensation refers to the subsidies provided to rail passenger operators in the European Union. Generally, the level of compensation is determined by the difference between projected costs and revenues. However, despite a common calculation methodology across European countries, there are variations in the costs considered in these contracts. This discrepancy contributes to differences in the compensation amounts between European countries.

6 Data Collection

As previously discussed, public support for passenger rail operators is provided to cover the costs of unprofitable lines and ensure their sustainability. The literature review has revealed that this financial assistance is referred to as compensation in PSO contracts. Consequently, this thesis aims to determine the amount of compensation allocated to PSO services across various European countries.

During my investigation into these compensations, I examined the financial reports of various passenger railway operators. I discovered contracts between member states and operators indicating the establishment of PSO agreements and the granting of compensation. However, the specific amounts of these compensations were not disclosed in either the contracts or the financial reports. Furthermore, the term "compensation" is often referred to by different names in the financial reports of various operators, adding an additional layer of complexity to this research. This challenge is particularly pronounced in countries where the language barrier complicates the interpretation of financial reports.

Another approach to acquiring relevant data involved consulting the regulatory bodies in various European countries. Although these regulatory bodies occasionally maintained databases, these databases typically did not include specific information regarding the amount of compensation or any form of public support provided to passenger railway operators. Instead, the available data predominantly focused on infrastructure-related aspects and the quality of travel services. Furthermore, I attempted to obtain data from independent organizations, such as the International Union of Railways. However, this endeavor also proved to be unfruitful, as these sources did not yield the specific information I was seeking regarding PSO compensations.

However, I may have found a way to estimate these compensations using the working documents provided by IRG Rail. Each year, IRG Rail publishes two documents: a market monitoring report and a working document, that offers a more detailed description and analysis of developments in the monitored countries. In the working document, various statistics and figures can be useful for ultimately determining the PSO compensation per passenger-kilometer. As a result of these calculations, I derived an estimation of the compensation allocated to the PSO operators. In the following paragraphs, I will detail the various calculations I have conducted. The calculations are derived from the databases provided by the IRG Rail working documents from 2018 to 2024 (see references : IRG Rail (2018), IRG Rail (2019), IRG Rail (2020), IRG Rail (2021), IRG Rail (2022), IRG Rail (2023) and IRG Rail (2024))

The initial data required is the number of passenger-kilometers in each European country. The per passenger-kilometer measure is often employed in assessing the efficiency and utilisation of public transportation services, considering both the number of passengers and the distance travelled. To calculate this measure, we first need to determine the per passenger-kilometer component. The per passenger-kilometer measure can be computed as follows:

$$Pkm_p = N_p * D_p$$

Here, N_p represents the total number of passengers in country p , D_p represents the distance travelled by each passenger in kilometers in country p and Pkm_p represents the number of passenger-kilometers in country p . Fortunately, the number of passenger-kilometers for each European country is provided in these working documents from IRG Rail.

Next, we will use the data on passenger railway undertakings' PSO revenues from fares per passenger-kilometer, which is expressed in Eurocents per passenger-kilometer for each European country. With this information, we can attempt to calculate the total passenger railway undertakings' PSO revenues from fares. The total can be computed as follows:

$$Rfares_p^T = Pkm_p * (Rfares_p/100)$$

In this context, $Rfares_p^T$ represents the total passenger railway undertakings' PSO revenues from fares in country p , Pkm_p represents the number of passenger-kilometers in country p and $Rfares_p$ denotes the passenger railway undertakings' PSO revenues from fares per passenger-kilometer in country p . It is necessary to divide $Rfares_p$ by 100 to convert the amount from Eurocents to Euros.

Subsequently, we will use the share of passenger railway undertakings' PSO revenues from fares and the share of passenger railway undertakings' PSO revenues from compensation. Assuming that these two shares constitute the entirety of the revenues for a company operating under a PSO contract, we can now calculate the total of passenger railway undertakings' PSO revenues; this being composed of the total revenues from fares and the total compensation. The equation for the total of passenger railway undertakings' PSO revenues appears as follows:

$$R_p^T = Rfares_p^T / Sfares_p$$

Here, R_p^T denotes the total of passenger railway undertakings' PSO revenues in country p and $Sfares_p$ represents the share of passenger railway undertakings' PSO revenues from fares in country p . Then, we can determine the total passenger railway undertakings' PSO revenues from compensation. There are two methods to calculate this total; however, both approaches yield the same amount of compensation. The first method can appear as follows:

$$Rcomp_p^T = R_p^T - Rfares_p^T$$

The first method involves simply subtracting the total passenger railway undertakings' PSO revenues from fares in country p from the total passenger railway undertakings' PSO revenues in country p . This calculation yields the total passenger railway undertakings' PSO revenues from compensation, denoted as $Rcomp_p^T$. Then, the second method can be represented as follows:

$$Rcomp_p^T = R_p^T * Scomp_p$$

In this context, we multiply the total passenger railway undertakings' PSO revenues in country p by the share of passenger railway undertakings' PSO revenues from compensation in country p , denoted as $Scomp_p$. Ultimately, these two methods yield the same result: the total passenger railway undertakings' PSO revenues from compensation.

Now that we have estimated the total passenger railway undertakings' PSO revenues from compensation, it is straightforward to determine the passenger railway undertakings' PSO revenues from compensation in Euros per passenger-kilometer. The equation is as follows :

$$Rcomp_p = Rcomp_p^T / Pkm_p$$

Thus, we derive the passenger railway undertakings' PSO revenues from compensation in country p , denoted as $Rcomp_p$, which is expressed in Euros per passenger-kilometer. Although these figures cannot be confirmed with absolute certainty, they provide a reliable estimation of these compensations. This estimation allows for a preliminary analysis of the subsidies within the methodological framework.

7 Research Methodology

To begin this methodology explanation, we must first define the time horizon and the countries under consideration. The time horizon will span from 2016 to 2022. The principles of PSO compensation were incorporated in Regulation 2007/1370/EC of the European Parliament and of the Council (2007), which is a pivotal regulation for PSO services. This regulation entered into force on December 3, 2009. Consequently, we must account for the time required by member states to transpose this regulation into their national legislation and there may have been existing contracts that delayed the full implementation of this regulation. Additionally, the database from IRG Rail does not mention compensation before 2016.

The thesis centers on comparative analyses among European countries. The study encompasses Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden. Malta and Cyprus are excluded due to the absence of operational railways. Additionally, the United Kingdom is included in the analysis for its pioneering role in railway liberalization. In the subsequent paragraphs, I will delineate the various criteria considered to establish a robust foundation for this comparative analysis.

The first criterion to be considered in this comparative analysis is the degree of vertical separation between infrastructure and passenger operators. As mentioned earlier in the organisation of the railway sector in Europe, vertical separation is crucial as it opens the railway market to new operators and in the end, promotes competition among these railway undertakings. This separation ensures transparent and non-discriminatory treatment of competitors for PSO contracts (Dionori et al. (2011)). Vertical separation is vital as it ensures that PSO contracts are not exclusively allocated to the domestic incumbent but are also accessible to new operators and foreign incumbents. This fosters a more competitive environment, encouraging efficiency and potentially leading to better services and lower costs. Enhanced competition for PSO contracts enables authorities to procure the most innovative range of services. Additionally, this enhanced competition allows PSO contracts to be awarded based on the principle of minimum compensation, which is a crucial aspect of this research.

The criterion of vertical separation has been considered, for example, in the research by Dolinayova and Domeny (2022). In the following table, I have categorized vertical separation into two types: institutional separation and organizational separation.

Institutional separation refers to the complete legal and administrative division between infrastructure management and railway operations. This typically means that the infrastructure manager and the railway operator are separate entities with no overlapping management or ownership. This type of separation can ensure that PSO contracts are awarded in a fair and transparent manner without favoritism towards the domestic incumbent.

Organizational separation, on the other hand, refers to the internal structuring within a single legal entity, where different divisions or departments are responsible for infrastructure management and railway operations. Although these divisions operate independently, they remain part of the same overarching organization, which can be, for instance, a holding company or a parent company. This

kind of separation can still present challenges in ensuring completely fair and non-discriminatory access to infrastructure for all operators. Consequently, it requires robust internal policies to mitigate conflicts of interest and ensure transparency.

As previously mentioned, I have classified the different European countries involved in this research into two categories of vertical separation. The classification is presented in the following Table 2:

Table 2: Overview of the vertical separation

Institutional Separation	Organizational Separation
CZ, DK, FI, GR, LT, NL, PT, RO, SK, ES, SE, UK	AT, BE, BG, HR, EE, FR, DE, HU, IT, LV, LU, PL, SI

Source : Nash (2008), Dionori et al. (2011), Ait Ali and Eliasson (2022) and Dolinayova and Domyeny (2022)

The distinction between institutional and organizational separation is highlighted in studies by Nash (2008), Dionori et al. (2011), Ait Ali and Eliasson (2022) and Dolinayova and Domyeny (2022). Specifically for Croatia, an article of law addressing organizational separation (Zakon.hr (2012)) has been identified, although it remains unclear whether the entity described functions as a holding or a parent company. Indeed, in organizational separation, the infrastructure manager and the operator maintain a connection, typically as subsidiaries of a parent or holding company. According to Ait Ali and Eliasson (2022), the infrastructure manager is often either a subsidiary of a holding company established to manage shares or a subsidiary of a larger parent company engaged in other activities within or beyond the rail sector. This study will attempt to delineate the specific relationship between the infrastructure manager and the passenger operator wherever possible.

Notably, Ireland will be absent from this analysis, which is unsurprising given its continued use of an integrated model in the railway market, lacking vertical separation. However, comparing Ireland with other European countries in another research could provide valuable insights into the distribution of compensation between vertical integration and separation.

In Table 2 above, it is evident that European countries are evenly divided between the two types of vertical separation. This observation underscores a notable divergence in regulatory approaches across the countries, highlighting varying degrees of institutional and organizational separation within national railway systems.

The second criterion considered for the comparative analysis pertains to competition in the provision of PSO services. Specifically, we aim to assess whether there is competition for these contracts. As discussed earlier in the literature review, PSO contracts can be categorized into two types of awarding: direct award and competitive tendering. Competitive tendering typically indicates a state preference for market competition, whereas direct award suggests the opposite (Stanojević et al. (2021)). It is important to note that the criterion under consideration here does not hinge on the method of contract allocation — whether through direct award or competitive tendering. Rather, the focus lies on whether multiple passenger operators are involved in delivering PSO services. Thus, the criterion primarily evaluates the presence or absence of multiple passenger operators engaged in PSO service provision.

Drawing from research and data provided by CNMC (2019), the Eighth Annual Market Monitoring from IRG Rail (2020), the Seventh Monitoring Report from European Commission (2021), and the Eighth Monitoring Report from European Commission (2023), European countries can be categorized into two groups: those with only one PSO operator, typically the domestic incumbent, and those with multiple PSO operators. The different situations can be observed in the Table 3 below:

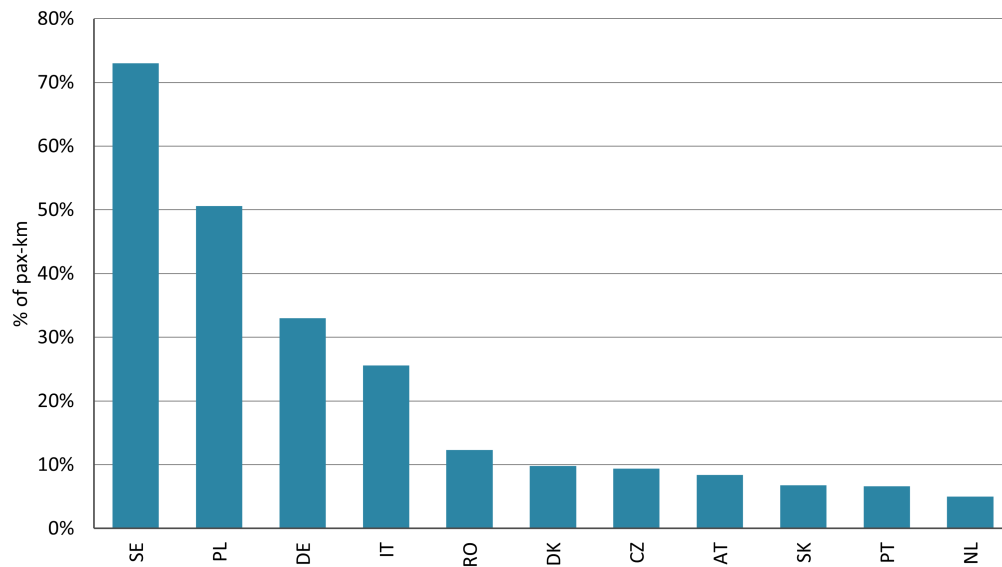
Table 3: Overview of PSO operators

One PSO operator	Multiple PSO operators
BE, BG, HR, EE, FI, FR, GR, HU, IE, LV, LT, LU, SI, ES	AT, CZ, DK, DE, IT, NL, PL, PT, RO, SK, SE, UK

Source : CNMC (2019), IRG Rail (2020), European Commission (2021) and European Commission (2023)

In the table above, it is evident that, as of 2020, there are no competitors in the PSO passenger market in Belgium, Bulgaria, Croatia, Estonia, Finland, France, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Slovenia, and Spain, according to European Commission (2023). In these European countries, the railway market continues to be served exclusively by the domestic incumbent, the historical operator.

Figure 3: Competitors' market share in PSO passenger market per country in 2020



Source : Eighth monitoring report on the development of the rail market from European Commission (2023)

In European countries with multiple PSO operators in the passenger market, competitors held significant market shares in 2020. For instance, in Sweden, competitors commanded the largest market share, accounting for 73 percent of the PSO passenger market. Similarly, in Poland, competitors captured the half of the market share. Although the Eighth Monitoring Report from European Commission (2023) does not provide data for the United Kingdom, the Seventh Monitoring Report from European Commission (2021) indicates that competitors in the United Kingdom held an 87 percent market share in 2018. It is reasonable to presume that this substantial market share for competitors has persisted. Ultimately, considering this criterion is meaningful because a higher market share for competitors in the PSO passenger market could likely correlate with reduced compensation levels (Nash et al. (2019), CNMC (2019)). This is due to more efficient competitive tendering or direct awarding processes, which aim to minimize the compensation provided. In cases where there is only one PSO operator, typically the domestic incumbent, the level of compensation received is unlikely to decrease due to the absence of market competition.

The final criterion considered for this comparative analysis is the method by which PSO contracts are awarded. There are two primary models for awarding these contracts: the centralized model and the decentralized model. In the centralized model, a single authority, typically at the national level, is responsible for awarding PSO contracts. In this case, the national authority is responsible for the long-distance services and the regional services. Conversely, the decentralized model involves multiple authorities; typically, the national authority handles long-distance services, while regional authorities manage regional services.

This criterion is considered significant because, as noted by Dolinayova and Domyeny (2022), there is a substantial difference in compensation between countries employing a centralized model for awarding PSO contracts and those using a decentralized model. The literature review also highlights that regionalization of subsidies is progressing in various European countries, as indicated by Nash (2008). Additionally, it is important to recognize that the decentralized model is sometimes adopted because regional compensations are insufficient to ensure viability, necessitating supplemental support from the national level (Gleave (2016)). Therefore, this criterion is non-negligible for understanding the financing of PSO contracts. The following table categorizes the various European countries into these two groups:

Table 4: Overview of the PSO model contract awarding

Centralized model	Decentralized model
BE, BG, HR, DK, EE, DE, GR, HU, IE, LV, LT, LU, PT, RO, SK, SI, ES, UK	AT, CZ, FI, FR, IT, NL, PL, SE

Source: Dolinayova and Domyeny (2022) and IRG Rail (2018)

Table 4 reveals that more European countries utilize the centralized model than the decentralized model for awarding PSO contracts. In countries following the centralized model, only the national authority is responsible for awarding PSO contracts, whether it is the long-distance services or the regional services. However, Germany is an exception in this category; in Germany, only regional authorities are responsible for awarding PSO contracts for both long-distance and regional services. Despite this, Germany’s model can still be considered centralized because the responsibility rests solely with one level of authority — the regional level.

In countries employing the decentralized model, regional authorities typically oversee regional services, while national authorities manage long-distance services. This arrangement is evident in France, Italy, the Netherlands, Poland, and Sweden. However, Austria and Finland present a slight variation to this model. In these countries, while the national level remains responsible for long-distance services, both national and regional authorities share responsibility for regional services. This dual oversight in Austria and Finland indicates a more collaborative approach in the decentralization of PSO contract awarding.

Overall, the distinction between centralized and decentralized models is significant for understanding how different European countries manage and finance their PSO contracts. The centralized model, with its singular level of authority, contrasts with the multi-tiered approach of the decentralized model, which may offer greater flexibility and responsiveness to regional demands. This criterion could be pivotal in conducting the comparative analysis

In conclusion, the methodology for this comparative analysis is structured around three essential criteria: the type of vertical separation, the presence of PSO operators in the PSO passenger market, and the method of awarding PSO contracts. The first criterion, concerning the type of vertical separation, evaluates the extent to which infrastructure management is institutionally or organizationally distinct from passenger railway undertakings, impacting market competition and the PSO compensation. The second criterion examines the presence of PSO operators in the PSO passenger market, distinguishing between markets with a single PSO operator, the domestic incumbent, and those with multiple PSO operators, which influences the level of competition and compensation dynamics. The third criterion assesses the method of awarding PSO contracts, comparing centralized and decentralized models, and the level of authority responsible, either at the national or regional level, for managing these contracts. Together, these criteria provide a comprehensive framework for analyzing the varied approaches European countries take in structuring and managing their PSO contracts, enabling a detailed comparative assessment of their public support through their different PSO contracts awarded.

8 Results

We can now proceed to categorize the various European countries into distinct groups based on the three criteria discussed earlier: the type of vertical separation, the presence of PSO operators, and the method of awarding PSO contracts. Where feasible, comparative analyses will be conducted within these groups to draw meaningful insights.

The methodology and calculations for these estimations have been thoroughly explained previously and will be strictly adhered to in this analysis. Despite extensive efforts to locate additional sources for the compensation amounts specified in different PSO contracts, no further data was available. Consequently, it is important to keep in mind that the figures presented in these results are estimations of the compensation levels. As such, the actual compensation could vary, potentially being either lower or higher than the estimates provided here.

I will also endeavor to provide comprehensive details about the various European markets included in these comparisons for each group, highlighting their commonalities and differences. This thorough examination will offer a nuanced understanding of how each market operates within the framework of the three criteria. This detailed comparative analysis aims to shed light on the varying degrees of effectiveness and efficiency in managing and financing PSO contracts across Europe. By examining both the commonalities and divergences, we can better appreciate the diverse strategies employed and their implications for market performance and public service delivery. To provide a comprehensive overview, the following table presents a broad categorization of the different European countries. This initial overview sets the stage for a more detailed examination, which will follow. Each country will be analyzed and grouped based on the three criteria earlier mentioned. This initial overview can be seen in the following Table 5. In the context of this table, a cross (X) indicates the presence of the specified criteria.

Table 5: Overview of the European countries based on the three criteria

Country	Separation		PSO Operator(s)		Model	
	Institutional	Organizational	One	Multiple	Centralized	Decentralized
AT		X		X		X
BE		X	X		X	
BG		X	X		X	
HR		X	X		X	
CZ	X			X		X
DK	X			X	X	
EE		X	X		X	
FI	X		X			X
FR		X	X			X
DE		X		X	X	
GR	X		X	X		
HU		X	X		X	
IT		X		X		X
LV		X	X		X	
LT	X		X		X	
LU		X	X		X	
NL	X			X		X
PL		X		X		X
PT	X			X	X	
RO	X			X	X	
SK	X			X	X	
SI		X	X		X	
ES	X		X		X	
SE	X			X		X
UK	X			X	X	

Source : Nash (2008), Dionori et al. (2011), Ait Ali and Eliasson (2022), Dolinayova and Domyeny (2022), CNMC (2019), IRG Rail (2020), IRG Rail (2018), European Commission (2021) and European Commission (2023)

According to Table 5, eight distinct groups comprising one or more European countries have been identified for this comparative analysis. It is important to note that Ireland is excluded from Table 5 due to the absence of vertical separation between infrastructure and operators. Ireland maintains a fully integrated railway system, with Iarnród Éireann (Irish Rail) being the sole PSO operator responsible for passenger rail transport. Consequently, there is no competition in the passenger PSO market in Ireland. Therefore, Ireland does not meet the criteria for inclusion in this analysis due to the lack of vertical separation. Moreover, the data available and the calculations performed regarding the compensation levels for Irish Rail are likely biased, as they are based solely on data from 2020, 2021, and 2022, years during which the impact of the pandemic significantly influenced railway operations and financials. Despite the lack of information for Ireland and its exclusion from this comparative analysis, we will now proceed with the description of the different categories and compare the levels of compensation within each group. Detailed tables containing the estimations for each group are provided in the appendices.

8.1 First group

We will begin this analysis with the first group, which comprises European countries that can be considered the least advanced in the liberalization of the passenger PSO market. Countries in this

group exhibit organizational separation, no competitors in the passenger PSO market, and utilize a centralized model for the financing of PSO contracts. The countries meeting these criteria are Belgium, Bulgaria, Croatia, Estonia, Hungary, Latvia, Luxembourg, and Slovenia.

However, there are notable data gaps for certain countries in different years within this group. Specifically, there is no data for Estonia in 2015, no data for Luxembourg in 2015, and no data for Slovenia from 2015 to 2019 inclusive. While the absence of data for Luxembourg and Estonia is less problematic, the lack of data for Slovenia is more significant, posing challenges for a thorough comparison involving Slovenia. On the other hand, the remaining countries have consistent data for each year of the study period.

As previously mentioned, this group operates under an organizational model, meaning that there remains a certain connection between the infrastructure manager and the PSO operator in each of these European country. This connection often manifests as subsidiaries under a holding or parent company. We will now examine this parameter across the countries in this group to understand their specific situations. According to Ait Ali and Eliasson (2022) and various sources on the different passenger PSO operators, the infrastructure manager and the PSO operator in Bulgaria and Hungary are part of the same holding company. In Hungary, Magyar Államvasutak functions as a holding company with multiple subsidiaries involved in different rail transportation aspects, including infrastructure management and passenger services. Similarly, in Bulgaria, Bălgarski dържавni železnici operates as a holding company with subsidiaries managing passenger and freight services.

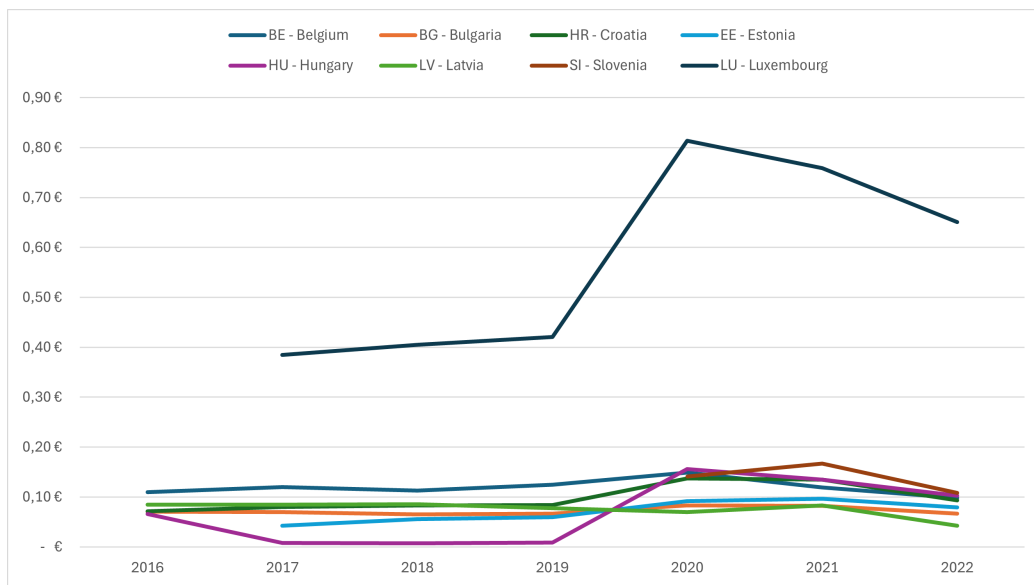
In contrast, in Belgium, Estonia, Latvia, Luxembourg, and Slovenia, both the infrastructure manager and the passenger operator are subsidiaries of the same parent company. Specifically, the pairs of entities are as follows: in Belgium, SNCB (passenger operator) and Infrabel (infrastructure manager) are subsidiaries of the same parent company; in Estonia, Elron (passenger operator) and Eesti Raudtee (infrastructure manager); in Latvia, Pasažieru Vilciens (passenger operator) and Latvijas Dzelzceļš (infrastructure manager); in Luxembourg, the CFL Group encompasses both functions; and in Slovenia, SŽ-Potniški Promet (passenger operator) and SŽ Infrastruktura (infrastructure manager) operate under the same parent company too. For Croatia, while the specific link between the infrastructure manager and the passenger operator has not been determined, it is established that an organizational separation exists, as per Croatian law (Zakon.hr (2012)).

This first group contains no competitors on the PSO passenger transport market, with only the historical incumbent responsible for passenger transport. Notably, some countries, such as Belgium, have signed contracts with their historical incumbents to extend their monopolies over passenger transport. Despite these extensions, there are clauses within these PSO contracts that allow the government to designate another PSO passenger operator if necessary. This indicates that while competition in the passenger PSO market is considered, it has not yet been implemented and is unlikely to be in the immediate future. The evolution of this market structure will require further observation over the coming years.

We can also note that the countries in this group employ a centralized model for awarding and financing PSO contracts. In these countries, the state is the sole authority responsible for awarding PSO contracts, regardless of whether they pertain to long-distance or regional services. This centralization means that all decisions related to PSO contracts, as such as the PSO compensation, are made at the national level in this first group.

With an understanding of the first group’s characteristics, we can now examine the different levels of compensation provided in these European countries. Figure 4 below presents the PSO compensations within this group. Notably, Luxembourg exhibits the highest PSO compensation per passenger-kilometer annually. In particular, Luxembourg’s PSO compensation per passenger-kilometer is nearly four times greater than the second-highest PSO compensation per passenger-kilometer, observed in Belgium, for the years 2017, 2018, and 2019.

Figure 4: PSO compensation per passenger-kilometer for the First Group from 2016 to 2022



Source: IRG Rail (2018 to 2024)

Additionally, there is a marked peak in 2020, where Luxembourg’s PSO compensation reaches 0.81 Euros per passenger-kilometer. This significant increase is likely attributable to the COVID-19 crisis, which had a profound impact that year. The pandemic’s effects seem to have persisted in subsequent years, as the PSO compensation per passenger-kilometer has not returned to the pre-pandemic levels of 2019 in Luxembourg. Although there was a decrease in compensation after the 2020 peak, the PSO compensation per passenger-kilometer remained elevated, at 0.76 Euros per passenger-kilometer in 2021 and 0.65 Euros per passenger-kilometer in 2022. This could be indicating a continued influence of the pandemic on compensation levels.

Furthermore, the elevated PSO compensation per passenger-kilometer can be also attributed to Luxembourg’s policy of providing free public transport since February 29, 2020. This policy covers trains, trams, and buses, eliminating the need for tickets except for first class tickets and passes (Le Ministre de la Mobilité et des Travaux publics (2020)). As a result, passenger rail transport mainly relies on PSO compensation for its revenue. Since the implementation of free public transport, there has been an increase in the share of passenger railway undertaking’s PSO revenues from

compensations. Indeed, this proportion has exhibited a significant increase, rising from 86 percent in 2016 to 99 percent in 2021. This can be observed in the Table 6 below. It is thus challenging to pinpoint a single definitive reason for this high PSO compensation, as it may result from both the lingering effects of the COVID-19 pandemic and Luxembourg’s policy of providing free public transport.

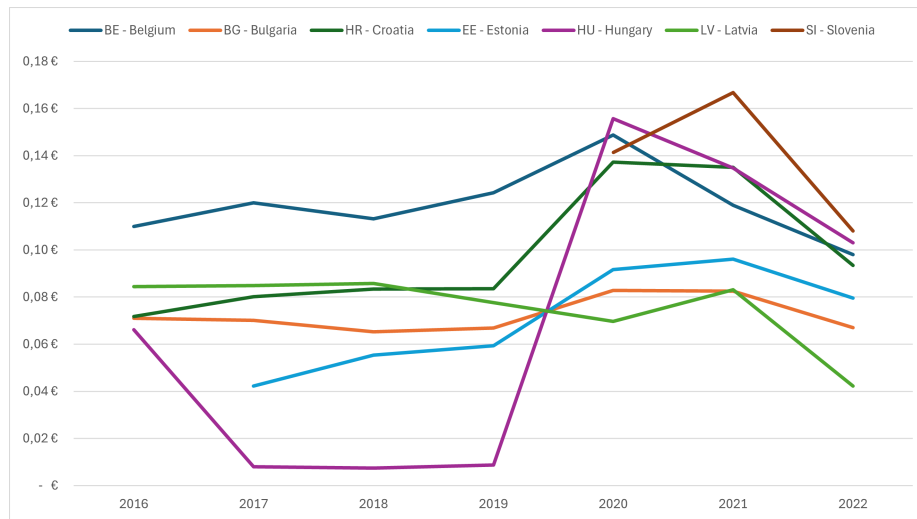
Table 6: Share of passenger railway undertaking’s PSO revenues from compensations in Luxembourg

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	86%	87%	88%	89%	98%	99%	99%

Source: IRG Rail (2018 to 2024)

To gain a clearer perspective on the PSO compensation per passenger-kilometer in other European countries in this first group, we will exclude Luxembourg for the following comparisons. This adjustment will allow us to better compare the amounts across the remaining countries. However, it is important to keep in mind the significant findings we observed in the case of Luxembourg. The revised Figure 5, reflecting this adjustment, is presented below.

Figure 5: PSO compensation per passenger-kilometer for the First Group from 2016 to 2022, excluding Luxembourg



Source: IRG Rail (2018 to 2024)

Firstly, an examination reveals no consistent trend across European countries regarding PSO compensation levels per passenger-kilometer, which vary significantly from one country to another. Among these nations, Slovenia reported the highest observed PSO compensation of 0.17 Euros per passenger-kilometer in 2021, while Hungary recorded the lowest between 2017 and 2019, with PSO compensation as low as 0.01 Euros per passenger-kilometer.

Prior to 2020, Belgium consistently recorded the highest PSO compensation per passenger-kilometer, ranging from 0.11 Euros in 2016 to 0.12 Euros in 2019; remind also that we have no data for Slovenia in this period. Conversely, Latvia, Croatia, and Bulgaria maintained relatively stable PSO compensation levels, ranging between 0.07 Euros and 0.09 Euros per passenger-kilometer during the same period. Estonia, for its part, experienced a slight increase in PSO compensation, rising from 0.04 Euros per passenger-kilometer in 2017 to 0.06 Euros in 2019.

Notably, Hungary witnessed a reduction in PSO compensation from 0.07 Euros per passenger-kilometer in 2016 to 0.01 Euros in 2017, remaining at this level until 2019. This decrease could be attributed to a significant decline in the proportion of PSO revenues as a share of passenger railway undertakings' total income, dropping from 71 percent in 2016 to 25 percent in 2019. Consequently, these railway undertakings relied predominantly on fare revenues rather than PSO compensation during this period.

However, the impact of the COVID-19 crisis in 2020 is evident in the adjustments made by several European countries to their PSO compensation rates per passenger-kilometer. Belgium and Estonia experienced an approximate increase of 0.03 euros per passenger-kilometer during this period. Specifically, Belgium's PSO compensation rose from 0.12 Euros per passenger-kilometer to 0.15 Euros per passenger-kilometer between 2019 and 2020, while Estonia saw an increase from 0.06 Euros to 0.09 Euros per passenger-kilometer over the same time frame. Croatia also raised its PSO compensation from 0.08 Euros to 0.14 Euros per passenger-kilometer, marking a larger increase compared to Belgium and Estonia.

Conversely, these adjustments pale in comparison to Hungary's significant increase from the lowest PSO compensation rate of 0.01 Euros per passenger-kilometer in 2019 to the highest rate of 0.16 Euros per passenger-kilometer in 2020. Meanwhile, Latvia and Bulgaria appear to have maintained or minimally adjusted their PSO compensation levels per passenger-kilometer during these years, indicating relative stability despite the pandemic's impact.

We will now examine whether the impact of the pandemic has been mitigated. Bulgaria has maintained its PSO compensation levels, returning to 0.07 Euros per passenger-kilometer in 2022, matching its 2019 figure. In Latvia, the compensation decreased to 0.04 Euros per passenger-kilometer in 2022, indicating that the COVID-19 crisis had a relatively minimal impact compared to other European countries.

Estonia has not yet returned to its 2019 compensation levels, but it is gradually approaching them, with a slight decrease to 0.08 Euros per passenger-kilometer in 2022 compared to 2021. Croatia still needs to make progress to reach its 2019 level of 0.08 Euros per passenger-kilometer, currently standing at 0.09 Euros per passenger-kilometer in 2022. Conversely, Belgium has reduced its compensation to 0.10 Euros per passenger-kilometer, now below the pre-pandemic level, potentially indicating a successful strategy for reducing PSO compensation, as well as a degree of resilience to the potential impact of the pandemic.

The situation in Slovenia is challenging to evaluate comprehensively due to limited data, covering only three consecutive years. Nevertheless, we observe a decrease from a peak of 0.17 Euros per passenger-kilometer in 2021 to 0.11 Euros per passenger-kilometer in 2022. Without pre-pandemic data, drawing definitive conclusions and making comparisons remains difficult.

Lastly, Hungary has not yet recovered from the pandemic's impact, with a current PSO compensation of 0.10 Euros per passenger-kilometer, approximately ten times higher than in 2019. This increase highlights the significant challenges faced by the Hungarian passenger railway sector. Additionally, the share of PSO revenues from compensations in Hungary rose dramatically to 85 percent in 2022, compared to just 25 percent in 2019, further illustrating the difficulties in returning to pre-pandemic levels, but also the requirement for the railway undertaking to receive a larger amount of PSO compensation to fulfill the PSO contract.

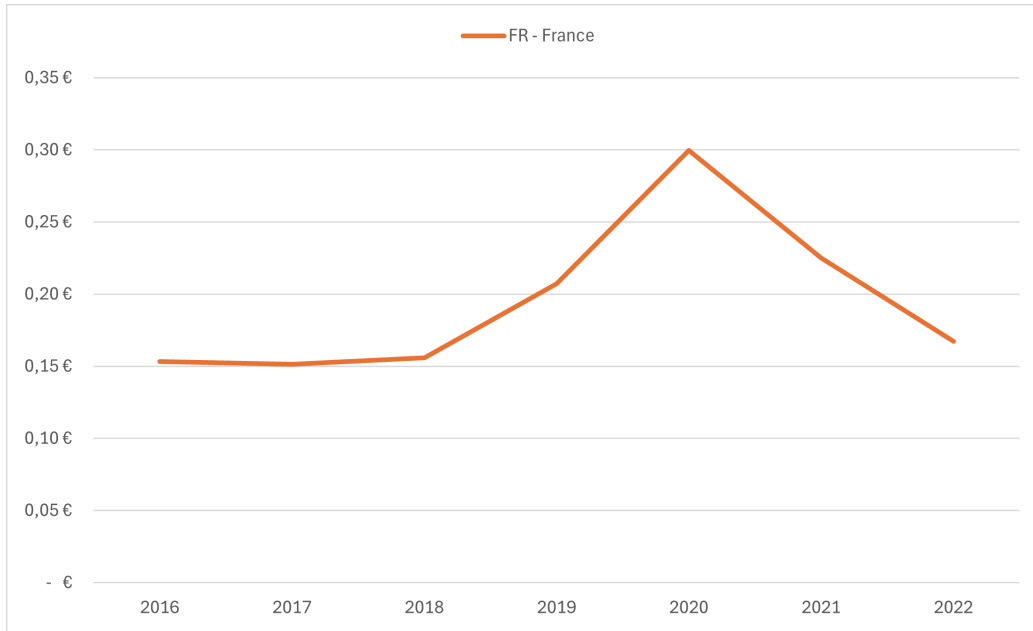
To summarize the analysis of this first group, it is evident that there are significant variations in PSO compensation per passenger-kilometer among these European countries. Despite all countries in this group sharing characteristics such as organizational separation, no competitors in the PSO passenger market, and a centralized model, there is no clear trend in the level of PSO compensation per passenger-kilometer. The diversity of these countries regarding PSO compensation is notable. Furthermore, the COVID-19 crisis has significantly impacted the evolution of PSO compensation, with lingering effects still observed in some countries, such as Hungary. Some countries have not yet returned to pre-pandemic levels of compensation. Consequently, drawing definitive conclusions for this group is challenging.

8.2 Second Group

We will now examine the second group of countries. This group is characterized by having organizational separation, no competitors in the PSO passenger market, and a decentralized model. Notably, only one country fits these criteria: France. Consequently, the following analysis will focus exclusively on the case of France.

France operates under an organizational separation model. Specifically, SNCF Voyageurs and SNCF Réseau are subsidiaries of the SNCF Group, which functions as a holding company. SNCF Réseau serves as the infrastructure manager, while SNCF Voyageurs is the sole PSO passenger operator. Unlike the first group, France employs a decentralized model for awarding and financing PSO contracts. In this model, the French state is responsible for long-distance services, while regional authorities manage regional services, exemplifying a typical decentralized approach (IRG Rail (2018)). With this context in mind, we can now examine the PSO compensation per passenger-kilometer in France from 2016 to 2022, as presented in Figure 6.

Figure 6: PSO compensation per passenger-kilometer in France from 2016 to 2022



Source: IRG Rail (2018 to 2024)

This figure reveals several key observations. Initially, from 2016 to 2018, the PSO compensation remained stable at approximately 0.15 Euros per passenger-kilometer. In 2019, there was a slight increase to 0.21 Euros per passenger-kilometer. The impact of the COVID-19 pandemic is evident in 2020, with the PSO compensation peaking at 0.30 Euros per passenger-kilometer. This rise aligns with the some patterns observed in the first group, where the pandemic significantly affected the passenger railway market in some countries (Hungary, Luxembourg, Belgium) and increased the support provided to PSO passenger operators. In 2020, SNCF Voyageurs' PSO revenues from compensations surged to 80 percent, up from around 68 percent in the preceding years, indicating a greater reliance on PSO compensation due to decreased fare revenues. In the subsequent post-pandemic years, PSO compensation per passenger-kilometer declined to approximately 0.17 Euros by 2022. This suggests that SNCF Voyageurs received sufficient support from the French state to navigate the COVID-19 crisis, with PSO compensation levels falling below those of 2019 and approaching the levels seen during 2016-2018. By 2022, the share of SNCF Voyageurs' PSO revenues from compensations had returned to a level slightly below that of the pre-pandemic period, at 66 percent. The evolution of the share of SNCF Voyageurs' PSO revenues from compensations can be observed in Table 7.

In conclusion, France represents a unique case within the second group, characterized by an organizational separation of its PSO passenger operator and infrastructure manager under the SNCF Group and, unlike the first group, France employs a decentralized model. The analysis of PSO compensation per passenger-kilometer from 2016 to 2022 highlights several key trends. Prior to the

Table 7: Share of passenger railway undertaking’s PSO revenues from compensations in France

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	69%	68%	68%	69%	80%	75%	66%

Source: IRG Rail (2018 to 2024)

COVID-19 pandemic, PSO compensation remained stable, with a notable increase in 2019. The pandemic year of 2020 saw a significant surge in PSO compensation, reflecting the heightened financial support required to sustain the passenger railway sector amidst reduced fare revenues. Post-pandemic, there is a discernible decline in PSO compensation, suggesting a recovery and stabilization of the market, with compensation levels approaching pre-pandemic norms by 2022. Overall, the French case underscores the critical role of state and regional support in navigating crises and stabilizing the passenger railway sector, while also highlighting the resilience and adaptability of decentralized models in managing PSO contracts.

8.3 Third Group

Let’s now turn to the third group. This groups contains the European countries where we have an organizational separation, competition on the PSO passenger market and a decentralized model. The European countries which fit these criteria are Austria, Italy and Poland. We will try to describe and analyse these countries in the following paragraphs. The organizational separation and decentralized model in these countries are similar to the situation of France in the second group, with the state generally responsible for long-distance services and the regions for the regional services. However, there is some competition in the PSO passenger market in these countries, and it is worth examining the situation in these three European countries.

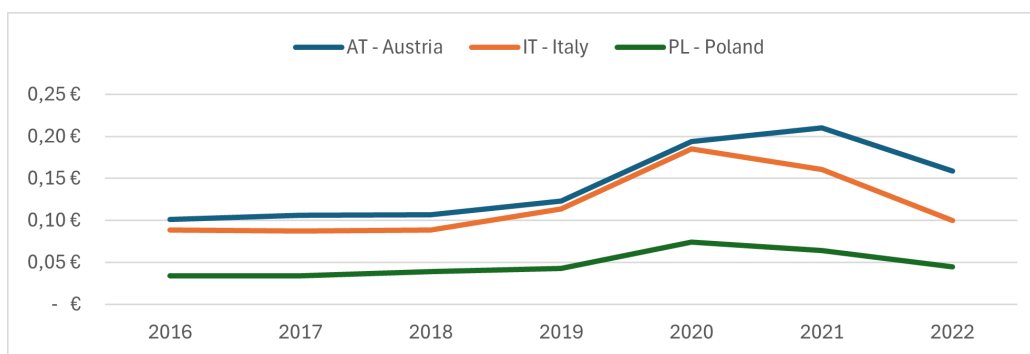
In Italy, the PSO passenger railway market is the primary segment of the passenger railway market due to its considerable size compared to the commercial passenger market (IRG Rail (2020)). Trenitalia dominates the PSO passenger market, holding about three-quarters of the market share. Sixteen other companies operate in this market, although they are not in direct competition, and no foreign incumbents are present (IRG Rail (2020)). In 2020, Italy had two PSO contracts competitively tendered and nineteen directly awarded, which was the biggest number of PSOs contracts directly awarded in 2020 (European Commission (2023)). It is also noteworthy that Trenitalia is a significant subsidiary of the infrastructure manager, Ferrovie dello Stato Italiane, leading to issues with other passenger companies, including cases of unfair grant of rights.

In Poland, Polregio, a regional service provider shared by regional authorities, and PKP Intercity, a state-owned incumbent providing long-distance services, hold substantial shares of the PSO passenger market. The infrastructure manager, PKP Polskie Linie Kolejowe, is eighteen percent owned by the PKP group, which also owns PKP Intercity. Direct competition occurs on several PSO routes in Poland (IRG Rail (2020)). In 2020, no PSO contracts were competitively tendered, but twelve were directly awarded (Eighth Market Monitoring of the European Commission (2023)).

In Austria, the predominant PSO passenger operator is ÖBB Personenverkehr, part of the same holding company as the infrastructure manager, ÖBB-Infrastruktur Betrieb. Austria also has regional PSO railway undertakings that serve as both railway operators and infrastructure managers (IRG Rail

(2020)). In 2020, eight PSO contracts were directly awarded, with no contracts awarded through competitive tendering, resulting in no direct market competition (European Commission (2023)). Unlike Poland and Italy, where the state is solely responsible for long-distance services, Austria's state and regional authorities share responsibility for regional services. This shared responsibility aligns with the presence of regional railway undertakings that also manage infrastructure. We now turn our attention to Figure 7, which presents the PSO compensation per passenger-kilometer in Italy, Poland, and Austria from 2016 to 2022.

Figure 7: PSO compensation per passenger-kilometer for the Third Group from 2016 to 2022



Source: IRG Rail (2018 to 2024)

Firstly, we can identify a trend in the distribution of PSO compensation per passenger-kilometer. The data reveals that the PSO compensation per passenger-kilometer remained quite stable until 2019, increased in 2020, and then slightly decreased until 2022, aiming to return to pre-pandemic levels. In this group, Austria and Italy both maintained a PSO compensation of approximately 0.10 Euros per passenger-kilometer until 2019, after which it rose to 0.19 Euros per passenger-kilometer due to the COVID-19 crisis. Notably, Italy appears to have returned to pre-pandemic levels more easily than Austria. Austria has not reverted to its pre-pandemic level, peaking in 2021 at 0.21 Euros per passenger-kilometer and reaching 0.16 Euros per passenger-kilometer in 2022.

This difference could be attributed to the proportion of revenues derived from compensation before the pandemic, which was about 60 percent in both countries. In 2020, Italy's percentage increased to 75 percent, whereas Austria's was only 69 percent. Subsequently, in 2021, Austria received greater compensation support, with a revenue share of about 80 percent, while Italy slightly decreased this share to 73 percent. By 2022, Italy had returned to its pre-pandemic share level, whereas Austria continued to struggle, with a revenue share of 72 percent. These observations could suggest that the difference in state and regional support in response to the COVID-19 crisis may have influenced Italy's swifter recovery to pre-pandemic levels compared to Austria. A more reactive approach to the pandemic seems to have facilitated Italy's return to pre-crisis levels more effectively than Austria. The evolution of the share of railway undertakings' PSO revenues from compensations in Austria and Italy can be observed in Table 8.

Table 8: Share of passenger railway undertakings' PSO revenues from compensations in Austria and Italy

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share in AT	61%	60%	58%	62%	69%	80%	72%
Percentage Share in IT	63%	62%	60%	60%	75%	73%	64%

Source: IRG Rail (2018 to 2024)

We must also consider the situation in Poland, where PSO compensation was approximately 0.03 Euros per passenger-kilometer in 2016-2017 and 0.04 Euros per passenger-kilometer in 2018-2019. A slight increase to 0.07 Euros per passenger-kilometer occurred in 2020. Post-pandemic, the level started to decrease, returning to the pre-pandemic level of 2019 relatively easily.

Prior to the COVID-19 crisis, Poland's share of revenues from compensations was around 60 percent. In 2020, this support increased to 75 percent, but subsequently, it slightly decreased, and by 2022, it had returned to the pre-crisis level. Therefore, the conclusion drawn from the comparison between Austria and Italy can also be applied to Poland: a more reactive approach to the pandemic appears to have facilitated Poland's return to pre-crisis levels effectively. This can be observed in Table 9 below.

Table 9: Share of passenger railway undertakings' PSO revenues from compensations in Poland

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	60%	59%	61%	58%	75%	71%	62%

Source: IRG Rail (2018 to 2024)

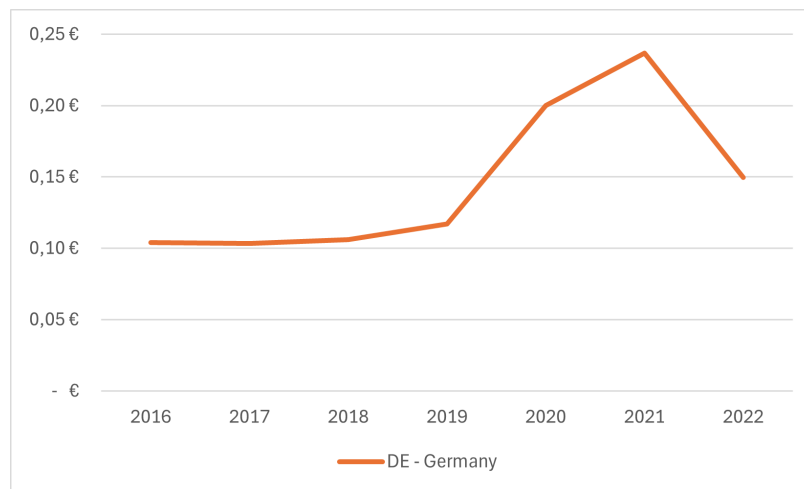
In conclusion, Italy, Austria and Poland showed broadly similar trends in their distribution of PSO compensation. However, reactions to the COVID-19 pandemic have varied in terms of PSO compensation per passenger-kilometer. Italy and Austria maintained stable compensation levels until 2019, increased in 2020, but Italy recovered more quickly by 2022. Austria struggled to return to pre-pandemic levels, reflecting a less effective recovery strategy. Poland, starting from a lower baseline, also saw a 2020 increase but swiftly reverted to pre-pandemic levels, demonstrating an effective support strategy. These differences highlight the importance of timely and adequate support measures coming from a decentralized model for recovery in the PSO passenger market.

8.4 Fourth Group

We now turn to the final group characterized by organizational separation. This fourth group also includes countries with competition in the passenger PSO market, and a centralized model. The only country meeting all these criteria is Germany. Germany was one of the first countries to introduce competition in the railway market, including the PSO segment, making it a pioneer in this area. In this centralized model, regional authorities are solely responsible for regional services, as there are no long-distance PSO services in Germany (IRG Rail (2018)). Indeed, the German PSO market is geographically segmented and administered by 30 competent regional authorities, with competition occurring across all these regions (IRG Rail (2020)). This method of organizing the PSO railway market is quite unique within the European Union.

The domestic incumbent for passenger transport is Deutsche Bahn Personenverkehr, which is part of the same parent company as the infrastructure manager, Deutsche Bahn InfraGo. This affiliation has led to instances of unfair grant rights to other PSO passenger operators, enabling the domestic incumbent to maintain its market position. Nevertheless, and based on IRG Rail (2020), the German PSO passenger market features numerous other players, such as Bayerische Oberlandbahn GmbH and Metronom Eisenbahngesellschaft. Additionally, subsidiaries of foreign incumbents, such as Keolis Deutschland, are also present. According to the Eighth Monitoring Report by the European Commission (2023), Germany had the highest number of competitively tendered PSO contracts, totaling nine. It is also notable that Germany directly awarded seven PSO contracts in 2020. Let's now take a look at the PSO compensation per passenger-kilometer in Germany between 2016 and 2022 in the Figure 8.

Figure 8: PSO compensation per passenger-kilometer for Germany from 2016 to 2022



Source: IRG Rail (2018 to 2024)

Figure 8 shows that Germany follows a similar trend observed in the third group, with relatively stable PSO compensation per passenger-kilometer from 2016 to 2019, an increase in 2020 and 2021, and a decrease in 2022. Specifically, PSO compensation was approximately 0.10 Euros per passenger-kilometer until 2019, rising to 0.21 Euros per passenger-kilometer in 2020 and peaking at 0.30 Euros per passenger-kilometer in 2021. By 2022, this figure decreased to 0.15 Euros per passenger-kilometer, which, while lower than the pandemic peak, has not yet returned to pre-pandemic levels. This trend might be attributed to the proportion of revenues from compensations, which was around 55 percent until 2019, increased to 68 percent in 2020, and decreased to 62 percent in 2022. Hence, the impact of the COVID-19 crisis is evident, and while recovery is underway, it is not yet complete.

8.5 Fifth Group

We now turn to the groups characterized by institutional separation. Institutional separation refers to a complete division between the infrastructure manager and the domestic incumbent. The fifth group includes countries with institutional separation, no competitors in the PSO passenger market, and a decentralized model. The only European country meeting these criteria is Finland. In Finland, the domestic incumbent is Valtion Rautatiet, while the infrastructure manager is the Finnish Transport Infrastructure Agency, which oversees railway infrastructure, the road network, and waterways. These are two distinct entities with no interrelation. Valtion Rautatiet remains the sole active railway undertaking, with domestic passenger traffic contracts directly awarded to it (IRG Rail (2020)). According to IRG Rail (2018), long-distance services fall under state authority, whereas both regional authorities and the state are responsible for regional services, similar to the situation previously noted in Austria. Unfortunately, analyzing the PSO passenger market in Finland is not feasible due to missing data for the years under review. No estimations could be made, and no data regarding PSO compensation were found during the research.

8.6 Sixth Group

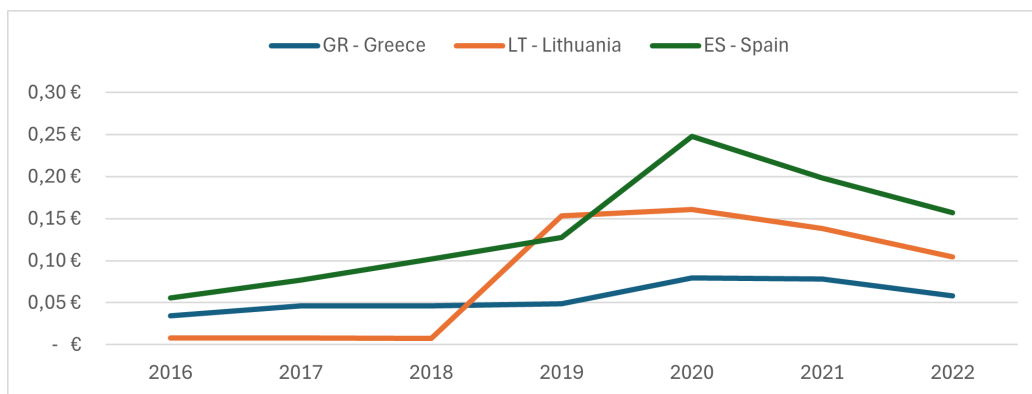
We now turn to the sixth group, which comprises countries with an institutional separation, no competition in the PSO passenger market, and a centralized model for awarding and financing PSO contracts. The European countries that meet these criteria are Greece, Lithuania, and Spain. In these countries, both long-distance and regional services are under the sole responsibility of the state, according to IRG Rail (2018). This section will detail the situation in each country as previously done.

In Greece, the domestic incumbent is Hellenic Train, a former state-owned company privatized in 2017. Previously a subsidiary of the infrastructure manager, Hellenic Railways Organisation, Hellenic Train is now a wholly owned subsidiary of Ferrovie dello Stato Italiane, the infrastructure manager of Italy. This demonstrates a complete institutional separation. Hellenic Train is the sole passenger operator and the main freight operator in Greece, with no competition in the PSO passenger market. According to European Commission (2023), the Greek state directly awarded 18 PSO contracts in 2020, with no contracts competitively tendered.

In Lithuania, the domestic incumbent is LTG Link, and the infrastructure manager is Lietuvos geležinkeliai, both separate entities according to Dionori et al. (2011). No competition exists in the PSO passenger market in Lithuania. In 2020, Lithuania directly awarded one PSO contract, with no competitively tendered PSO contracts (Eighth Monitoring Report of the European Commission (2023)).

In Spain, the domestic incumbent is Renfe, which operates both passenger and freight transport on the infrastructure managed by Administrador de Infraestructuras Ferroviarias, a Spanish public body responsible for the national rail network. Renfe is the sole PSO passenger operator in Spain, with no competition in this market. In 2020, no competitively tendered procedures for awarding PSO contracts were observed, as well as no new PSO contracts were directly awarded in that year (Eighth Monitoring Report of the European Commission (2023)). We will now observe and analyze the PSO compensation per passenger-kilometer in Greece, Lithuania, and Spain between 2016 and 2022, as presented in Figure 9.

Figure 9: PSO compensation per passenger-kilometer for the Sixth Group from 2016 to 2022



Source: IRG Rail (2018 to 2024)

Let's now examine the PSO compensation per passenger-kilometer in these countries. It is challenging to identify a clear trend in these comparisons due to the diverse distribution of PSO compensation per passenger-kilometer. Lithuania exhibited the lowest level of PSO compensation per passenger-kilometer from 2016 to 2018, maintaining a level of 0.01 Euros per passenger-kilometer. A significant increase occurred in 2019, with PSO compensation rising to 0.15 Euros per passenger-kilometer. The pandemic did not impact Lithuania as severely as other countries seen previously (Germany, France), as evidenced by the PSO compensation of 0.16 Euros per passenger-kilometer in 2020. Subsequently, Lithuania attempted to reduce this PSO compensation, but by 2022, it had not returned to pre-2019 levels, with a PSO compensation of 0.10 Euros per passenger-kilometer.

The increase observed in 2019 can be attributed to the share of the Lithuanian passenger railway undertaking's revenues from compensation, which rose from approximately 20 percent during 2016-2018 to 74 percent in 2019. This percentage further increased to 80 percent in 2020 and 2021, before returning to 70 percent in 2022. This rise in the share of total revenues appears to explain the increase in PSO compensation per passenger-kilometer. Notably, this increase occurred before the COVID-19 crisis, indicating that the pandemic was not the primary cause of the rise. The share of the Lithuanian passenger railway undertaking's revenues from compensation can be observed in Table 10.

Table 10: Share of passenger railway undertaking's PSO revenues from compensations in Lithuania

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	20%	19%	19%	74%	83%	80%	70%

Source: IRG Rail (2018 to 2024)

For Greece, we observed a generally low PSO compensation per passenger-kilometer, starting at 0.03 Euros per passenger-kilometer in 2016 and increasing to 0.05 Euros per passenger-kilometer from 2017 to 2019. This figure rose by 0.03 Euros per passenger-kilometer in 2020 and 2021,

likely due to the COVID-19 crisis. However, it began to decrease slightly in 2022, reaching 0.06 Euros per passenger-kilometer. Although this level has not returned to pre-pandemic figures, it appears poised to revert to those levels in the coming years. This increase in PSO compensation per passenger-kilometer is also reflected in the share of revenues from compensations, which were around 50 percent before 2020 and approximately 60 percent during 2020-2021, underscoring the additional support provided during the pandemic. This can be observed in Table 11.

Table 11: Share of passenger railway undertaking's PSO revenues from compensations in Greece

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	46%	53%	51%	47%	61%	58%	50%

Source: IRG Rail (2018 to 2024)

The last country in this group is Spain. In Spain, there was a consistent increase in PSO compensation per passenger-kilometer from 2016 to 2019, rising from 0.06 Euros in 2016 to 0.13 Euros in 2019. Compared to Greece and Lithuania, Spain saw a significant peak in 2020, with PSO compensation reaching 0.25 Euros per passenger-kilometer, the highest in this group. This figure decreased to 0.20 Euros in 2021 and further to 0.16 Euros in 2022. While Spain has not yet returned to pre-pandemic levels, the downward trend suggests it may do so in the coming years. The gradual increase in PSO compensation from 2016 to 2019 is also reflected in the share of total revenues from compensations, which rose from 46 percent in 2016 to 60 percent in 2019. Due to the COVID-19 crisis, this share surged to 78 percent in 2020 and remained relatively high at approximately 75 percent in 2021 and 2022, indicating potential ongoing challenges for Renfe in generating profits and increasing revenues from tickets and fares. The evolution of share of total revenues from compensations can be observed in Table 12.

Table 12: Share of passenger railway undertaking's PSO revenues from compensations in Spain

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	46%	54%	60%	60%	78%	74%	75%

Source: IRG Rail (2018 to 2024)

In conclusion, the sixth group, consisting of Greece, Lithuania, and Spain, displays diverse trends in PSO compensation per passenger-kilometer from 2016 to 2022. Greece exhibited a low and relatively stable compensation with a slight increase due to the COVID-19 crisis. Lithuania experienced a significant rise in 2019, with further increases during the pandemic, highlighting the impact of increased revenue shares from compensations. Spain showed a consistent increase in compensation pre-pandemic, peaking in 2020, with gradual decreases thereafter, reflecting sustained financial challenges. Overall, these trends underscore the varying impacts of the pandemic and the unique structural dynamics within each country's PSO market.

8.7 Seventh Group

Denmark, Portugal, Romania, Slovakia, and the United Kingdom all meet the criteria of the seventh group. This group is characterized by institutional separation, competition in the PSO passenger market, and a centralized model for awarding and financing PSO contracts. In this centralized

model, the state is solely responsible for both long-distance and regional services (IRG Rail (2018)). Unfortunately, data for Denmark and Slovakia are unavailable, as the necessary calculations could not be performed using the reports from IRG Rail and no relevant data on subsidies or compensation for PSO contracts were found. Therefore, the analysis will focus only on Portugal, Romania, and the United Kingdom. The following paragraphs will provide detailed information on the railway market in each country within this seventh group, even for Denmark and Slovakia.

Denmark has some competition in the PSO passenger market. The Danish incumbent, Danske Statsbaner, and the infrastructure manager, Banedanmark, operate under institutional separation, ensuring fair and non-discriminatory track allocation. Other operators in this market include Midtjyske Jernbaner and Arriva. According to the Eighth Monitoring Report by the European Commission (2023), all passenger traffic in Denmark was performed under PSO services in 2020. Additionally, Denmark directly awarded two PSO contracts in 2020, with no contracts competitively tendered (European Commission (2023)).

In Portugal, the PSO passenger market is served by two operators: the main incumbent, Comboios de Portugal, and the private operator, Fertagus. According to IRG Rail (2020), the domestic incumbent held an 85 percent share of the market, while Fertagus operated in the suburbs of Lisbon. Notably, the two companies are not in direct competition (IRG Rail (2020)), as Comboios de Portugal covers the entire Portuguese network, whereas Fertagus operates exclusively in the Lisbon suburbs. The infrastructure manager, Infraestruturas de Portugal, is responsible for managing and administering the country's rail and road infrastructure.

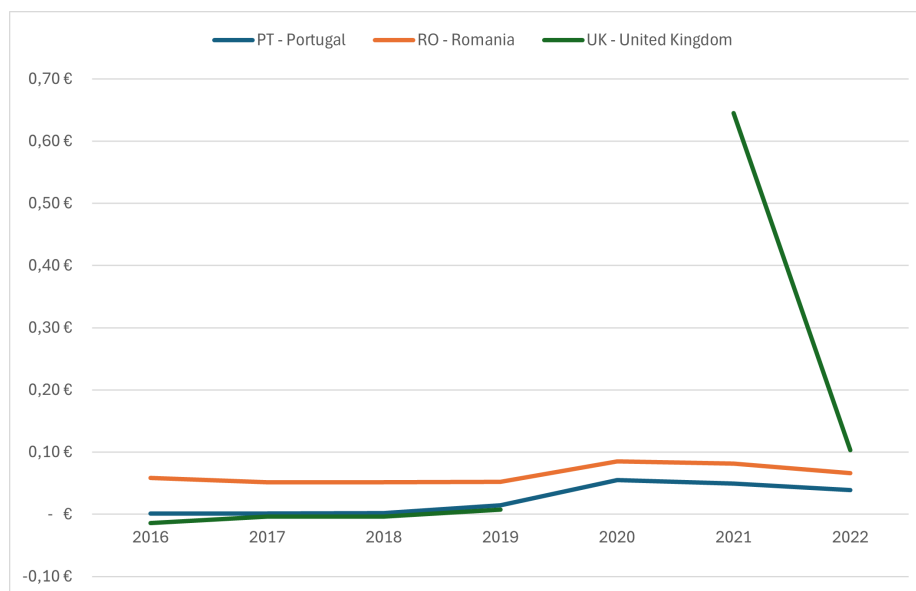
In Romania, the domestic incumbent, Căile Ferate Române Călători, holds the largest market share among various PSO passenger operators, including Softrans, Transferoviar Calatori, and Regio Calatori. According to the Eighth Monitoring Report by the European Commission (2023), all passenger services in Romania were provided under PSO contracts in 2020. The infrastructure manager, Compania Națională de Căi Ferate, is responsible for infrastructure management, and there is no link between the domestic incumbent and the infrastructure manager, as noted by Dionori et al. (2011).

In Slovakia, there is institutional separation between the domestic incumbent, Železničná spoločnosť Slovensko, and the infrastructure manager, Železnice Slovenskej republiky, as reported by Dionori et al. (2011). There is some competition on different tracks, with private company RegioJet fulfilling some PSO contracts for instance. However, information on the railway situation in Slovakia is limited, resulting in a shorter description.

In the United Kingdom, the situation is distinct, as it is a pioneering country in the liberalization of the railway market. There are two major infrastructure managers: Network Rail, which manages and owns most of the infrastructure and operates under the Department for Transport, and Northern Ireland Railways, which connects Northern Ireland's infrastructure with that of Ireland. In 2018, there were approximately 21 PSO passenger operators in the United Kingdom, each running specific services within designated areas (IRG Rail (2020)). According to the Seventh Monitoring Report by the European Commission (2021), the United Kingdom predominantly uses competitive tendering over direct awarding of PSO contracts, with approximately 60 percent of PSO contracts awarded through competitive tendering. The United Kingdom serves as a model for attributing PSO contracts via competitive tendering, promoting a fair and non-discriminatory allocation of tracks,

reducing barriers to entry, and fostering a healthier market. Figure 10 illustrates the distribution of PSO compensation per passenger-kilometer in Portugal, Romania, and the United Kingdom from 2016 to 2022.

Figure 10: PSO compensation per passenger-kilometer for the Seventh Group from 2016 to 2022



Source: IRG Rail (2018 to 2024)

It is important to note that we have a data gap for the United Kingdom in 2020. Before the COVID-19 crisis in 2020, Romania had the highest PSO compensation per passenger-kilometer, approximately 0.05 Euros, whereas Portugal had a compensation level close to 0.01 Euros per passenger-kilometer. This discrepancy is also evident in the share of passenger PSO operators' revenues from compensations. In Romania, the share was around 60 percent during these years, while in Portugal, it was only 2 percent until 2019, when it increased to 19 percent. Table 13 shows the evolution of the share of passenger railway undertaking's PSO revenues from compensations.

Table 13: Share of passenger railway undertakings' PSO revenues from compensations in Portugal and Romania

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share in PT	2%	2%	3%	19%	52%	50%	41%
Percentage Share in RO	60%	59%	58%	58%	70%	70%	62%

Source: IRG Rail (2018 to 2024)

In 2020, Romania saw an increase in PSO compensation to 0.08 Euros per passenger-kilometer, and Portugal's compensation rose to 0.05 Euros per passenger-kilometer. The share of revenues

also changed significantly, reaching 70 percent in Romania and 52 percent in Portugal. As of 2022, neither country has returned to pre-pandemic levels, with Romania at 0.07 Euros per passenger-kilometer and Portugal at 0.04 Euros per passenger-kilometer. However, Romania's share of PSO passenger operators' revenues from compensation has reverted to pre-pandemic levels, whereas Portugal continues to struggle with a higher percentage of 41 percent in 2022. This data underscores the ongoing impact of the COVID-19 crisis on the railway market and the continued support needed for recovery.

In the United Kingdom, PSO compensation was negative from 2016 to 2018. This unusual situation implies that railway undertakings returned a portion of their revenues to the state. Specifically, PSO compensation per passenger-kilometer ranged from -0.01 Euros to nearly zero Euros in 2018. These negative figures may result from overestimated compensations in prior years, corrected in subsequent periods, leading to net negative values. If the government or responsible authority determined that excessive compensation was provided previously, railway undertakings might have been required to repay the overcompensation. This hypothesis is plausible given the difficulty in finding detailed information on these negative figures.

A data gap exists for 2020, but the PSO compensation per passenger-kilometer in 2021 suggests significant impact from COVID-19, increasing the compensation level to 0.65 Euros per passenger-kilometer, the highest in the group and second only to Luxembourg during the year. This increase is mirrored in the share of PSO operators' revenues from compensation, which rose from 4 percent in 2019 to 79 percent in 2021, indicating substantial state support during the crisis. By 2022, PSO compensation decreased significantly to 0.10 Euros per passenger-kilometer, suggesting a recovery in activity and reduced need for state support. However, this level has not yet returned to pre-pandemic figures. This can be observed in Table 14.

Table 14: Share of passenger railway undertaking's PSO revenues from compensations in United Kingdom

Years	2016	2017	2018	2019	2020	2021	2022
Percentage Share	-9%	-2%	-2%	4%	-%	79%	35%

Source: IRG Rail (2018 to 2024)

The seventh group shows varied PSO compensation practices within a framework of institutional separation, centralized models, and market competition. Portugal's and Romania's PSO markets saw increased compensation during the pandemic, reflecting heightened state support. The United Kingdom had unique negative PSO compensations from 2016-2018 due to overcompensation corrections, followed by a significant rise in 2021 due to the pandemic. Overall, state intervention has again been crucial in stabilizing the PSO passenger market during crises, with varied impacts based on market competition and institutional arrangements. Future adjustments are anticipated as markets recover and state support is recalibrated.

8.8 Eighth Group

Lastly, the eighth group comprises countries with institutional separation, competition in the PSO passenger market, and a decentralized model for awarding and financing PSO contracts. This group,

meeting all three key criteria, represents the most advanced model and serves as an exemplar of the European Union's vision for the PSO passenger market. The countries in this group are Czechia, the Netherlands, and Sweden. In these countries, the state is responsible for long-distance services, while regional services fall under the purview of regional authorities (IRG Rail (2018), Dolinayova and Domeny (2022)). The following sections will provide a detailed description of the PSO passenger markets in each of these countries.

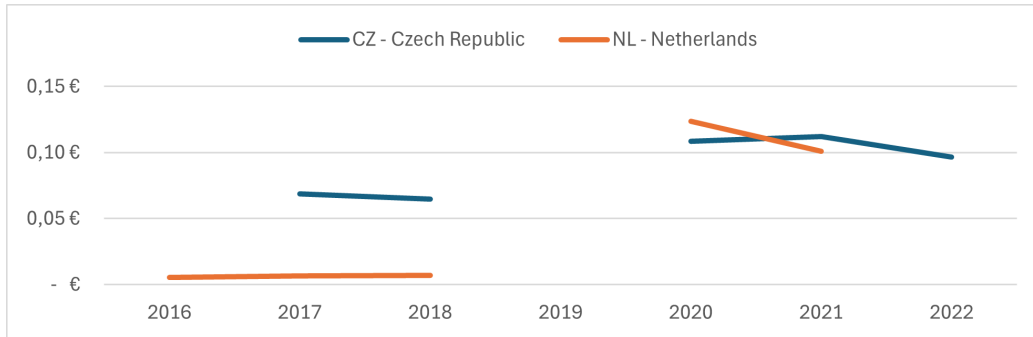
We begin with Czechia. In Czechia, the domestic incumbent is České dráhy and the infrastructure manager is Správa železnic. These two companies operate independently due to the complete vertical separation. According to the report of IRG Rail (2020), PSO contracts covered 92 percent of passenger transport in 2018. The main PSO passenger operator was the domestic incumbent; however, there were also seven other railway undertakings in the PSO passenger market in 2018, such as RegioJet and GW Train Regio, the second largest railway undertaking. The allocation of PSO contracts in Czechia is primarily through direct awards, with seven PSO contracts directly awarded in 2020 and none competitively tendered (Eighth Monitoring Report of the European Commission (2023)).

In the Netherlands, the domestic incumbent is Nederlandse Spoorwegen, and the infrastructure manager is Railinfratrust, managed and maintained by the government agency ProRail. These entities are entirely separate. Competition in the Netherlands was limited, as long-distance and regional services were directly awarded to the domestic incumbent in 2018, covering 95 percent of passenger-kilometers (IRG Rail (2020)). Nevertheless, there are competitors in the PSO passenger market with competitively tendered PSO contracts. These include subsidiaries of foreign incumbents such as Qbuzz from Trenitalia and Keolis from SNCF, as well as private companies like Connexion (IRG Rail (2020)). No new PSO contracts were competitively tendered or directly awarded in 2020 according to the Eighth Monitoring Report of the European Commission (2023).

In Sweden, passenger traffic is almost exclusively managed by regional authorities, with limited long-distance services, which reduces the compensation from the Swedish state (IRG Rail (2020)). The domestic incumbent is Statens Järnvägar, and the infrastructure manager is Trafikverket, a government agency controlled by the Riksdag, the legislature and the supreme decision-making body of the Kingdom of Sweden, and the Government of Sweden. There is competition in the Swedish PSO passenger market. In 2018, there were five different railway undertakings in the PSO passenger market, with the main players being the domestic incumbent, Arriva (a subsidiary of Deutsche Bahn), and MTRX (a subsidiary of the Finnish incumbent Valtion Rautatiet) according to the report of IRG Rail (2020). In 2020, five PSO contracts were competitively tendered, with none directly awarded according to European Commission (2023). Sweden has been a pioneer in the liberalization of the railway market and exemplifies the European Union's vision for the sector.

We now examine the distribution of PSO compensation per passenger-kilometer for this final group of countries. Unfortunately, data on PSO compensation for Swedish passenger operators are unavailable, and it was not possible to estimate these compensations. Additionally, data for Czechia and the Netherlands are incomplete for various years. Specifically, there are no data for Czechia for 2016 and 2019, and for the Netherlands for 2019 and 2022. This lack of data complicates the analysis of PSO compensation per passenger-kilometer for this last group. Consequently, Figure 11 presents the available PSO compensation data for Czechia and the Netherlands from 2016 to 2022.

Figure 11: PSO compensation per passenger-kilometer for the Eighth Group from 2016 to 2022



Source: IRG Rail (2018 to 2024)

The available data indicate that Czechia had a PSO compensation level of 0.07 Euros per passenger-kilometer in 2017 and 0.06 Euros per passenger-kilometer in 2018. In contrast, the Netherlands had a lower level of PSO compensation during these years, with a consistent level of 0.01 Euros per passenger-kilometer from 2016 to 2018. Despite the absence of data for 2019, the share of revenues from compensations did not vary significantly between 2018 and 2019, with levels of 62 percent and 66 percent, respectively. This suggests that the PSO compensation per passenger-kilometer in 2019 likely remained close to the 2018 level. Czechia appears to have been impacted by the COVID-19 crisis, with PSO compensation rising to 0.11 Euros per passenger-kilometer in 2020 and 2021, before slightly decreasing to 0.10 Euros per passenger-kilometer in 2022. Similarly, although data for the Netherlands in 2020 are missing, it is evident that the country also had to increase PSO compensation, reaching 0.12 Euros per passenger-kilometer in 2021, which then decreased slightly to 0.10 Euros per passenger-kilometer. The lack of data for 2022 prevents a conclusive assessment of whether this decreasing trend in the Netherlands continued.

The eighth group, comprising Czechia, the Netherlands, and Sweden, exemplifies an advanced stage in the liberalization of the PSO passenger market, characterized by institutional separation, competition, and a decentralized model of awarding and financing PSO contracts. Despite data gaps, analysis indicates that Czechia and the Netherlands both experienced increases in PSO compensation per passenger-kilometer during the COVID-19 pandemic, reflecting heightened government support. While Czechia showed a slight decrease in compensation in 2022, the trend in the Netherlands remains unclear due to missing data. This group's structure aligns well with EU goals for a competitive and fair railway market.

9 Conclusion

To fully grasp the conclusion, it is essential to revisit the research question and the objectives of this thesis. The primary aim of this study was to investigate the scale of public subsidies received by passenger rail operators across European countries and to analyze the evolution of this financial support over time. Specifically, the thesis sought to calculate the subsidy per passenger-kilometer for various European countries from 2016 to 2022, despite challenges related to data availability. By employing the per passenger-kilometer metric, the research endeavored to offer a detailed understanding of the financial compensation provided to the rail passenger transport sector and to assess its implications for the performance and competitiveness of passenger rail operators. These objectives were encapsulated in the central research question: What is the scale of public subsidies received by rail passenger operators in Europe, and how has this public support evolved across different European countries between 2016 and 2022 ?

As mentioned earlier, this thesis has delved into the complexities of public subsidies in the European passenger rail sector, with a particular focus on the evolution of financial support from 2016 to 2022. Through an in-depth comparative analysis across various European countries, the research has shed light on the different approaches to public service obligation compensation and its implications for the efficiency and competitiveness of the railway market. Indeed, the analysis of PSO compensation, which forms the central focus of this study, pertains to the subsidies provided to passenger rail operators managing non-profitable lines under PSO contracts.

To conduct European comparisons and present the findings, this thesis relied on a methodology built upon three critical criteria. The first criterion is the degree of vertical separation between the infrastructure manager and passenger operators. A clear vertical separation facilitates market entry for new passenger operators and ensures equitable competition with the domestic incumbent, as it promotes transparency and non-discriminatory treatment among rail operators. Vertical separation is categorized into two types: organizational separation, where the infrastructure manager and passenger operators are part of the same overarching organization, and institutional separation, which entails a complete legal and functional division between infrastructure management and railway operations. The second criterion considered is the presence of competition in the PSO railway passenger market. European countries are divided into two categories based on this criterion: those where multiple railway operators fulfill different PSO contracts, indicating the presence of competition, and those where the domestic incumbent solely dominates the PSO rail passenger market, reflecting an absence of competition. The final criterion is the method by which PSO contracts are awarded, categorized as either a centralized or decentralized model. In a centralized model, a single authority — typically the state — oversees both long-distance and regional services. Conversely, in a decentralized model, multiple authorities are responsible, with the state usually managing long-distance services and regional authorities overseeing regional services. These three criteria formed the methodological framework of this thesis, enabling a comparative analysis of the PSO compensation allocated to rail passenger operators across different European countries.

The findings of this thesis reveal significant disparities in PSO compensation per passenger-kilometer across the European Union. Countries with institutional vertical separation and multiple PSO operators, such as Portugal, Romania, the United Kingdom, Czechia, and the Netherlands, generally

demonstrated more competitive markets. This competitive environment has resulted in lower compensation levels and enhanced efficiency. These countries have successfully maintained or even increased service levels while optimizing costs, particularly through the implementation of competitive tendering processes.

In contrast, countries characterized by organizational separation and the presence of a single PSO operator — such as France, Belgium, and Luxembourg — tend to exhibit higher compensation levels, indicative of a less competitive market environment. These countries often rely heavily on direct awards for PSO contracts, which can limit the potential benefits of competition, including cost reductions and service enhancements. However, drawing a comprehensive conclusion across different European countries remains challenging due to the varied approaches to determining and distributing PSO compensation, as well as the distinct methodologies employed by each country.

Furthermore, the impact of external factors, essentially the COVID-19 pandemic, has added a big layer of complexity to the landscape of PSO compensation in the railway sector. The disruptions caused by the pandemic underscored the resilience of different national systems and emphasized the need for adaptable and robust subsidy mechanisms capable of withstanding such shocks. In response to the pandemic, PSO compensations increased across many countries as governments sought to stabilize the sector amid drastically reduced passenger numbers. However, the recovery trajectories have varied significantly. Some countries, such as Italy or Romania, have returned more quickly to pre-pandemic levels of compensation, while others, like Austria, Hungary or Spain, continue to face challenges in their recovery. The pandemic's influence has also introduced biases into the analysis conducted in this thesis, as the period under review was notably affected by the unprecedented disruptions, thereby complicating a clear assessment of long-term trends.

In conclusion, while this thesis has provided a detailed analysis of the current state of PSO compensation in the European passenger railway sector, it also highlights important avenues for future research. The findings suggest that the effectiveness of public subsidies in the railway sector is influenced not only by the amount of financial support provided but also by the broader regulatory and competitive environment. The ongoing challenges of market liberalization, the potential for further harmonization of subsidy mechanisms across the European Union, and the long-term sustainability of public support in an increasingly competitive and dynamic market remain critical areas for further investigation. As Europe continues its efforts toward greater integration and liberalization of its railway markets, both freight and passenger markets, these factors will be essential in shaping the future efficiency and sustainability of rail transport across the continent.

10 Appendices

Table 15: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the First Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
BE	0.11	0.12	0.11	0.12	0.15	0.12	0.10
BG	0.07	0.07	0.07	0.07	0.08	0.08	0.07
HR	0.07	0.08	0.08	0.08	0.14	0.14	0.09
EE	-	0.04	0.06	0.06	0.09	0.10	0.08
HU	0.07	0.01	0.01	0.01	0.16	0.13	0.10
LV	0.08	0.08	0.09	0.08	0.07	0.08	0.04
LU	-	0.38	0.40	0.42	0.81	0.76	0.65
SI	-	-	-	-	0.14	0.17	0.11

Source: IRG Rail (2018 to 2024)

Table 16: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the Second Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
FR	0.15	0.15	0.16	0.21	0.30	0.23	0.17

Source: IRG Rail (2018 to 2024)

Table 17: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the Third Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
AT	0.10	0.11	0.11	0.12	0.19	0.21	0.16
IT	0.09	0.09	0.09	0.11	0.19	0.16	0.10
PL	0.03	0.03	0.04	0.04	0.07	0.06	0.04

Source: IRG Rail (2018 to 2024)

Table 18: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the Fourth Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
DE	0.10	0.10	0.11	0.12	0.20	0.24	0.15

Source: IRG Rail (2018 to 2024)

Table 19: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the Sixth Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
GR	0.03	0.05	0.05	0.05	0.08	0.08	0.06
LT	0.01	0.01	0.01	0.15	0.16	0.14	0.10
ES	0.06	0.08	0.10	0.13	0.25	0.20	0.16

Source: IRG Rail (2018 to 2024)

Table 20: PSO compensation per passenger-kilometer in euro per passenger-kilometer for the Seventh Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
PT	0.01	0.01	0.01	0.01	0.05	0.05	0.04
RO	0.06	0.05	0.05	0.05	0.08	0.08	0.07
UK	-0.01	-0.00	-0.00	0.01	-	0.65	0.10

Source: IRG Rail (2018 to 2024)

Table 21: compensation per passenger-kilometer in euro per passenger-kilometer for the Eighth Group from 2016 to 2022

Years	2016	2017	2018	2019	2020	2021	2022
CZ	-	0.07	0.06	-	0.11	0.11	0.10
NL	0.01	0.01	0.01	-	0.12	0.10	-

Source: IRG Rail (2018 to 2024)

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12 Executive Summary

This thesis aims to examine the extent of public subsidies provided to passenger rail operators across various European countries and to analyze the evolution of this financial support. In light of recent developments in the European railway market, the thesis seeks to shed light on an often overlooked aspect of the market. The complexity of this research lies in the availability and accessibility of data related to subsidies. To address this challenge, we present an estimation method for the relevant data for each European country, as well as a methodology in order to group the European countries. The study concludes that drawing comprehensive conclusions is difficult due to the impact of COVID-19 pandemic, the diverse approaches each European country takes regarding subsidies for passenger rail operators, as well as the differing methodologies used for calculating these subsidies.