Communication 1/2024, of 12 March 2014, of the National Markets and Competition Commission on the oversight of the charges for the use of railway lines belonging to the General Interest Railway Network

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1. INTRODUCTION

1. Railway charges are mainly composed of two parts: the charge itself, which should reflect the costs directly incurred as a result of the operation of rail services, and the mark-up, which may be added when the market can bear it, to recover the remaining costs borne by infrastructure managers that can be recovered through charges.

2. According to current regulations, the infrastructure manager must objectively demonstrate that the costs allocated to charges are directly incurred as a result of the operation of rail services, i.e. variable with rail traffic. In order to levy mark-ups, it must demonstrate that the market can bear them, that they do not exclude from infrastructure use market segments that could pay at least the direct cost, that they respect the productivity gains achieved by railway undertakings and that the competitiveness of the rail mode is ensured.

3. Law 26/2022 of 19 December 2022, amending Law 38/2015 of 29 September 2015 on the railway sector, decoupled the determination of railway charges from the General State Budget Act, stating that they shall be approved by means of a regulation issued by the infrastructure manager.

4. Law 26/2022 of 19 December 2022 also amended Law 3/2013 of 4 June 2013 on the creation of the National Markets and Competition Commission (hereinafter, 'LCNMC' as per its Spanish acronym), emphasising the powers of the CNMC, as an independent regulator, in the oversight of railway charges. Furthermore, the

Court of Justice of the European Union (hereinafter, 'CJEU') and the Spanish National High Court have confirmed the role of the CNMC as the sector regulator in controlling the legality of the charging system and the amount and structure of railway charges.

5. The determination of the direct costs and mark-ups requires a thorough knowledge of the infrastructure manager's costs and of the demand for rail services in order to discriminate, through a series of complex economic calculations, the costs that are variable with traffic, and to ensure that the mark-ups can be borne by the relevant market segments.

6. Railway undertakings must invest for the long term, so the charging system must be predictable and infrastructure managers must establish a stable methodology to avoid uncertainty about its evolution.

7. Article 100(4) of Law 38/2015, of 29 September 2015, on the railway sector (hereinafter, 'the Railway Sector Act') provides that the activity plan of infrastructure managers shall contain a forecast of updates to charges during its period of validity. It is therefore necessary to establish a methodology for calculating direct costs and determining mark-ups for multi-year periods.

8. The legality analysis that the CNMC must carry out is particularly relevant in the new framework for the approval of railway charges established by Law 26/2022, of 19 December 2022. Given the powers of the CNMC to supervise railway charges, the purpose of this Communication is to provide transparency to the principles that will guide its actions in the analysis of the legality of the charges and mark-ups regulated in Articles 96(4) and 97(5)(3) of the Railway Sector Act, submitted by the infrastructure manager.

2. JURISDICTIONAL POWERS

9. According to Article 11(1) of the LCNMC, this Commission *"shall exercise, either on its own initiative or at the request of the competent authorities or interested parties, the following functions: (i) Ensure that railway charges and private prices established by the infrastructure manager comply with the provisions of European Union law, the railway sector legislation and its implementing regulations, and that they are non-discriminatory"*.

10. Article 11(2) of the LCNMC states that the CNMC shall supervise and control, on its own initiative, the activities of infrastructure managers regarding, among others:

"(b) the charging system and the amount and structure of railway charges, fares and prices for the use of infrastructure and services.

(d) the consultation process prior to establishing charges and tariffs between railway undertakings or applicants and infrastructure managers. The CNMC shall intervene where it considers that the outcome of this process may contravene the provisions in force."

11. In order to supervise this matter, Article 11(1)(h) of the LCNMC confers on the CNMC the power to *"[m]onitor compliance with the applicable accounting provisions and the provisions on financial transparency established in paragraphs 3 and 4 of Article 21 of Law 38/2015, of 29 September 2015, on the railway sector, within the framework of railway regulations, for which it may carry out or commission audits to infrastructure managers, operators of service facilities and, where appropriate, railway undertakings."*

12. Article 11(3) of the LCNMC confers on the CNMC the power to adopt *"on its own initiative and where appropriate, the necessary measures to correct discrimination to the detriment of applicants, market distortions and other undesirable market conditions, in particular with regard to the provisions of numbers 1 to 9 of Section 1(f) of Article 12"*. Point 3 of Article 12(1)(f) refers to the amount, structure and application of railway charges.

13. Therefore, the CNMC has the power to supervise and take measures relating to railway charges.

14. Article 30(3) of the LCNMC establishes that the CNMC *"may issue communications clarifying the principles guiding its actions"*.

3. REGULATORY FRAMEWORK

3.1. European Framework

15. Article 4 of Directive 2012/34/EU of 21 November 2012, establishing a single European railway area (hereinafter, the RECAST Directive), states that *"while respecting the charging and allocation framework and the specific rules established by Member States, the infrastructure manager shall be responsible for its own management, administration and internal control"*. Article 7 of the same Directive requires infrastructure managers to be independent with regard to their essential functions: allocating infrastructure capacity and establishing railway charges. The ultimate aim of this independence is for infrastructure managers to use charges as a management tool to market and make optimum effective use of the available infrastructure capacity (Article 26).

16. According to Article 56 of the RECAST Directive, the regulatory body shall monitor railway charges on its own initiate or at the request of another party and ensure that they comply with the provisions of Section 2 of Chapter IV of Directive 2012/34/EU and are non-discriminatory.

17. The CJEU has ruled on different occasions on the role of the regulatory body in the oversight of railway charges:

- The Judgment of 9 November 2017 (Case C-489/15)[1] concluded that *"the reimbursement of charges by application of the provisions of civil law can be envisaged only if, in accordance with the provisions of national law, the illegality of the charge in the light of the legislation concerning access to the railway infrastructure has first been found by the regulatory body or by a court which has reviewed that body's decision (…)"* (paragraph 97, emphasis added).

- The Judgment of 9 September 2021 (case C-144/20)[2] confirmed the powers of the regulatory body to make binding decisions concerning infringements of the provisions of Section 2 of Chapter IV of Directive 2012/34 or breaches of the principle of non-discrimination. This judgment, moreover, confirms that this power can be exercised ex officio and confers on the regulator the power to instruct the infrastructure manager what amendments it must make to the charging system in order to correct incompatibility with the rules (paragraphs 38 and 47):

  "(38) Article 56 of Directive 2012/34/EU of the European Parliament and of the Council of 21 November 2012 establishing a single European railway area must be interpreted as meaning that it confers on the regulatory body the power to adopt, on its own initiative, a decision requiring the undertaking exercising the essential functions of the railway infrastructure manager, referred to in Article 7(1) of that directive, to make certain amendments to the infrastructure charging system, even though that system does not entail discrimination vis-à-vis applicants.
  (47) Article 56 of Directive 2012/34 must be interpreted as meaning that the conditions to be introduced in a charging system that the regulatory body is authorised to require of the undertaking exercising the essential functions of railway infrastructure manager must be based on an infringement of Directive 2012/34 and be limited to remedying situations of incompatibility, and cannot include appraisals of appropriateness by the regulatory body that would undermine the latitude enjoyed by the infrastructure manager."

[1] CJEU Judgment of 9 November 2017. ECLI:EU:C:2017:834
[2] CJEU Judgment of 9 September 2021. ECLI:EU:C:2021:717

- In the same vein, the Judgment of 27 October 2022 (Case C-721/20)[3] states the following:

  "(79) Therefore, in order to preserve the full effectiveness of Article 102 TFEU and, in particular, in order to guarantee applicants effective protection against the adverse consequences of an infringement of competition law, the exclusive competence conferred on the regulatory body by Article 30 of Directive 2001/14 cannot prevent the national courts having jurisdiction from hearing claims for the reimbursement of an alleged overpayment of infrastructure charges based on Article 102 TFEU.

  (80) However, that provision in no way precludes, in view of the need for consistent management of the rail network referred to, in particular, in paragraphs 57 to 66above, the retention, subject to the following considerations, of the exclusive competence of the regulatory body to hear all aspects of the disputes brought before it pursuant to Article 30(2) of Directive 2001/14.

  (81) Thus, where a railway undertaking intends, on the basis of Article 102 TFEU, to obtain reimbursement of an alleged overpayment of infrastructure charges, it must, prior to any action being brought before the national courts having jurisdiction, refer the question of their lawfulness to the national regulatory body."

18. In short, the CJEU's interpretation of the existing regulation has confirmed that the regulatory body can take binding decisions for the parties on railway charges and that railway undertakings and applicants must, as a first step, refer the matter to the regulatory body for a ruling on the compliance of charges with the regulatory framework. Only when the regulatory body has concluded that railway charges do not comply with the regulatory framework can railway undertakings seek reimbursement in court[4].

3.2. Spanish Framework

19. Article 96(1) of the Railway Sector Act, in its original wording, defined the revenues that infrastructure managers receive for the use of railway infrastructure and stations as *"regulated charges that shall be known as railway charges"*. Article 100 regulated the procedure for their revision, stating that:

- The infrastructure manager should draw up an economic report justifying its proposal to modify the amounts of charges.

[3] CJEU Judgment of 27 October 2022. ECLI:EU:C:2022:832
[4] As well as, where appropriate, damages for abuse of a dominant position.

- This proposal should be submitted to the railway undertakings for consultation and to the CNMC for reporting.

- Finally, the amounts obtained were to be included in the preliminary draft of the General State Budget Act.

20. Law 26/2022, of 19 December 2022, modified the legal nature of railway charges in order to define them as non-tax public charges, which shall be approved by means of a regulation adopted by the board of directors of the infrastructure manager, to be published in the Official State Gazette and included in the network statement.

21. Regarding the powers of the CNMC, in addition to Article 100 stating that the mandatory report is without prejudice to the powers regarding railway charges provided for in the LCNMC, an amendment is introduced to this law *"expressly conferring on the CNMC the power to ensure that railway charges comply with the law"* (new letter (i) to Article 11(1) of the LCNMC).

22. Royal Decree-Law 23/2018, of 21 December 2018, literally transposed Article 56 of Directive 2012/34/EU into the LCNMC, conferring on the CNMC the power to verify, at the request of a party or on its own initiative, the charging system and the amount and structure of charges (Articles 11(2) and 12(1)(f) of the LCNMC) and to take appropriate measures to correct discrimination and market distortions (Article 11(3) of the LCNMC).

23. The Judgments of 19 September 2022 of the National High Court[5] confirmed that the CNMC's functions in terms of railway charges are not limited to the mandatory report provided for in Article 100 of the Railway Sector Act, but that the CNMC may adopt binding decisions to supervise, in accordance with Article 11(2) of the LCNMC, the charging system and the amount and structure of charges.

4. BACKGROUND

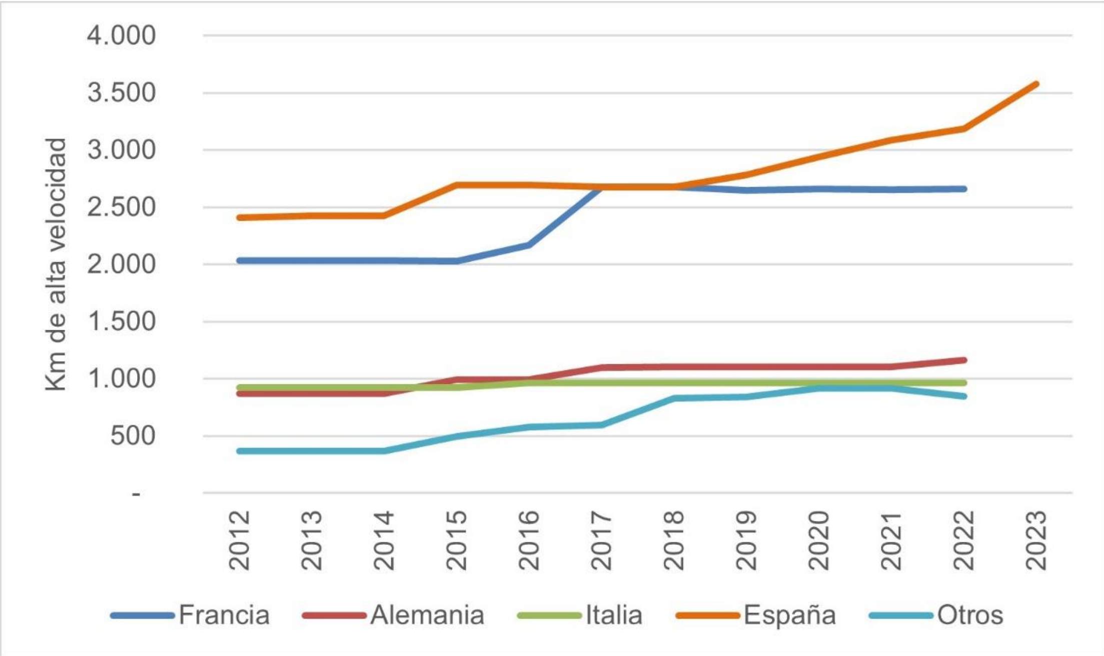
4.1. Railway Services

24. Spain has a rail network of 15,615 km, of which more than 3,500 km are high-speed lines, making it the most extensive high-speed network in the EU. In 2021, the Spanish high-speed network accounted for 35% of the total kilometres in the EU. In terms of network length, Spain is followed by France with 2,657 km and Germany with 1,104 km. According to the European Commission (September

[5] ECLI:ES:AN:2022:4400 and ECLI:ES:AN:2022:4406

2023)[6], between 2015 and 2020, the Spanish high-speed network was the second fastest growing, with 485 additional kilometres, only behind France, which added 676 km. The additions to the Spanish network do not include the latest stretches brought into service, such as the last stretch of the Madrid-Galicia line (119 km in December 2021) and the stretch between Venta de Baños and Burgos (90 km in July 2022).

Graph 1. High-speed network in Europe (km)

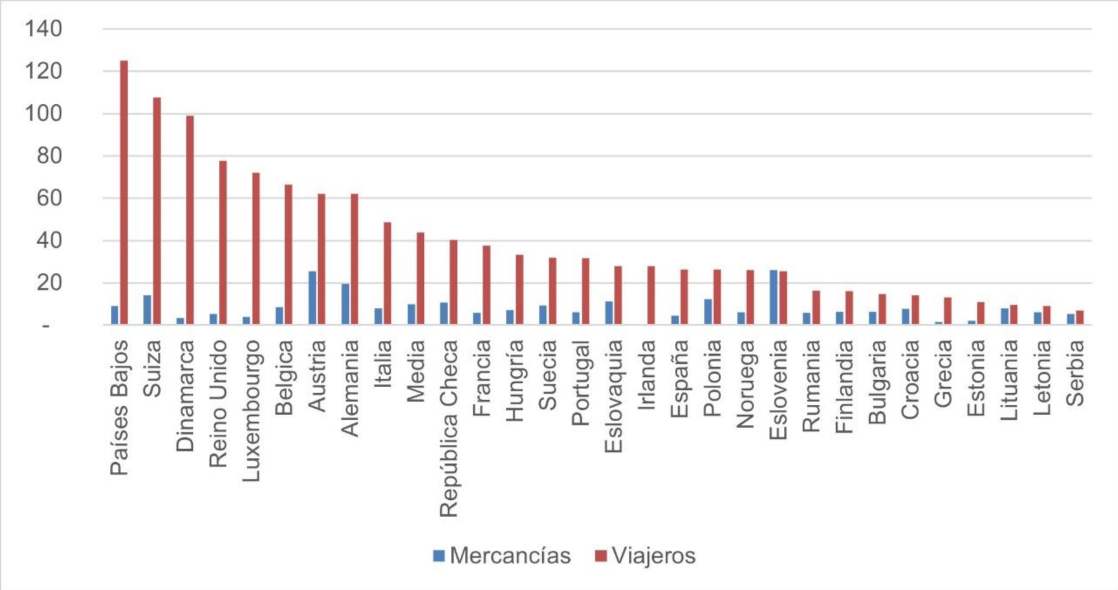


Source: CNMC based on data from IRG-Rail and ADIF and ADIF AV's network statement.

25. In 2022, the use of the Spanish network amounted to 30 trains per day per km (4 freight and 26 passenger trains), below the EU average of 54 trains per day (10 freight and 44 passenger trains).

Graph 2. Rail network utilisation rate (2022)

[6] Working document accompanying the 8th Rail Market Monitoring Report, page 30. https://eur-lex.europa.eu/resource.html?uri=cellar:fdd93148-521e-11ee-9220-01aa75ed71a1.0001.02/DOC_1&format=PDF



Source: CNMC based on data from IRG-Rail.

26. This lower intensity of use is even more pronounced on the high-speed network. In 2022, while high-speed services in France reached 119 million train-km and 61 billion passenger-km, according to the French regulator[7], in Spain, these same services amounted to 32.6 million train-km and 11.49 billion passenger-km (52.8 million train-km and 15.27 billion passenger-km including conventional long-distance services). According to the IRG-Rail methodology, 49 trains per day per km run on the Spanish high-speed network, compared to more than 122 trains per day in France (60% less).

27. The evolution of the number of commercial passengers in Spain is linked to the commissioning of new high-speed infrastructure, which has substantially increased demand due to better performance. It was only in 2013, when RENFE Viajeros substantially reduced the prices of AVE services and new fares were introduced[8], that a significant increase in demand not linked to new infrastructure was observed.

Graph 3. Commercial service passengers

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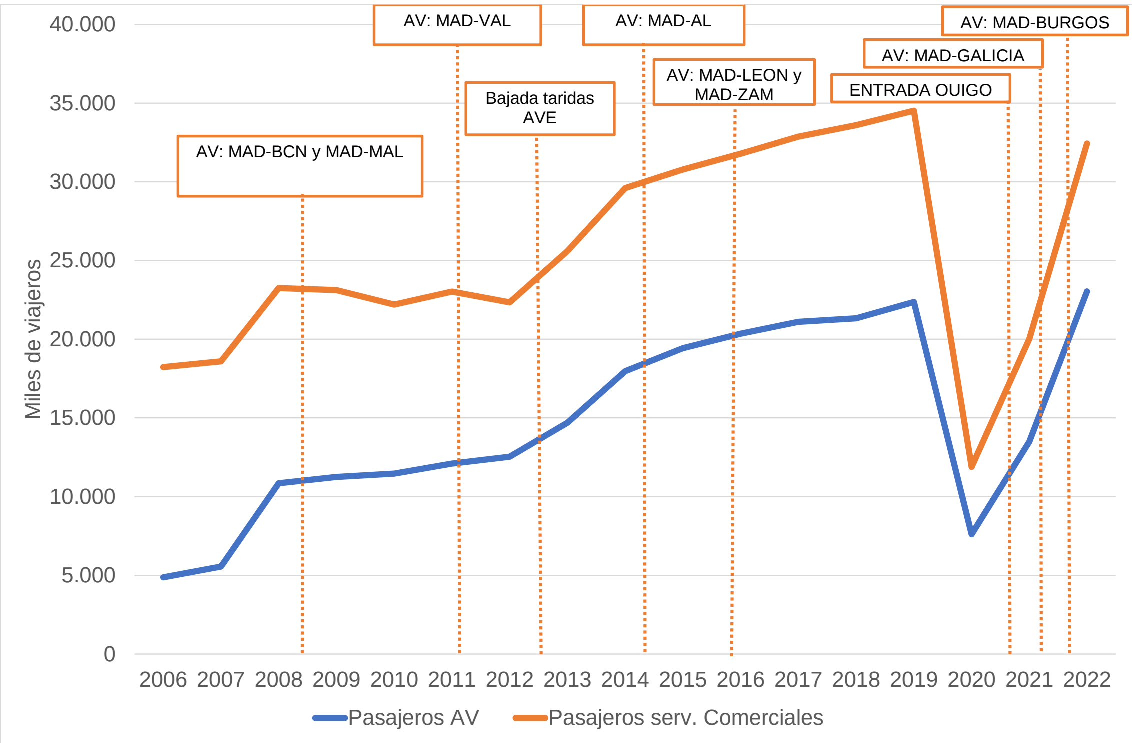
[7] https://www.autorite-transports.fr/actualites/2022-annee-des-premiers-effets-positifs-de-louverture-a-la-concurrence-pour-les-usagers-du-train/

[8] On 8 February 2013, RENFE Viajeros' new fare policy came into force, reducing the price of AVE services by 11% and creating new BonoAVE fares (10 journeys with a 35% discount), and Promo and Promo+ fares, with discounts of up to 70%.

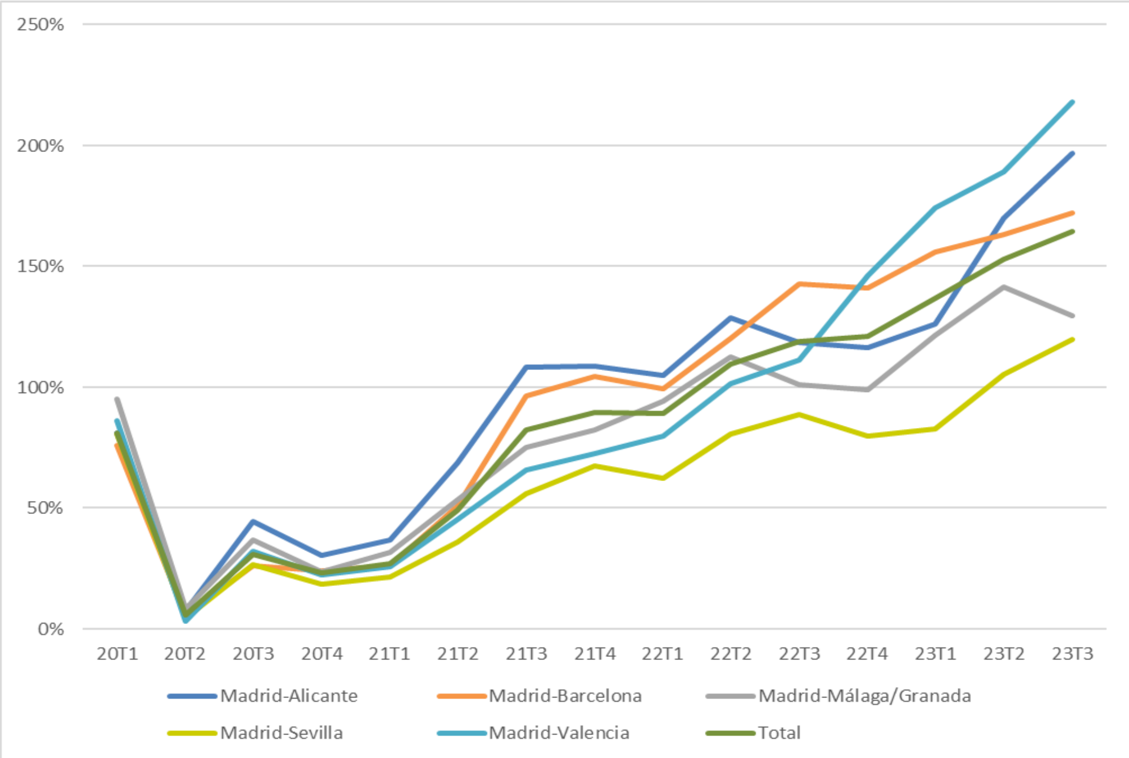


Source: CNMC based on data from its annual reports and the Spanish Railway Observatory.

28. Since 11 May 2021, when competition was introduced in national passenger transport services, there has been an intense growth in demand with new entrants in the different corridors[9], especially in those with three operators.

Graph 4. Passenger numbers on routes with allocated framework capacity

[9] OUIGO began operating between Madrid and Barcelona on 11 May 2021, between Madrid and Valencia on 7 October 2022 and between Madrid and Alicante on 27 April 2023. RENFE launched its AVLO service between Madrid and Barcelona on 26 June 2021, between Madrid and Valencia on 21 February 2022, between Madrid and Alicante on 27 March 2023, and between Madrid and Sevilla/Málaga on 1 June 2023. IRYO entered the Madrid-Barcelona corridor on 25 November 2022, the Madrid-Valencia corridor on 16 December 2022, the Madrid-Sevilla/Málaga corridor on 30 March 2023 and the Madrid-Alicante corridor on 2 June 2023.

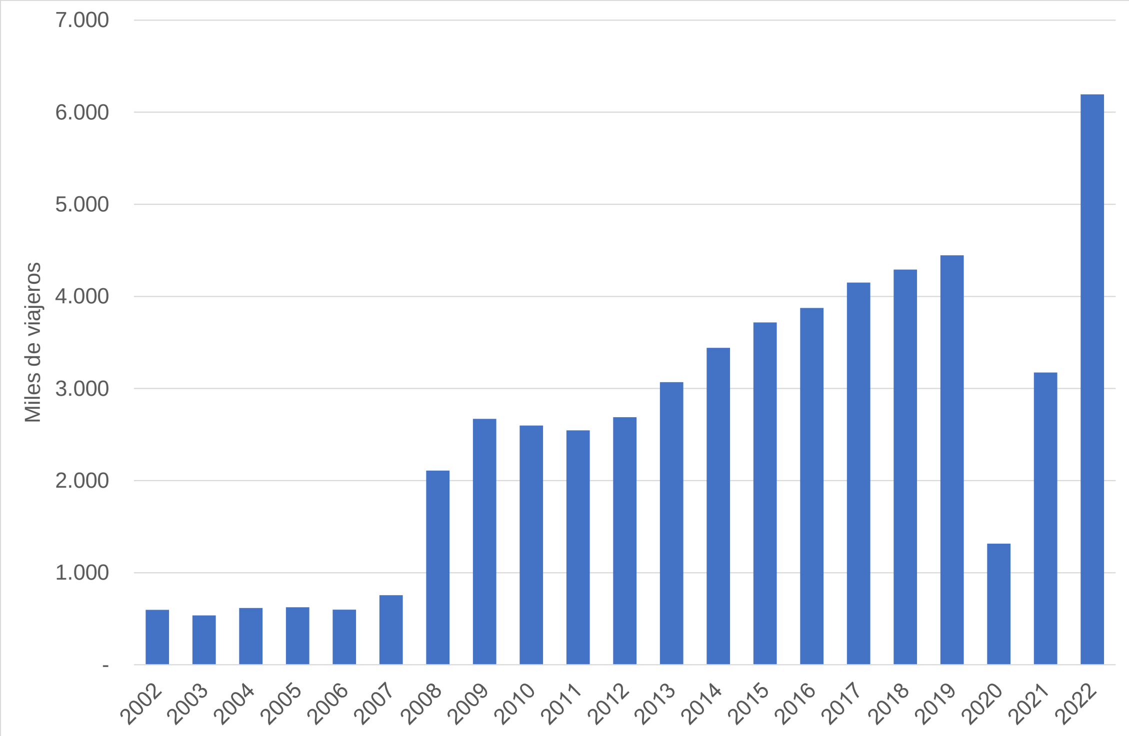


(*) Percentages are calculated with respect to the same quarter of 2019.

Source: CNC based on quarterly data.

29. An analysis of the evolution of passengers between Madrid and Barcelona (point-to-point) shows that the opening of the high-speed line in 2008 increased demand by 1.35 million passengers, while the entry of competition increased passenger numbers by almost 1.75 million since the peak traffic reached in 2019 (4.45 million).

Graph 5. Passengers on the Madrid-Barcelona route (point-to-point)



Source: CNMC based on its quarterly data and on data from the Spanish Railway Observatory

30. In short, the entry of competition in high-speed passenger rail services has brought about a structural change in its evolution, with significant increases in demand comparable to those observed when the infrastructure was upgraded to high-speed.

4.2. Evolution of Railway Charges

31. The public entities Administrador de Infraestructuras (hereinafter, 'ADIF') and ADIF-Alta Velocidad (hereinafter, 'ADIF AV') implemented for the first time in 2017 the charging system provided for in the Railway Sector Act of 2015[10].

[10] Until then, the structure of railway charges was derived from Law 39/2003 of 17 November 2003 on the railway sector, which differentiated between access charges (which remain the same regardless of the use of the network), capacity reservation charges (which depend on the train paths reserved), running charges (which depend on the train paths actually run), and traffic charges (which depend on the number of train-kilometres run). As detailed below, the 2015 Railway Sector Act modified the structure of the charges, equating their amount to the direct costs, plus a mark-up to cover the remaining costs when the market can bear it.

32. On A-lines[11], charges have remained stable[12]. They were reduced only in 2021[13] by 11.2% on the Madrid-Barcelona corridor and by 22% on the Levante corridor as a result of the impact of the pandemic on rail demand (see, by way of example, the values of charges for VL1 services[14]).

Table 1. Charges and mark-ups for VL1 services in A-lines[15]

	2017	2018	2019*	2020*	2021	2022	2023
Charge (€/train-km)							
Mode A	1.9275	1.9275	1.9275	1.9275	1.6767	1.6767	1.6767
Mode B	4.7931	4.7931	4.7931	4.7931	3.6414	3.6414	3.6414
Mode C	0.8020	0.8020	0.8020	0.8020	0.4865	0.4865	0.4865
Mark-up (€ cents/seat-km)							
Madrid-Barcelona	1.7611	1.7611	1.7611	1.7611	1.7611	1.7611	1.7611
Madrid-Andalusia	0.8647	0.8647	0.8647	0.8647	0.8647	0.8647	0.8647
Other A-lines	-	-	-	-	-	-	-

(*) The amounts of railway charges submitted by ADIF and ADIF AV for these years were not implemented because the corresponding General State Budget acts were not approved.

Source: CNMC.

33. On non-A lines, in 2017, ADIF chose to waive the subsidy it had been receiving to cover its operating costs, setting the charges for services subject to public service obligations (passenger suburban and medium-distance services or 'VCM' in its Spanish acronym) at the direct cost level. It also established the addition provided for in Article 97.5.2º(b) on these services, to cover all of the revenues it

[11] A-lines are those that allow a speed of at least 200 km/h on at least two-thirds of their route. The remaining lines are non-A-lines.

[12] ADIF AV suggested increasing the mark-ups in 2020, but the proposal did not come into effect as the General State Budget Act was not passed that year.

[13] For 2021, ADIF AV suggested reducing the charge and increasing the mark-up, setting the amounts of 2.2014 € cents/seat-km on the Madrid-Barcelona corridor, 1.0809 € cents/seat-km on the Madrid-Andalusia corridor and 0.5404 € cents/seat-km on the remaining lines. In its Decision of 8 October 2020, the CNMC concluded that the market could not bear these increases. As a result, ADIF AV was required to apply the mark-ups in force. The 2021 General State Budget Act and the agreement subsequently signed between the infrastructure manager and the Ministry of Transport, Mobility and Urban Agenda provide for compensation for the difference between the above amounts and those in force.

[14] The original Railway Sector Act defined the following railway services: (i) VL1 (long-distance services, except those designated as VL2 and VL3); (ii) VL2 (long-distance services on variable-gauge connections); (iii) VL3 (long-distance services on long cross-connections, longer than 700 km and not originating in or terminating in Madrid); (iv) VCM (urban or suburban and interurban passenger services, with distances of less than 300 km); (v) VOT (passenger trains and rolling stock without passengers); and (vi) M (freight services).

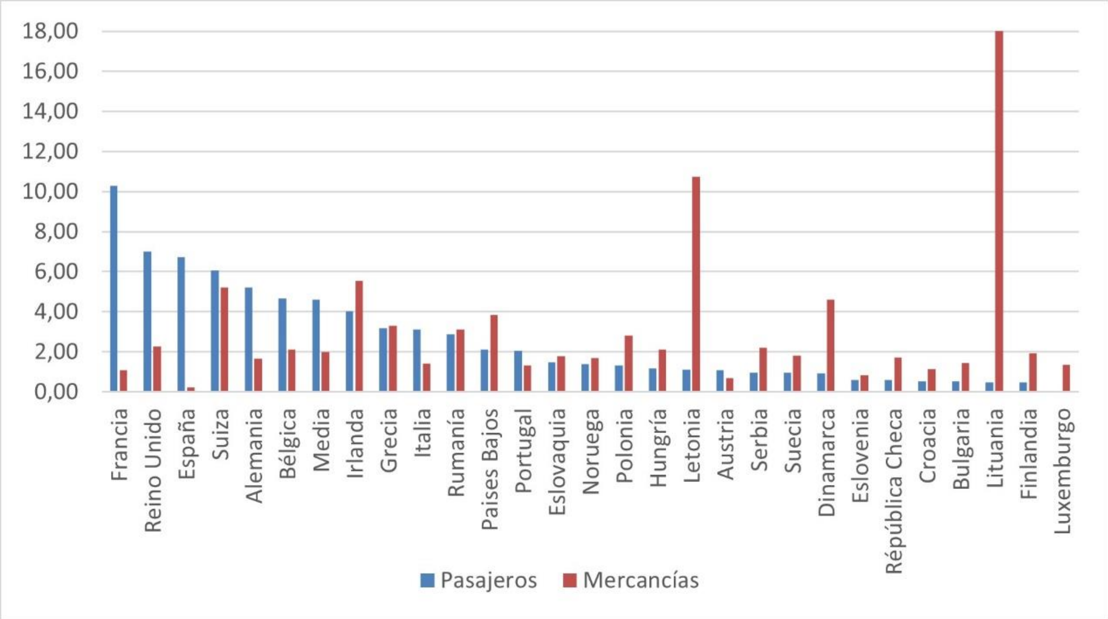
[15] The Railway Sector Act differentiates between the capacity allocation charge (Mode A) for the capacity allocation service, the railway line use charge (Mode B) for the act and effect of using a railway line, and the charge for the use of traction power transformation and distribution facilities (Mode C) for the act and effect of using the electrification facilities of a railway line.

had been receiving until then through the General State Budget[16]. Subsequently, for the 2018 financial year, railway charges for all conventional network services were increased by 160%, except for VCM and freight services. For 2019, ADIF proposed a four-year plan to increase charges for passenger services and a 10-year plan for freight services to fully cover direct costs. This plan was not implemented because the General State Budget for that year was not approved. Currently, the agreement signed between ADIF and the Ministry of Transport, Mobility and Urban Agenda (MITMA in its Spanish acronym) covers the gap between current charges and network management costs.

34. Railway charges for passenger services in Spain are the third highest in the EU, only behind France and the United Kingdom, at 6.74 €/train-km, while freight charges are the lowest, at 0.23 €/train-km, followed by Austria (0.69 €/train-km).

[16] The subsidy previously received by the infrastructure manager was transferred to RENFE Viajeros to cover the costs of suburban and medium-distance services subject to public service obligations.

Graph 6. Passenger and freight railway charges (2022)



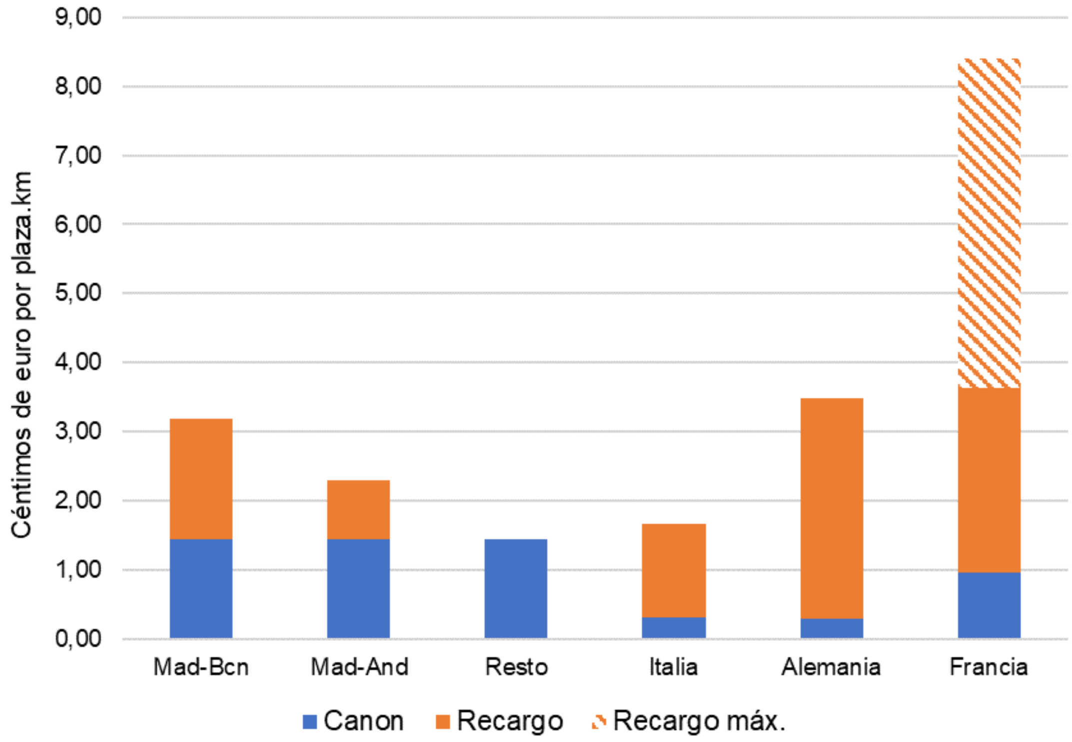
Source: CNMC based on data from IRG-Rail.

35. Direct costs have much more weight in railway charges in Spain than in other European countries with a high-speed network. Another peculiarity is that in Spain, mark-ups are calculated according to the number of seats-km offered and not according to the number of train-km produced as in the rest of the countries. However, in some cases, different amounts are established for double trains (France) or for trains exceeding a certain number of seats or a certain weight (Italy).

36. For a standard train[17], Spanish railway charges for high-speed services are similar to German ones on the Madrid-Barcelona corridor, significantly higher than Italian ones on the Madrid-Barcelona and Madrid-Sevilla/Málaga corridors and similar to Italian ones on the rest of the high-speed lines.

[17] The comparison shown in the graph is based on the technical specifications of the RENFE Viajeros 103 series train model, which is one of the most widely used on the Spanish high-speed network, with 404 seats and a weight of 453.3 tonnes.

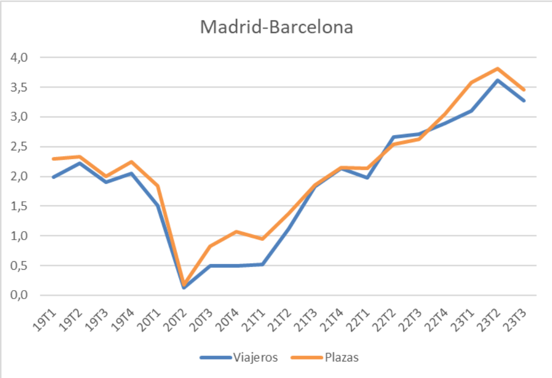
Graph 7. Current amounts of railway charges per seat-km applied on a standard train

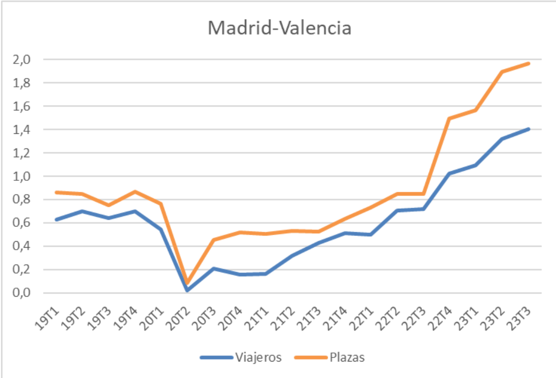


Source: CNMC based on data from the infrastructure managers' network statements.

37. In any event, the amounts of charges must be related to market conditions. Given that, according to the regulatory framework, mark-ups can only increase charges when the market can bear them, no comparative exercise can ignore the characteristics of the market and the network in each country. Firstly, the amounts of the charges on corridors where there is a mark-up, account for a substantial part of the cost of the railway undertakings. This circumstance means that on routes where no mark-up is applied (such as the Madrid-Valencia route), supply has grown more intensely than on those with a mark-up (such as the Madrid-Barcelona route), decoupling from demand because trains can be profitable with lower occupancy and creating space for demand to grow.

Graph 8. Evolution of seat and passenger numbers between Madrid and Barcelona/Valencia (millions)





Source: CNC based on quarterly data.

38. Secondly, the presence of three competing companies on some corridors has substantially reduced retail prices. As a result, railway charges have increased their weight in the final ticket price. Between Madrid and Barcelona, depending on the operator and according to the average prices published by the CNMC in the report for the first quarter of 2023, charges accounted for 32% to 91% of the final price[18]. In the second quarter, prices increased, reducing the weight of charges to a maximum of 67%[19]. This percentage is much lower on other corridors.

Table 2. Weight of charges in retail prices.

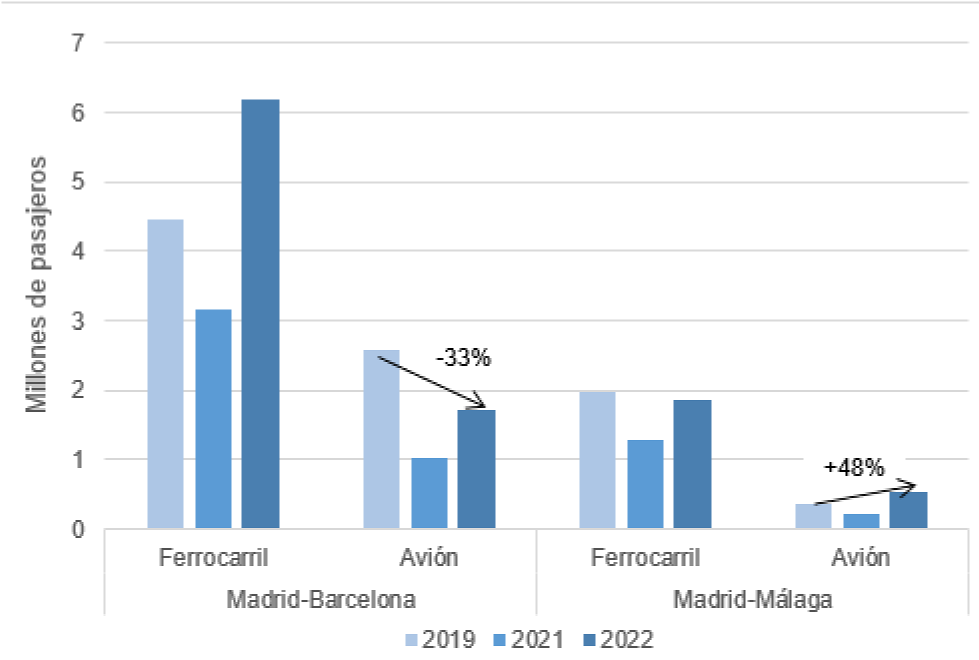
		1st quarter				2nd quarter			
		AVE	AVLO	IRYO	OUIGO	AVE	AVLO	IRYO	OUIGO
MAD-BCN	Price	65.6	39.9	33.3	32.9	66.4	46.9	45.3	407
	Charge/pax	20.7	19.5	30.2	16.1	20.7	19.5	30.2	16.1
	%	32%	49%	91%	49%	31%	42%	67%	40%
MAD-SEV	Price	66.4		57.5		71.6		56.7	
	Charge/pax	13.3		12.6		13.3		12.6	
	%	20%		22%		19%		22%	
MAD-VAL	Price	38.1	21.7	20.9	22.9	43.8	24.7	26.3	22.3
	Charge/pax	9.9	6.6	10.5	4.8	9.9	6.6	10.5	4.8
	%	26%	30%	50%	21%	23%	27%	40%	22%

Source: CNC based on quarterly data.

[18] https://www.cnmc.es/sites/default/files/4713945.pdf
[19] https://www.cnmc.es/sites/default/files/4889759.pdf

39. Thirdly, on some routes, such as Madrid-Barcelona and Madrid-Malaga, rail competes with other modes of transport, such as air travel. Due to the increase in supply, in terms of seats and frequencies, and the reduction in prices resulting from the entry of competitors, between Madrid and Barcelona, air travel carried 33% fewer passengers in 2022 than in 2019. In contrast, between Madrid and Malaga, air travellers were 48% more.

Graph 9. Passengers between Madrid and Barcelona/Málaga by mode of transport

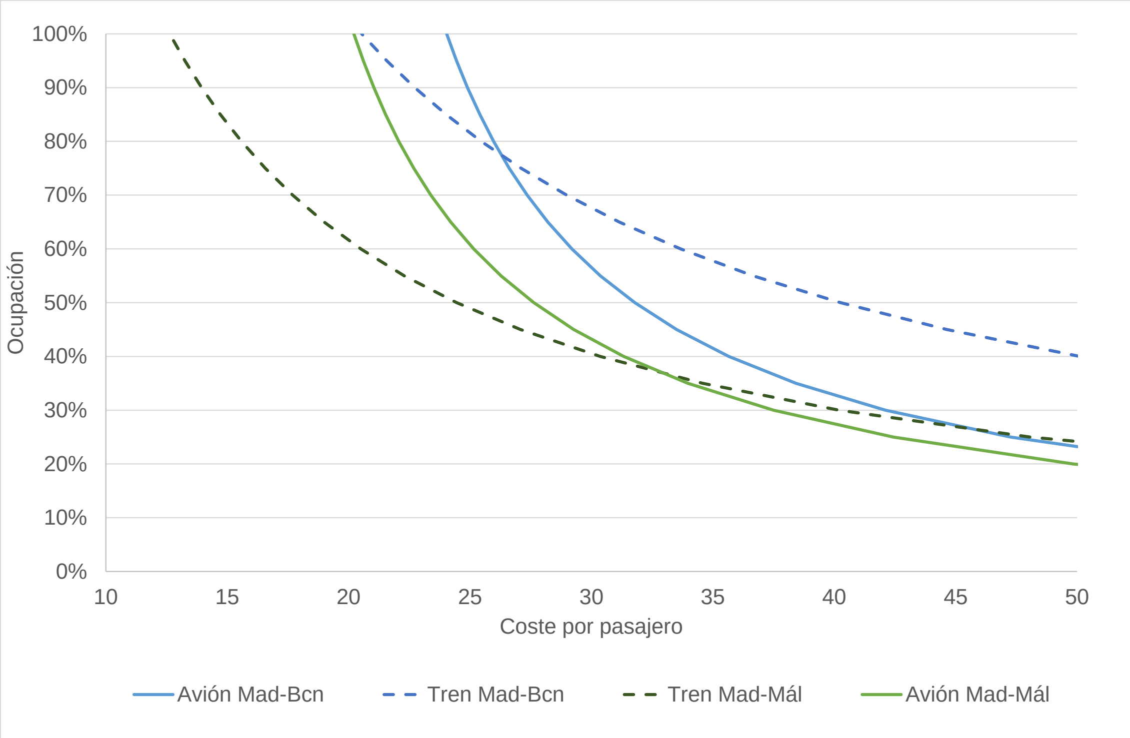


Source: CNMC based on its quarterly data and data from AENA.

40. Air and airport charges, like railway charges, are unavoidable costs that affect the competitiveness of each mode of transport. On the Madrid-Barcelona route, these air and airport charges imply, for occupancies between 50% and 100%, a cost per passenger of €24 to €31.8, while railway charges amount to €20.5 to €40.2 for the same range of occupancies. In the case of the Madrid-Malaga route, railway charges are lower than air charges for occupancies over 40%[20].

Graph 10. Comparison of the cost per passenger of railway charges and air and airport charges on the Madrid-Barcelona and Madrid-Malaga routes

[20] The BOEING 737-800 (WINGLETS) aircraft was used as the benchmark for this comparison, as it is the model with the highest number of domestic commercial traffic operations, based at Adolfo Suárez Madrid Barajas airport. The fares used correspond to those published by AENA and ENAIRE for May 2023. In the case of rail, a 450-seat train is considered, as well as the current charges, including both the charges of Article 97 of the Railway Sector Act and the station charges provided for in Article 98 of the same Act.



Source: CNMC based on data from AENA, ENAIRE and ADIF AV's network statement.

41. The larger size of trains compared to planes, together with the higher charges, means that railway companies face greater risks in running a train than an airline would face in flying a plane on the same route.

4.3. Financing of Infrastructure Managers

4.3.1. Instruments for infrastructure planning and financing

42. According to Article 25(3) of the Railway Sector Act, *"the Government shall adopt the necessary measures to ensure that, under normal business circumstances and over a period of no more than five years, the profit and loss accounts of the general railway infrastructure managers reflect at least a balanced situation between, on the one hand, revenues from charges for infrastructure use, revenues from charges for the provision of ancillary and complementary services, surpluses from other commercial activities, non-refundable revenues from private sources and State funding including, where appropriate, advances paid by the State and, on the other hand, infrastructure expenditure"*. These funds shall be channelled through the signing of an agreement between the Ministry of Transport, Mobility and Urban Agenda (MITMA in its Spanish acronym) and the infrastructure managers (point 2 of Article 25) .

43. ADIF and ADIF AV signed agreements with the MITMA on 26 July 2021[21], which establish revenue and expenditure forecasts for the period 2021-2025, as well as contributions from the MITMA totalling 12.76 billion euros to undertake investments worth more than 17.8 billion euros. The agreements also provide for public contributions of 1.03 billion euros for ADIF and 150 million euros for ADIF AV to cover the managers' charging and operating deficits.

44. In November 2022, the MITMA published the Indicative Strategy for the Development, Maintenance and Renewal of Railway Infrastructure, provided for in Article 5 of the Railway Sector Act[22]. This document establishes the priorities for the development and maintenance of rail infrastructure within the general objectives of *"opening up markets, strengthening safety, multimodality and interoperability of Spanish infrastructure, sustainability and decarbonisation of transport, and promoting digitalisation and cybersecurity"*[23].

45. As pointed out in the Report of the CNMC of 10 February 2022[24], the signing of the agreements between the MITMA and the infrastructure managers preceded the approval of the Indicative Railway Strategy. Thus, public contributions were decided before establishing the strategic objectives to be achieved through the development of the railway infrastructure. Given the ambitious modal shift objectives assumed in the Indicative Railway Strategy, the agreements should have provided for public contributions to reduce charges in line with these objectives.

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[21] Decision of 29 July 2021 of the Directorate General for Planning and Evaluation of the Railway Network, which publishes the agreements with the public business entities Administrador de Infraestructuras Ferroviarias (ADIF) and ADIF-Alta Velocidad, for the economic sustainability of the railway infrastructure included in their networks during the period 2021-2025.

[22] https://www.mitma.gob.es/recursos_mfom/paginabasica/recursos/estrategia_indicativa_finalv2.pdf

[23] The European and Spanish mobility strategies have committed to ambitious targets for the sustainability and decarbonisation of transport, including a modal shift from road to rail. On 9 December 2020, the European Commission presented its mobility strategy, as part of the so-called Green Deal, which was adopted at the end of 2019. This strategy sets the targets of doubling high-speed passenger numbers by 2030 and tripling them by 2050, as well as increasing freight traffic by 50% by 2030 and doubling it by 2050, all compared to 2015. On 14 December 2021, the European Commission launched an action plan to boost long-distance and cross-border passenger rail services. Recognising the importance of charges in the cost structure of railway companies, the Action Plan states, inter alia, that the methods for setting railway charges should be improved in order to increase the overall supply of services and the competitiveness of rail, ensuring that the mark-ups provided for in Article 32 of the RECAST Directive are only applied when the market can bear them and do not harm the competitiveness of rail. To this end, the European Commission is working on guidelines for access charges to support and encourage the development of cross-border and long-distance passenger services.

[24] Report of 10 February 2022 on the initial version of the Indicative Strategy for the Development, Maintenance and Renewal of Rail Infrastructure. https://www.cnmc.es/sites/default/files/3945665.pdf

46. According to Article 25(4) of the Railway Sector Act, *"[i]n the framework of the Government's general policy and in accordance with the indicative strategy for the development, maintenance and renewal of the railway infrastructure, the general infrastructure managers shall approve an activity programme which shall include investment and financing plans".* Furthermore, according to Article 100(4), this activity programme *"shall contain a forecast of the updates of railway charges during the period of validity of the programme".* The amounts of the charges may not be increased individually by more than 5% over those indicated in the activity programme, except for exceptional reasons that must be justified in the economic-financial report corresponding to that financial year.

47. Thus, the business plan of the infrastructure managers must establish a stable framework for the evolution of railway charges, and this evolution must be consistent with the Indicative Railway Strategy. However, given that the agreements did not envisage public contributions to ensure the competitiveness of the rail mode and the modal shift, the ability of charges to act as a lever to achieve the decarbonisation of transport will be limited.

4.3.2. State of play for infrastructure managers

48. Infrastructure managers' revenues come from charges (around 40%) and fees for other services, particularly traction energy in the case of ADIF AV[25]. For the past years, public contributions to cover operating costs have been virtually non-existent in the case of ADIF AV, and have been substantially reduced for ADIF since it waived them in 2017 to increase charges for VCM services (see paragraph 33).

Table 3. Evolution of ADIF and ADIF AV's revenues

[25] For traction current services, ADIF AV simply resells the energy it purchases on the electricity market to railway undertakings, with the addition of management costs.

Million euros		2017	2018	2019	2020	2021	2022
ADIF	Charges	379.0	659.0	664.1	548.2	570.7	599.0
	Operating subsidies	358.5	- 0.1	- 0.1	- 0.0	129.0	182.3
	Other revenues	925.8	572.7	654.8	629.6	787.5	891.3
	Total	1,663.3	1,231.5	1,318.7	1,177.8	1,487.2	1,672.6
ADIF AV	Charges	548.8	572.1	610.7	327.1	390.1	563.0
	Operating subsidies	-	-	-	-	40.8	66.1
	Other revenues	416.7	420.8	446.7	355.9	589.4	921.5
	Total	965.5	992.8	1,057.4	683.0	1,020.3	1,550.5

Source: CNMC based on ADIF and ADIF AV's annual accounts.

49. Public contributions account for a significant percentage of the resources of European infrastructure managers. According to a PRIME report (May 2022)[26], in 5 of the 17 national cases compared, this percentage exceeds 70%, and in 9 cases, 50%. For instance, public contributions account for 28% of SNCF Réseau's resources, 45% for Deutsche Bahn and 72% for Ferrovie dello Stato[27]. According to the European Commission (September 2023)[28], 58% of rail infrastructure financing comes in Spain from the infrastructure managers' own funds, while this percentage is 50% in France, 27% in Germany and 3% in Italy.

50. An analysis of the income of Spain's infrastructure managers shows that, although ADIF AV's EBITDA[29] is positive (except in 2020), network depreciation and high financial expenses (which amounted to 244 million euros in 2022) mean that the profit and loss account has been consistently negative in recent years.

Table 4. Revenues, costs and income of ADIF and ADIF AV

[26] PRIME is the European Network of Infrastructure Managers (https://transport.ec.europa.eu/transport-modes/rail/market/infrastructure-managers-prime_en).
[27] See "Summary of PRIME study on Charging and State Funding of Infrastructure Managers". https://wikis.ec.europa.eu/download/attachments/44167372/PRIME_DD_Funding-Report_Summary_Publication_20220525.pdf?version=1&modificationDate=1662654226047&api=v2
[28] See the working document accompanying the 8th Rail Market Monitoring Report, September 2023, page 19. https://eur-lex.europa.eu/resource.html?uri=cellar:fdd93148-521e-11ee-9220-01aa75ed71a1.0001.02/DOC_1&format=PDF
[29] EBITDA (earnings or gross operating profit before interest, taxes and depreciation) is a measure of the profitability of the business as it does not take into account financial and tax issues and non-cash flow costs.

Million euros		2017	2018	2019	2020	2021	2022
ADIF	Revenues	1,304.84	1,231.61	1,318.82	1,177.77	1,358.18	1,490.24
	Costs	1,225.04	1,260.64	1,352.16	1,335.80	1,375.90	1,532.21
	EBITDA	79.80	- 29.03	- 33.34	- 158.03	- 17.72	- 41.98
	Income before taxes	30.70	- 74.27	- 83.50	- 193.55	28.21	- 78.86
ADIF AV	Revenues	965.53	992.84	1,057.41	683.02	979.43	1,484.43
	Costs	687.79	696.14	781.27	692.47	923.75	1,255.83
	EBITDA	277.74	296.70	276.13	- 9.44	55.68	228.60
	Income before taxes	- 200.00	- 223.41	- 179.24	- 460.86	- 425.44	- 296.79

Source: CNMC based on ADIF and ADIF AV's annual accounts.

51. Spain's infrastructure managers have made significant investments during this period, financed by public capital contributions (those not intended to cover operating costs) and debt, particularly by ADIF AV. This significant debt generates, as mentioned above, high financial costs which, on average over the last six years, have accounted for around 23% of the total revenues of this infrastructure manager.

Table 5. ADIF and ADIF AV's capital subsidies and debt

Million euros		2017	2018	2019	2020	2021	2022
ADIF	Investments	64	48	18	20	62	97
	Capital subsidies	329	247	449	493	442	798
	Debt	748	879	636	648	1.633	1.138
ADIF AV	Investments	1,094	1,172	1,123	1,142	1,020	1,319
	Capital subsidies	151	209	377	427	259	441
	Debt	15,841	16,255	16,969	17,285	19,125	18,937
Total debt		**16,589**	**17,133**	**17,604**	**17,932**	**20,758**	**20,075**

Source: CNMC based on ADIF and ADIF AV's annual accounts.

5. COSTS DIRECTLY INCURRED BY THE OPERATION OF THE TRAIN SERVICE

5.1. Regulation

52. Article 31(3) of the RECAST Directive provides that *"the charges for the minimum access package and for access to infrastructure connecting service facilities shall be set at the cost that is directly incurred as a result of operating the train service"*.

53. Similarly, Article 96(4) of the Railway Sector Act establishes that the "*charges for the minimum access package to the railway lines belonging to the General Interest Railway Network and for access to infrastructure connecting service facilities shall be published in the network statement, and their amount shall be equivalent to the cost that is directly incurred as a result of operating the train service, which shall be calculated in accordance with the corresponding European Union regulation governing the methods for calculating this type of cost*".

54. The CJEU noted[30], in a 2013 judgment, that the regulatory framework does not define the concept of "costs directly incurred as a result of operating the train service" and concluded that fixed costs connected to maintenance and traffic management relating to the provision of a stretch of line on the rail network are not directly incurred as a result of operating rail services. It also excluded from direct costs indirect costs and financial costs, as well as depreciation, where *"they are not determined on the basis of the actual wear of the infrastructure triggered by traffic, but with reference to accounting rules (...)"*.

55. Implementing Regulation (EU) 2015/909 on the detailed rules for calculating costs directly incurred as a result of operating rail services (hereinafter Regulation 2015/909) states that *"the infrastructure manager should be allowed to include in the calculation of its direct costs only costs that it can objectively and robustly demonstrate that they are triggered directly by the operation of the train service"*.

56. Direct costs are therefore costs which, in addition to being related to the provision of railway services, vary according to traffic.

57. Moreover, Community legislation assimilates, in its recitals, direct costs to short-term marginal costs as the most efficient way of charging for railway infrastructure. Thus, Recital 70 of the RECAST Directive states that infrastructure charging systems should allow traffic which can at least pay for the additional cost which it imposes to use the rail network[31].

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[30] Case C-512/10, CJEU Jugement of 20 May 2013. https://curia.europa.eu/juris/document/document.jsf;jsessionid=2459CA288595C8F9E7225DD0C077D397?text=&docid=137833&pageIndex=0&doclang=ES&mode=lst&dir=&occ=first&part=1&cid=55928

[31] In the same vein, the White Paper of the Commission of the European Communities (COM (1998) 466) "Fair payment for infrastructure use: a phased approach to a common transport infrastructure charging framework in the EU", concluded that *'[t]he only charging strategy that fully meets these criteria is one based on marginal [social] costs: charging users for the costs, both internal and external, that they cause at the point of use'*. https://op.europa.eu/en/publication-detail/-/publication/ceccf466-59bd-46e6-a08b-972286cebdc6/language-en

58. Recital 12 of Regulation 2015/909 states that "[*i*]*t is a well-established economic principle that user charges based on marginal costs ensure the optimum effective use of available infrastructure capacity. Hence, the infrastructure manager may decide to use the proxy of marginal costs for calculating its costs directly incurred as a result of operating the train service*". Moreover, Recital 14 assimilates direct costs and marginal costs, stating that other "*forms of econometric or engineering modelling might offer a higher degree of precision in calculating direct costs or marginal costs of the use of infrastructure*".

59. For its calculation, Article 3 of Regulation 2015/909 provides that *"direct costs on a network-wide basis shall be calculated as the difference between, on the one hand, the costs of providing the services of the minimum access package and access to the infrastructure connecting service facilities and, on the other hand, the non-eligible costs referred to in Article 4"*. The non-eligible costs included in Article 4 are structural or overhead costs, such as financial costs, and costs which, while related to the rail service, do not vary with the operation of the service, such as the costs of intangible assets, costs related to technological obsolescence or electric supply costs which are not directly incurred by operating the train service.

60. Article 6 of the same Regulation, on the other hand, allows infrastructure managers to calculate direct costs differently, namely *"by means of robustly documented econometric or cost engineering modelling, provided it can demonstrate to the regulatory body that the direct unit costs include only direct costs incurred by the operation of the train service and, in particular, do not include any of the costs referred to in Article 4"*. *Econometric studies* approximate the short-term marginal cost of a rail network by analysing the effect of traffic on the total cost and including in the analysis other variables that may be relevant to explain variations in cost, such as infrastructure characteristics. *Engineering studies*, on the other hand, propose to estimate the same relationship between the cost of the infrastructure and the wear produced by traffic by constructing bottom-up models, which determine the marginal cost of the network based on the technical characteristics of the infrastructure and the estimated wear according to possible traffic.

61. Regulation 2015/909 therefore allows direct costs to be calculated on the basis of different methodologies, which should yield similar results. Firstly, the **subtraction methodology,** which subtracts from the total cost allocable to charges all costs that do not vary with traffic or are not directly triggered by traffic (non-eligible costs). As the IRG-Rail points out[32], this methodology is complex

[32] IRG-Rail, 2022. "Overview of the Implementation of Direct Cost in Europe".

because it requires properly identifying fixed costs and eliminating them from the amount transferred to the charges.

62. Secondly, **econometric or engineering models** can improve the accuracy of direct costs by including information about railway activity, the operations of infrastructure managers and the technical characteristics of their network. The IRG-Rail notes that engineering models need to be complemented by accounting information to approximate the reality of the manager's costs.

5.2. International Comparison

63. Experience in estimating direct costs from econometric models is extensive. In 2007, the European Commission launched the CATRIN project[33], which compiles studies on estimating the marginal cost of network operation, maintenance and renewal of rail infrastructure.

64. Thus, the CATRIN project[34] includes multiple econometric studies on infrastructure costs in different countries, identifying the data used and the functional ways of modelling the relationship between traffic and costs (linear, logarithmic, translogarithmic models or Box-Cox transformations).

65. The results of the econometric models included in the CATRIN project estimate traffic elasticities of 8% to 40% of the costs of different maintenance activities and 19% to 30.2% when also including infrastructure renewal costs.

Table 6. Lists of econometric studies

Study	Country	Proportion cost of maintenance included	Reported elasticity (mean)
Table 16 D.1 CATRIN			
Only maintenance			
Wheat & Smith (forthcoming) Model IV	Great Britain	45%	0.239
Wheat & Smith (forthcoming) Model VI	Great Britain	45%	0.378
Both Allen & Hamilton	Great Britain	60%	0.280
Anderson (2006a)	Sweden	100%	0.204

[33] Cost Allocation of Transport Infrastructure cost.
[34] See CATRIN deliverable D.1: Link, H., Stuhlemmer, A. (DIW Berlin), Haraldsson, M. (VTI), Abrantes, P., Wheat, P., Iwnicki, S., Nash, C., Smith, A., CATRIN (Cost Allocation of TRansport INfrastructure cost), Deliverable D 1, Cost allocation Practices in the European Transport Sector. Funded by Sixth Framework Programme. VTI, Stockholm, March 2008.

Marti & Neuschwander (2006) Model I	Switzerland	Assumed 70%	0.200
Marti & Neuschwander (2006) Model II	Switzerland	Assumed 70%	0.285
Tervonen & Idstrom (2004)	Finland	55%	0.133-0.175
Munduch et al. (2002)	Austria	Assumed 70%	0.270
Gaundry & Quinet (2003)	France	Assumed 70%	0.370
Maintenance and renewal			
Anderson (2006a)	Sweden	100%	0.302
Marti & Neuschwander (2006)	Switzerland	Assumed 70%	0.19
Tervonen & Idstrom (2004)	Finland	66%	0.267-0.291
Table 4.3. D.8 CATRIN[35]			
Only maintenance			
	France		0.32-0.40
	Sweden		0.23-0.25
	Switzerland		0.22
	Austria		0.35-0.37
	Great Britain		0.08-0.25
Table 2 Nash (2005)[36]			
Maintenance - Track			0.30
Maintenance - Signalling	Great Britain		0.05
Maintenance - Electrification			0.10

Source: CNMC based on data from Table 16 in Deliverable D.1 CATRIN, Table 4.3. Deliverable D.8 CATRIN and Table 2 Nash (2005).

66. The CATRIN project also includes engineering studies (though fewer than econometric studies), which calculate traffic elasticities ranging from 5% for the maintenance cost of signalling elements to 95% for the cost of rail renewal.

Table 7. Lists of engineering studies included in the CATRIN project

Cost category	% variable with traffic
Track	
Maintenance	30%
Renewal	
Rails	95%

[35] Phill Wheat, Andrew Smith and Chris Nash (ITS), CATRIN (Cost Allocation of Transport Infrastructure cost), Deliverable 8 - Rail Cost Allocation for Europe. Funded by Sixth Framework Programme. VTI, Stockholm, 2009.
[36] Nash, Chris. (2005) Rail Infrastructure Charges in Europe. Journal of Transport Economics and Policy. 39. 259-278. https://www.researchgate.net/publication/227627108_Rail_Infrastructure_Charges_in_Europe

Sleepers	25%
Ballast	30%
Switches and level crossings	25%
Structure	10%
Signalling	
Maintenance	5%
Renewal	0%
Electrification	
Maintenance	
Alternating current (AC)	10%
Direct current (DC)	10%
Renewal	
Alternating current (AC)	35%
Direct current (DC)	41%

Source: Table 17 in Deliverable D.1 CATRIN

67. In practice, for the calculation of direct operating and network renewal costs, infrastructure managers in France, Norway and Sweden use a purely econometric approach, while those in Germany and Finland use a mixed approach, combining econometric models with subtraction or engineering models.

Table 8. Modelling used by European infrastructure managers

Country	Operations	Maintenance	Renewal	Subsidies included Cost base used
Austria	Subtraction	Subtraction	Engineering	Gross cost
Belgium	Engineering	Engineering	Not included	Net cost
Croatia	Mixed	Engineering	Not included	Net cost
Finland	Mixed	Mixed	Mixed	Gross cost
France	Econometric	Econometric	Econometric	Net cost
Germany	Engineering	Engineering	Econometric	Gross cost
Hungary	Mixed	Mixed	Mixed	Net cost
Latvia	Subtraction	Subtraction	Subtraction	Net cost
Lithuania	Subtraction	Subtraction	Subtraction	Net cost
Netherlands	Econometric	Mixed	Mixed	Net cost
Norway	Not included	Econometric	Not included	Gross cost
Portugal	Subtraction	Subtraction	Not included	Net cost
Romania	Subtraction	Subtraction	Subtraction	Net cost
Slovakia	Subtraction	Subtraction	Subtraction	Net cost
Slovenia	Subtraction	Subtraction	Subtraction	Net cost
Spain	Subtraction	Subtraction	Subtraction	Net cost
Sweden	Econometric	Econometric	Econometric	Gross cost

Source: Table 10 in IRG-Rail (2022).

68. The French infrastructure manager uses an econometric model for the calculation of direct operating, maintenance and renewal costs, under the supervision of the regulator body[37]. For the period 2021-2023, this model estimates direct costs as a percentage of the total costs for the different components.

Table 9. Marginal cost as a percentage of the total cost of the SNCF Réseau network.

Marginal share of cost (variable with traffic)	
Maintenance	18%
Operating	10%
Renewal	22%

Source: CNMC based on data from IRG-Rail "Appendix on Direct Cost" referring to SNCF Réseau, Network Statement 2021-2023, Appendix 5.1.1, p. 11

69. In Sweden, the infrastructure manager calculates the direct cost on the basis of econometric studies produced by the National Road and Transport Research Institute (VTI in its Swedish acronym). These studies use a translogarithmic specification[38], which results in an overall maintenance cost elasticity of 0.1674. The calculated elasticities yield a direct cost or marginal cost per train-km and per tonne-km of SEK 3.33 and SEK 0.0152, respectively.

70. The Finnish infrastructure manager's model removes all non-eligible costs identified in the accounts and then applies econometric modelling to the remaining costs. The model estimates the cost elasticity to traffic from a logarithmic function that includes, in addition to traffic, the weight carried by the infrastructure and the length of the track stretches. The resulting traffic elasticity is 0.2452[39].

71. The German infrastructure manager's model subtracts all cost centres which, because of their content, do not vary with traffic. It then applies econometric and engineering models to determine the percentage variability of the remaining cost centres.

72. In conclusion, there are numerous examples, both in the literature and in practice, of the use of alternative modelling for a better estimation of the direct cost as a marginal cost. This is in line with the interpretation of most European rail

[37] IRG-Rail "Appendix on Direct Cost" referencing SNCF Réseau, Network statement 2021-2023.
[38] See CTS Working paper 2018:22, Marginalkostnader för reinvesteringar i järnvägsanläggningar: En delrapport inom SAMKOST 3, y CTS Working paper 2018:24, Marginalkostnader för järnvägsunderhåll: trafikens påverkan på olika anläggningar.
[39] See Chapter 3 of IRG-Rail "Appendix on Direct Cost".

regulators, who also equate the concept of direct cost with that of the short-term marginal cost of using the rail network[40].

5.3. Methodology Applied by ADIF and ADIF AV

73. In 2017, ADIF and ADIF AV reported their analytical accounting model for calculating the costs allocable to railway charges to the CNMC. The model includes almost 4,000 cost centres (functional or activity units where costs and/or revenues are incurred). These cost centres are grouped into 31 divisions and 5 activity segments.

74. The CNMC has analysed this model on different occasions, concluding that *"it has a structure and methodology that allows for the calculation of the cost of railway charges in a causal, objective manner that aligns with the precepts of Article 97 of the Railway Sector Act"*[41].

75. The analytical accounting model is based on the audited profit and loss account for the relevant financial year, and allocates direct costs and revenues, as well as common and joint costs, to each segment and division. Specifically, the divisions that make up the network management segment aggregate the costs that can be passed on to the different types of railway charges, i.e. those associated with the provision of the minimum access package to the railway infrastructure in Article 20(1) of the Railway Sector Act.

76. Once the costs allocable to charges have been determined, the costs directly allocable to the railway service are calculated using the subtraction method, obtaining the direct costs as the difference between the costs allocable to railway charges and the non-eligible costs outlined in Articles 3 and 4(1) of Regulation 2015/909.

77. The CNMC has pointed out on several occasions that this way of determining direct costs does not adequately identify the non-eligible costs under Regulation 2015/909:

- The Decision on railway charges for 2018 required the infrastructure managers to demonstrate that the costs considered eligible under certain headings of Article 4(1) of Regulation 2015/909 were indeed variable with

[40] IRG-Rail, 2020. "Review of Charging Practices for the Minimum Access Package in Europe".
[41] For all, see Decision of 21 September 2017 on the ADIF and ADIF Alta Velocidad's charging proposal for 2018, adopting measures pursuant to Article 11 of Law 3/2013 of 4 June 2013. https://www.cnmc.es/sites/default/files/1802628_9.pdf

rail traffic[42]. The Decision required, due to its significance, further justification of the calculation of non-eligible costs relating to the provision of a stretch of line (point (a) of Article 4(1) of Regulation 2015/909)[43].

- The Decision on railway charges for 2019[44] noted that the calculation of non-eligible costs was incorrect for intangible assets and electric supply equipment. Therefore, the direct costs included in ADIF and ADIF AV's submission for that year were corrected.

- The Decision on railway charges for 2020[45] highlighted that the direct unit cost per train-km of the Spanish network *"is significantly higher than that of other European countries, which range from €1 to €2.5 per train-km. Meanwhile, the direct unit cost per train-km of ADIF and ADIF AV's network is €4.5 per train-km"*. Thus, reiterating the Decision on railway charges for 2018, ADIF and ADIF AV were requested to submit "*a proposal to improve the analytical accounting model to identify all non-eligible costs in accordance with* [Regulation] *2015/909*".

- The Decision on railway charges for 2021[46] reiterated that, although ADIF and ADIF AV's cost accounting model correctly identified the costs allocable to charges, it included in the direct cost some costs that do not vary with traffic, such as a portion of depreciation or preventive maintenance costs. In view of the lack of progress since the Decision on

[42] Specifically, (i) intangible assets (letter (g) of Article 4(1) of Regulation 2015/909), (ii) costs of information, communication or telecommunication equipment not located on the track (letter (i)), (iii) costs of power supply equipment for the supply of traction current not directly incurred in the operation of the rail service (letter (k)), and (iv) depreciation not determined by the actual wear and tear of the infrastructure due to the operation of the rail service (letter (n)).
[43] ADIF and ADIF AV only consider as ineligible costs for the provision of a stretch of line certain preventive maintenance costs for the performance of periodic inspection and verification operations of the railway infrastructure to ensure safety on a given stretch of the Railway Network of General Interest, such as the verification and assessment of the state of the infrastructure, track and track installations (visual checks, inspections, checks, auscultation car, etc.), the passage of the weed killer train, the passage of the exploration train or the daily line opening train (only for high-speed lines), and the management of traffic related to the above operations.
[44] Decision of 27 September 2018, on ADIF and ADIF Alta Velocidad's charging proposal for 2019, adopting measures for the next year of monitoring in accordance with Article 11 of law 3/2013 of 4 June 2013 (Decision on railway charges for 2019).
https://www.cnmc.es/sites/default/files/2161326_10.pdf
[45] Decision of 5 March 2020 on ADIF and ADIF Alta Velocidad's charging proposal for 2020, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013 (Decision on railway charges for 2020).
https://www.cnmc.es/sites/default/files/2881513_0.pdf
[46] Decision of 8 October 2020 on ADIF and ADIF Alta Velocidad's charging proposal for 2021, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013 (Decision on railway charges for 2021).
https://www.cnmc.es/sites/default/files/3184346.pdf

railway charges for 2018 and considering the international comparison mentioned in the Decision on railway charges for 2020, it was announced that "*the CNMC will analyse in depth the model used by infrastructure managers to calculate the directly allocable costs to ensure that the costs included are indeed variable with rail traffic, in accordance with the provisions of* [Regulation] *2015/909*".

- The Decision on railway charges for 2022[47] found, as an indication of the inadequate estimation of direct costs, that it was *"paradoxical that direct costs, which, as previously stated, should be dependent on traffic, remained the same or even increased in a context of such significant reductions in traffic as those observed in 2020"*[48].

78. In short, the CNMC has repeatedly pointed out that the direct costing model applied by ADIF and ADIF AV allocates costs that do not vary with traffic to charges, which is incompatible with Regulation 2015/909. Despite the numerous requests for infrastructure managers to improve their model, the CNMC has not observed any progress in this regard.

79. Additionally, in their proposal for railway charges for 2023 and 2024, ADIF and ADIF AV used the projected costs for those years instead of historical costs for the calculation of the direct cost. Consequently, the Decision on railway charges for 2023[49] imposed transparency obligations to ensure that the projected costs allocated to charges are in line with the costs actually incurred by the infrastructure managers.

5.4. The CNMC's Direct Costing Model

80. The CNMC commissioned[50] an analysis of the ADIF and ADIF AV model for determining the direct cost and possible alternatives for its calculation based on internationally widespread econometric models that could complement the

[47] Decision of 22 September 2021 on ADIF and ADIF Alta Velocidad's charging proposal for 2022, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013 (Decision on railway charges for 2022).
https://www.cnmc.es/sites/default/files/3705131_80.pdf
[48] The direct cost of the high-speed network increased by 5.1%, despite traffic falling by more than 42%.
[49] Decision of 22 September 2022 on ADIF and ADIF Alta Velocidad's charging proposal for 2023, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013.
https://www.cnmc.es/sites/default/files/4332354.pdf
[50] Ernst & Young S.L. was awarded a contract to assist in the evaluation of the model and possible alternatives for modelling direct costs through a public tender in Case 210229 for the analysis and evaluation of the model for calculating direct costs and non-eligible costs of ADIF and ADIF Alta Velocidad.

subtraction method applied by the Spanish infrastructure managers. Based on this analysis, the CNMC has developed an econometric model that examines the extent to which the operating costs of preventive maintenance vary with traffic[51]. According to the audited accounts of the infrastructure managers in 2022, these costs account for 68% of the costs of the maintenance divisions and 60% of the costs of the infrastructure divisions.

81. The econometric study established the relationship between costs and traffic by analysing data corresponding to 6,851 observations, which collected information on track stretches[52] from 2017 to 2022, and by distinguishing the estimate for the different elements that make up the infrastructure[53]. The model also considered that the intensity of infrastructure wear, and therefore its cost, might not be linear and may vary according to traffic volume[54] or be affected by other factors, such as the technical characteristics of the network or geography. Therefore, in addition to traffic, other variables were included in the model to ensure that the results were not biased.

82. Appendix I provides a full description of the model developed, the alternatives considered (functional form and specification), the option finally chosen and its statistical significance.

83. The chosen modelling approach estimates the cost elasticity to traffic, i.e. the percentage of the operational cost of preventive maintenance accounted for that varies with traffic. These results contrast with ADIF and ADIF AV's model, which allocates almost all of these costs to charges[55].

Table 10. Elasticity of maintenance costs to traffic

Track and infrastructure	Overhead catenary	Electrical substations	Telecommunications	Signalling

[51] Operating costs include personnel, supply, material and service costs. Preventive maintenance comprises, according to the cost model, the *"programming, execution and monitoring of actions aimed at maintaining the quality level of the facilities, thus reducing the probability of failure or deterioration of the functions of an element, as well as the control and management of infrastructure risks"*.
[52] A stretch of track is a segment of a railway line that is shorter than the length of the line and bounded by two kilometre points.
[53] Maintenance costs are grouped into specialities or sets of elements that make up the infrastructure: track and infrastructure, overhead catenary, electrical substations, telecommunications and signalling.
[54] Therefore, transformations of the model variables, such as logarithmic or translogarithmic transformations, must be used to improve the fit. Translogarithmic transformations, in addition to taking the values of the variables in logarithms, replace the variable itself with a polynomial of a given degree, which provides a different elasticity depending on the values of each observation.
[55] See footnote 43.

0.274	0.179	0.217	0.218	0.247

Source: Econometric study by the CNMC.

84. These results are similar to those obtained by other infrastructure managers and those included in the aforementioned CATRIN project, considering that the costs analysed are limited to the operating costs of preventive maintenance, unlike in other cases.

Table 11. Comparison of the elasticities of maintenance costs to traffic

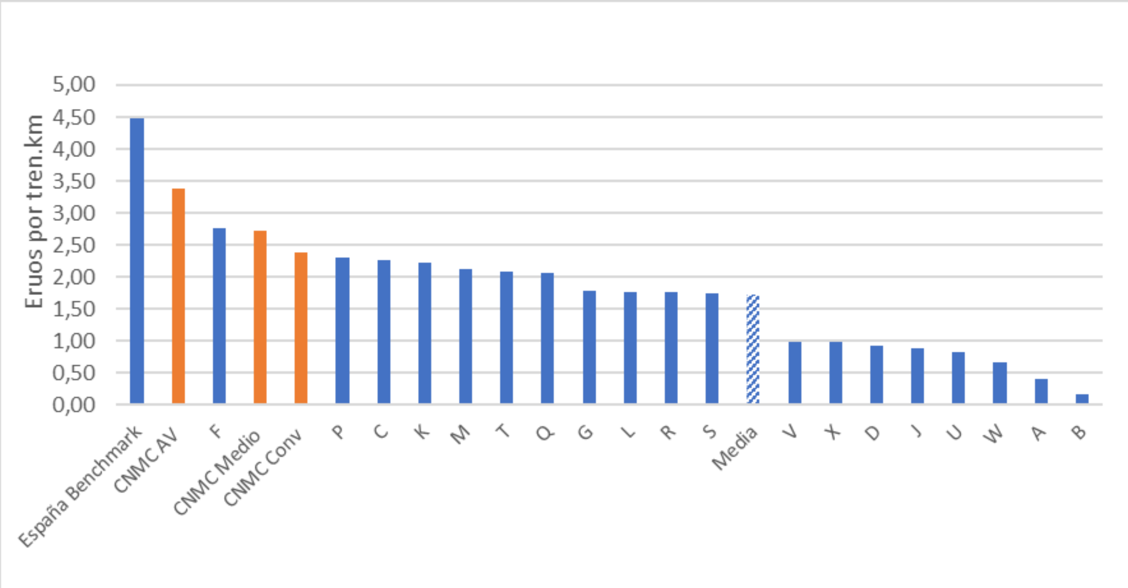
Study	Country	Component/speciality	Elasticity
CNMC (only operating preventive maintenance cost)	Spain	Global Track and infrastructure Signalling Electrical substations Overhead catenary Telecommunications	25% 27% 25% 22% 18% 22%
Econometric studies (see Table 11)	Multiple	Multiple	5%-40%

Source: CNMC.

85. The results show that ADIF and ADIF AV are allocating an excessive proportion of preventive maintenance operating costs to charges, as these include costs that do not vary with traffic, which should be considered non-eligible. Using 2022 as a benchmark, the proportion of preventive maintenance operating costs consistent with Regulation 2015/909 would be 25%. This proportion represents 23% of preventive and corrective maintenance operating costs, compared to 88% as calculated by the current ADIF and ADIF AV model.

86. With this result, the amounts of direct unit costs are more consistent with those of other European countries, which serves to confirm that the CNMC's econometric modelling aligns with current regulations (see bars highlighted in orange in the graph below, compared with the blue bar marked "Spain Benchmark", which corresponds to the model applied by ADIF and ADIF AV, resulting in a direct unit cost that is more than double the "Average" cost and 50% higher than the second highest cost, which corresponds to country "F").

Graph 11. Comparison of direct unit costs



Source: CNMC based on the IRG-Rail document "Benchmark on Financing of Main Railway Infrastructure Managers in Selected European Countries" and on ADIF and ADIF AV's costs for 2019.

87. The European Commission also notes that railway charges in Spain, excluding mark-ups—i.e. direct costs—are the second highest in the EU, only behind Belgium[56].

5.5. Direct Cost Oversight

88. According to the above analysis, ADIF and ADIF AV's direct costing model allocates to charges costs that do not vary with traffic, which is incompatible with Regulation 2015/909. The unit values of other infrastructure managers, as well as studies conducted by the European Commission and other institutions and regulators, confirm these conclusions.

89. Therefore, the CNMC will analyse the legality of the direct cost that the Spanish infrastructure managers propose to allocate to charges based on the cost elasticity to traffic calculated according to the econometric model described in Appendix I, which will be updated annually. The CNMC will provide ADIF and ADIF AV access to the econometric model so that they can calculate the directly allocable maintenance costs and propose improvements that must be justified

[56] Working document accompanying the 8th Rail Market Monitoring Report pursuant to Article 15(4) of Directive 2012/34/EU of the European Parliament and of the Council, page 16. https://eur-lex.europa.eu/resource.html?uri=cellar:fdd93148-521e-11ee-9220-01aa75ed71a1.0001.02/DOC_2&format=PDF

under the provisions of Regulation 2015/909. The econometric model may be modified on the basis of information and experience gained during its application, subject to consultation with infrastructure managers, railway companies and other stakeholders[57].

90. In order to carry out its legality check, the CNMC will analyse whether the cost which the infrastructure managers propose to allocate to charges corresponds to the directly allocable cost resulting from multiplying the elasticity by the operating cost of preventive maintenance for each of the elements making up the infrastructure (see footnote 53) for the relevant financial year53[58]. The other direct costs calculated and justified by the infrastructure managers will be added to this amount.

91. In this regard, Article 4(1)(h) of Regulation 2015/909 establishes that, of the costs of track-side sensors, track-side communication equipment and signalling equipment, only those which are directly incurred by the operation of rail services shall be direct costs. Similarly, according to Article 4(1)(n), only depreciation determined *"on the basis of real wear and tear of infrastructure due to the train service operation" may be allocated to railway charges"*.

92. However, the ADIF and ADIF AV cost model allocates almost all traffic management costs (personnel costs, costs of centralised traffic control—CTC—centres and other costs arising from traffic and safety activities)[59] and asset depreciation[60]. The infrastructure managers should therefore continue to improve

[57] The econometric model, including its functional form and selected variables, may be adjusted if it is found that, as a consequence of the inclusion of new observations, changes occur in the explanatory power of the model as a whole (adjusted R^2) or in relation to the statistical significance of individual variables.
[58] If ADIF and ADIF AV justify that the predicted costs are appropriate for the calculation of direct costs as provided for in Regulation 2015/909, the elasticities calculated by the model shall be applied to these predicted costs.
[59] *According to the CATRIN project, the elasticity of these costs on the Swedish rail network is 0.324 (Andersson, M. (2006a), Case study 1.2D I: Marginal railway infrastructure cost estimates in the presence of unobserved effects*, Annex to Deliverable 3 of GRACE (Generalisation of Research on Accounts and Cost Estimation), funded by the European Commission Sixth Framework Programme. ITS, University of Leeds, Leeds). In Austria, the cost of staff required to keep the network operational, even in the absence of traffic, is considered a non-eligible cost. In the Czech Republic, Finland, Great Britain and Norway, no operating costs are charged for traffic management activities. In France, the variable cost of these activities was calculated by econometric modelling, and it was concluded that only 10% of the total cost is variable (see Table 9.). Furthermore, as in Sweden, the costs of the staff required to allocate train paths are excluded in France.
[60] Rather than allocating the full depreciation costs calculated solely on the basis of accounting criteria, the German infrastructure manager (DB Netz AG) uses an econometric regression to determine the fixed, i.e. non-eligible, component of the depreciation costs of each network stretch. For this purpose, the depreciation of assets which are not subject to wear and tear due to rail

their model for determining directly allocable costs, establishing in an objective, transparent and robust manner the variability of these costs according to traffic, in accordance with the provisions of Regulation 2015/909.

93. Finally, the Decision on railway charges for 2020 noted, in its 4th conclusion, that *"the railway infrastructure designed for passenger traffic entails certain requirements that are not necessary for freight transport"*. The Decision on railway charges for 2021 stressed the need for ADIF and ADIF AV to develop a technical study to estimate the long-term incremental costs of freight traffic on lines designed for passenger traffic, in line with the experience of other countries[61].

94. This improvement in the way charges for freight services are determined aims to ensure that in those cases where, as a result of infrastructure developments, the conventional network ceases to be operational and freight railway undertakings are forced to use the high-speed network, freight services remain competitive, limiting the costs charged to them to those elements of the infrastructure they actually use.

6. MARK-UPS ON CHARGES FOR THE USE OF RAILWAY INFRASTRUCTURE

6.1. Regulation

95. Article 32(1) of the RECAST Directive allows infrastructure managers to levy mark-ups on the directly chargeable cost for full cost recovery, provided that: (i) the market can bear them, (ii) they are based on efficient, transparent and non-discriminatory principles, (iii) they ensure optimal competitiveness of segments, respecting productivity increases achieved by railway undertakings, and (iv) they do not exclude market segments which "can pay at least the cost that is directly incurred as a result of operating the railway service, plus a rate of return which the market can bear".

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traffic or assets whose useful life exceeds a reasonable observation period are considered non-eligible costs. For the remaining assets, a statistical model relating the depreciation costs to the traffic in each stretch, including other control variables, has been estimated. The Polish infrastructure manager (PKP PLK) uses a technical study to correct the accounting useful life of the assets according to the different elements of the infrastructure (rails, curvature, number of tracks and switches), the type of trains running (speed, axle weight and percentage of freight trains) and the frequency of maintenance for each stretch. The direct cost is determined according to this adjusted useful life and weighted by the actual capacity utilisation of each stretch.

[61] See report by the UK regulator (ORR). https://www.raildeliverygroup.com/files/Publications/archive/2014-07_charges_and_incentives_user_guide.pdf

96. The analysis of whether a mark-up can be borne by the market is based on its impact on demand in the market segments that managers must identify. On this issue, the CJEU has indicated that the full cost recovery mark-up *"can only be applied if the market can bear it, which requires a market study to verify"*[62].

97. Annex VI of the RECAST Directive identifies a list of potential market segments, with Article 32 of the Directive stating that the infrastructure manager shall consider at least three: freight services, passenger services within the framework of a public service contract and other passenger services. Infrastructure managers must also identify segments in which railway undertakings are not currently operating but may provide services during the period of validity of the charging system. The list of market segments should be published in the network statement and reviewed at least every five years under the supervision of the regulatory body.

98. Article 97(5)(3) of the Railway Sector Act transposes Article 32(1) of the RECAST Directive into Spanish law, establishing the following:

- ADIF and ADIF AV may levy a mark-up on the cost directly incurred by operating the railway service which allows for full recovery of the costs incurred. The Railway Sector Act establishes that the costs that may be recovered by mark-ups shall be the *"sum of financial expenses, replacement costs for platforms, tunnels, bridges, tracks, buildings and means used for maintenance and conservation, as well as those necessary for a reasonable development of these infrastructures and all costs enabling railway infrastructure managers to achieve the economic sustainability of the infrastructure they manage"*.

- Mark-ups *"shall be based on efficient, transparent and non-discriminatory principles as far as the market can bear them and while ensuring optimal competitiveness of the railway market segments"*. However, the level of charges shall not exclude the use of infrastructure by market segments which can pay at least the cost directly incurred by the operation of railway services, plus a rate of return which the market can bear.

- Before approving the levying of a mark-up, *"infrastructure managers shall assess the significance of the mark-up for the market segment concerned"*. To this end, Article 97(5)(6)(3) lists the pairs of segments included in Annex VI of the RECAST Directive and, like the Directive, states that the

[62] Paragraph 87 of CJEU judgment in Case C-556/10.
https://curia.europa.eu/juris/document/document.jsf;jsessionid=EBA48CD8FA19414AABD883EB85DEF9BA?text=&docid=134373&pageIndex=0&doclang=ES&mode=lst&dir=&occ=first&part=1&cid=6735903

infrastructure manager's final list of segments shall include at least freight services, passenger services within the framework of a public service contract and other passenger services.

The list of market segments should be reviewed by the infrastructure managers at least every five years, under the supervision of the CNMC, and published in the network statement.

6.2. International Comparison

99. The IRG-Rail published a comparison of the methodologies applied by rail infrastructure managers for the definition of market segments and the levying of mark-ups[63], showing that the most commonly used methodology is the Ramsey-Boiteux pricing methodology. The IRG-Rail document notes that the application of this methodology requires the determination of the demand elasticities of the different market segments.

100. The Appendix to the IRG-Rail[64] document describes the mark-up calculation methodologies in force in the following countries:

- In Austria, the infrastructure manager uses the Ramsey-Boiteux pricing methodology to allocate, between the different market segments, the revenues that the Austrian government determines should be recovered through mark-ups. For the application of the Ramsey-Boiteux pricing methodology, a parameter called "relative ability to bear a higher cost" is used. This parameter is a transformation of the inverse elasticity of final consumers weighted by the cost structure of operators (weight of charges over total costs) and the cost pass-through ratio to final prices[65].

- In Belgium, the infrastructure manager defines 36 market segments according to the type of service, the traffic density of the lines travelled (number of train-km travelled per kilometre of that line) and the period of the day (peak hour, weekend, etc.). The Ramsey-Boiteux pricing methodology is applied to determine mark-ups.

- In France, mark-ups are applied only on passenger services because freight services are deemed unable to bear a charge higher than the direct

[63] IRG-Rail, 2021. *"Overview of the application of market segments and mark-ups in consideration of Directive 2012/34/EU"*. https://www.irg-rail.eu/download/5/895/IRG-Rail20219-PaperonMarketSegmentationMark-Ups.pdf

[64] IRG-Rail, 2021. "Appendix to the paper on Market Segmentation and Mark-up Case Studies".

[65] This pass-through ratio is assumed to be 100%, so that any increase in costs is passed through to prices.

cost. The infrastructure manager segments commercial passenger services according to the population of the cities connected by a route and the intensity of modal competition (from both road and air travel). For the analysis of the market's ability to bear mark-ups, their impact on a theoretical profit and loss account of a high-speed “standard transport operator” is analysed by establishing the effect of raising or lowering the amount of the mark-up at different times of the day.

- In Germany, the infrastructure manager identifies 64 segments according to the type of traffic (type of service, distance and speed) and the type of goods transported[66]. A Ramsey-Boiteux pricing model similar to the Austrian one is applied to set the mark-ups, whereby the German government sets the amount of subsidies DB Netz will receive over a multi-year period, but regulations also stipulate that the infrastructure manager's revenues from charges may not exceed the historical costs of the minimum access package. In line with this revenue target, the model analyses the impact of a mark-up increase on both operators (access price increases and pass-through of the increase to ticket prices) and end-users, determining the impact on the demand for train paths.

- In Great Britain, the main infrastructure manager applies mark-ups to services subject to public service obligations, to inter-city stretches of commercial services and to freight services carrying certain types of goods (coal, iron ore, nuclear waste and biomass). The determination of mark-ups follows a different methodology depending on the type of service. For services subject to public service obligations, the mark-up is set according to the amount that can be passed on to governments or authorities through public service contracts without affecting the service provision level.

  For commercial intercity services, the model analyses the profitability of railway undertakings based on the estimated costs of each service and the elasticity of demand data, establishing the maximum amount of the mark-up that the railway undertaking could bear in the worst-case scenario.

  For freight services, the model identifies the segments that can bear a higher cost by using the elasticity of demand data for each type of goods transported and other elements such as the degree of modal competition.

[66] The infrastructure manager defines 12 long-distance passenger segments, distinguishing between speeds of less than 100 km/h and more than 160 km/h, between the stations covered according to their volume of activity, the days of operation (weekdays or weekends) and night trains. For suburban services, 17 segments are defined according to population centres. Finally, the 35 freight segments are differentiated according to train weight, dangerous goods and distance covered.

In these segments, the impact of the mark-up on demand is analysed, concluding that the market cannot bear the mark-up if demand in the segment is reduced by more than 10%.

- In the Netherlands, the infrastructure manager segments the market according to the elasticities of the different types of traffic, grouping together those with similar demand elasticities. Based on these segments and the public contributions received, the Ramsey-Boiteux methodology is applied to determine the amount of the mark-up for the different segments[67].

6.3. Determination of Mark-ups by ADIF and ADIF AV

101. ADIF and ADIF AV have proposed to modify the mark-ups on two occasions since the transposition of the framework for determining railway charges of the RECAST Directive with the approval of the Railway Sector Act in September 2015. In the economic memorandum attached to the charging proposal for 2017, ADIF AV noted that using direct costs would reduce the total revenue on high-speed lines and highlighted the dynamism of high-speed rail traffic and the *“increase in the average occupancy of trains running on these lines, which makes it possible to increase the collection by the operator”*[68].

102. Therefore, ADIF AV proposed to levy a mark-up on all high-speed lines considering *“on the basis of historical experience, the capacity of certain market segments to bear additions and mark-ups that allow the rail infrastructure manager to compensate for the economic imbalance resulting from the modulation of the basic tariffs of the different types of services”*.

103. Subsequently, in the charging proposal for 2020, ADIF AV proposed to increase the mark-up on the Madrid-Barcelona line by 25% and to establish a mark-up on the rest of the high-speed lines equivalent to 50% of the current mark-up on the Madrid-Andalusia corridor. The infrastructure manager justified the new mark-ups

[67] On 11 May 2023, the Dutch regulator (ACM) launched a public consultation because it concluded, in a preliminary analysis, that it could not establish whether the price elasticity of freight transport considered by ProRail (infrastructure manager) in its mark-up calculation methodology was reliable. Therefore, ACM could not conclude on the legality of the charges proposed by ProRail, given that price elasticity is used to establish the additional payments for segments with a higher relative ability to pay. ACM has not yet completed its analysis (the public consultation ended on 12 July 2023).
https://www.acm.nl/nl/publicaties/ontwerpbesluit-over-methode-extra-heffing-prorail-2025-2029-ter-consultatie

[68] Decision of 3 November 2016 on ADIF and ADIF Alta Velocidad's charging proposal for 2017, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013.
https://www.cnmc.es/sites/default/files/1171322_10.pdf

on the grounds that the addition had remained unchanged since 2017, the evolution of passengers on the different high-speed transport services was positive and on the lines that did not have a mark-up *“the market has already acquired sufficient maturity to bear it”*.

104. The CNMC analysed ADIF AV's first mark-up proposal in the Decision on Railway Charges for 2017, noting that the market analysis carried out differed from that expected according to the economic literature, as it did not consider the price sensitivity of the final demand as an indicator of the market's capacity to bear the mark-ups. Despite this, the Decision concluded that in a non-liberalised context “*RENFE's results could be an adequate estimate of the market's capacity to absorb the proposed mark-ups*”, as the absence of competition made it difficult to gauge the impact of the increase in charges on the end market.

105. Subsequently, the Decision on Railway Charges for 2020[69], which analysed the second mark-up modification proposal, required ADIF AV to develop a methodology to determine whether the market can bear the mark-ups. This methodology should include market segmentation, identifying traffic or services with common characteristics from the point of view of supply and demand, and the capacity of the market to bear the mark-up considering, among other factors, the profitability of operators, the coverage of direct costs, the modal share of rail in the corridor and finally, the competitiveness of the segments based on the price elasticity of demand.

6.4. Mark-up Oversight

6.4.1. Legality Checks

Efficient Mark-up Determination

106. Article 97(5)(3) of the Railway Sector Act requires, firstly, that mark-ups be based on efficient, transparent and non-discriminatory principles. Transparency implies that ADIF and ADIF AV must publish the principles for determining mark-ups and their amounts in the network statement. Non-discrimination implies that traffic demonstrating the same ability to pay should have equivalent mark-ups. According to economic literature, the Ramsey-Boiteux methodology is the most efficient way to achieve a revenue target, maximising social welfare[70]. Moreover,

[69] See footnote 45.

[70] Pérez-Reyes, R (2008). “Política de precios y subsidios” [Pricing Policy and Subsidies]. Chapter 15 in García Delgado (et al.). “Energía y regulación en Iberoamérica”. [Energy and Regulation in Ibero-America]. Comisión Nacional de Energía (CNE - Spain) / Asociación iberoamericana de entidades reguladoras de energía (ARIAE) / THOMSON-CIVITAS (Civitas Economics and

international comparisons show that this methodology is widely used by European infrastructure managers to determine mark-ups.

107. Under this methodology, the mark-up is inversely proportional to the price elasticity of each market segment, so that those with more inelastic demand bear higher mark-ups:

$$\frac{Ctot_i - CD_i}{Ctot_i} = \frac{k}{\varepsilon_i}$$

Where:
$Ctot_i$: Total charge for segment *i* (direct cost + mark-up) per train-km.
CD_i: Direct cost of segment *i* per train-km.
ε_i: Price elasticity of path demand of segment *i.*
k: Ramsey constant or parameter replacing $\frac{\lambda}{1+\lambda}$.
λ: Lagrange multiplier.

108. The mark-up ($Ctot_i - CD_i$), calculated as a margin on direct costs, is determined by the price elasticity of demand for each segment, which, in turn, is influenced by the elasticity of end users, the weight of charges on segment prices and the pass-through ratio of cost increases to final prices.

$$\varepsilon_i = \varepsilon UF_i * \frac{Ctot'_i}{U_i} * Rtras$$

Where:
εUF_i: Price elasticity of final consumers of segment *i*
U_i: Final service price of segment *i* per train-km.
$Ctot'_i$: Initial total amount of the charge of segment *i* per train-km.
$Rtras$: Pass-through ratio of higher costs to prices.

109. The parameter λ of the constant k expression must be adjusted to reach the target revenue:

$$Ingreso\ objetivo = \sum_i (Ctot_i - CD_i) * tren.km_i$$

Business Library; Economics Collection). Schweickardt, G. A. (2014). “Modelo de optimización para definir subsidios intrínsecos en distribución eléctrica” [Optimisation Model for the Definition of Intrinsic Subsidies in Electricity Distribution].

Market Test

110. Any methodology for calculating mark-ups must also ensure *"the optimal competitiveness of rail market segments*". The CJEU has pointed out that the term 'competitiveness' in this context *"does not refer to competition between railway undertakings, but to the competitiveness of the railway sector in relation to other modes of transport"*[71].

111. It must also ensure that the level of charges does not exclude *"the use of infrastructure by market segments which can pay at least the cost directly incurred by the operation of the train service, plus a rate of return which the market can bear"*. To comply with this requirement, the amount of the proposed mark-up must not lead to a reduction in demand for the segment, since otherwise, a part of the demand that could pay the direct cost would be excluded from using the railway infrastructure.

112. Finally, although this point is not included in the Railway Sector Act, Article 32 of the RECAST Directive states that mark-ups must respect the productivity increases achieved by railway undertakings. This means that the mark-up may not appropriate the profit generated by reductions in the costs of items over which railway undertakings have managerial discretion.

6.4.2. Elements to be included in mark-up proposals

113. Where the infrastructure manager proposes to levy a new mark-up or modify an existing mark-up, it shall provide a market study identifying the market segments, detailing the volume of activity, the characteristics of demand and the price elasticity of each segment. On the basis of this study and a mark-up collection target, it must apply the Ramsey-Boiteux methodology to determine the amount of the mark-up for each segment.

114. ADIF and ADIF AV may levy the mark-up resulting from the Ramsey-Boiteux price methodology, provided that: (i) as a result of the levying of the mark-up and its pass-through to final prices, in accordance with the estimated price elasticity, the demand for the segment does not decrease, and (ii) the rail mode remains competitive with other modes of transport. For the latter, infrastructure managers may justify that the price elasticity of demand already includes modal competition, requiring no additional analysis.

115. The benchmark demand for the analysis in (i) above shall be the one resulting from the exercise described in Section 8 of this Communication, to ensure that

[71] See Paragraph 59 of Case C-144/20.

the modification of mark-ups achieves the optimal demand for the segment. Managers should periodically update the market study and review the optimal demand for the segment, considering exogenous factors where appropriate, such as exceptional events or changes in service provision.

116. Where the implementation of the mark-up results in a reduction in demand, infrastructure managers may only levy the mark-up to the extent that, according to the price elasticity of the segment, the condition that demand is not reduced is fulfilled.

117. In the case of routes without competition, while the market study is also necessary, the impact of mark-ups and their pass-through to final prices is uncertain due to the position of the sole service provider. As stated in the CNMC Decision of 3 November 2016[72], in a non-liberalised context, it is difficult to gauge the impact of the increase in charges on the final market due to the absence of competition, so that "*RENFE's results could be an adequate estimate of the market's capacity to absorb the proposed mark-ups*". Therefore, in such cases, the infrastructure managers may set or modulate the mark-up according to the profitability of the sole operator providing the services.

118. The infrastructure managers may carry out this analysis over a multi-year period. To do so, ADIF and ADIF AV must establish the period in which they propose to levy the mark-up, during which it will remain stable (reference period), and provide a forecast of the evolution of demand based on factors such as gross domestic product, inflation, energy prices and any other relevant elements, justifying their impact on the demand of the segment or segments in which they intend to levy the mark-up.

119. In addition, at the request of the infrastructure managers, the CNMC shall calculate, after consultation with the undertakings concerned, the costs of an average efficient operator providing the services in the segment on which the mark-up is intended to be levied and shall make a forecast of the efficiency gains and profit margins, identifying the productivity increase of this average efficient operator.

120. ADIF and ADIF AV may levy a mark-up provided that, during the reference period, the pass-through of the mark-up to final prices does not result in a reduction in demand for the segment concerned and the efficiency gains of railway undertakings are respected.

[72] Decision of 3 November 2016 on ADIF and ADIF Alta Velocidad's charging proposal for 2017, adopting measures for the next year of monitoring in accordance with Article 11 of Law 3/2013 of 4 June 2013.
https://www.cnmc.es/sites/default/files/1171322_10.pdf

7. CONSULTATION PROCEDURE

121. The original wording of Article 100 of the Railway Sector Act provided for infrastructure managers to consult with railway undertakings on proposals for updating railway charges. Within the framework of its powers under Article 11(2)(d) of the LCNMC, the CNMC has highlighted the importance of convening meetings with railway undertakings to allow them to express their points of view and has regulated this process.

122. Thus, in its Decision of 3 November 2016 on ADIF and ADIF Alta Velocidad's charging proposal for 2017, adopting measures for the next oversight period in accordance with Article 11 of Law 3/2013, of 4 June 2013[73], the CNMC stressed that *"the consultation procedure should become a constructive forum to discuss the essential elements on which railway charges and fares are based"*. Therefore, it considered that *"in addition to the written submission of the charging proposal, ADIF and ADIF AV should convene other stakeholders by holding at least two meetings with them to discuss the proposed charges and analyse the basic information for their calculation, as well as the assumptions and forecasts made by the infrastructure manager in relation to the volume of activity considered for their calculation"*. Additionally, the CNMC stated that ADIF and ADIF AV should provide the economic-financial information at least two weeks in advance of the meeting so that railway undertakings could analyse it beforehand.

123. In the Decision on Railway Charges for 2019, the CNMC pointed out the importance of bringing the process forward and holding consultations earlier when the changes in charges were substantial, as was the case that year.

124. The new wording of Article 100(2) of the Railway Sector Act provides that infrastructure managers shall publish on their website the values of railway charges *"in order to allow affected citizens to voice their concerns and to obtain any additional contributions from other persons or entities, during a non-extendable period of fifteen calendar days"*. Within the same period, the proposal shall be consulted with those liable to pay the charges and with the autonomous communities, *"which may submit the corresponding report before the end of the aforementioned fifteen days"*.

125. The CNMC considers it advisable for the infrastructure managers to continue summoning railway companies to two consultation meetings during the process of updating charges. The first meeting should take place before the formal start of the procedure, so that the infrastructure managers may know, on a preliminary basis, the points of view of those obliged to pay railway charges. ADIF and ADIF

[73] https://www.cnmc.es/sites/default/files/1171322_10.pdf

AV should send the relevant information sufficiently in advance so that railway undertakings can analyse it, including cost information and any other relevant information, such as market studies and the reasons for the proposed market segmentation for the determination of mark-ups.

126. Finally, in line with the above-mentioned Decision on Railway charges for 2019, when a substantial modification of the structure or the amount of the charges in force is envisaged, the consultation process should be brought forward and even include additional meetings.

8. FIRST ADJUSTMENT OF RAILWAY CHARGES

127. The first implementation of this Communication will lead to a reduction in direct costs compared to those currently in force.

128. ADIF and ADIF AV must justify, through a market study, that the proposed mark-ups comply with the requirements established in Article 97(5)(3) of the Railway Sector Act.

129. Furthermore, Section 4.1 describes the increase in demand brought about by liberalisation, favoured by significant reductions in ticket prices. The increase in traffic, while charges have remained unchanged, has resulted in a significant improvement in ADIF AV's turnover in this area[74].

130. The present situation, in which charges have remained unchanged and the increase in demand derives from the reduction in ticket prices upon liberalisation and the introduction of competition in the market, exceptionally requires ensuring that the average efficient operator is able to offer the necessary services to satisfy optimal mobility demand in a cost-effective manner.

131. The market study should determine the total mobility of the segment, including all modes of transport, and an optimal demand for the rail mode consistent with the capacity of the infrastructure. Based on the elasticity of demand, both for rail and cross-modal, retail prices shall be determined to ensure that optimal demand is achieved. Finally, it shall be verified that the average efficient operator obtains average revenues, given the prices resulting from the market study, which are higher than its average costs.

[74] From 236 million in Q3 2022 to 466 million (+43%) in Q3 2023 according to ADIF AV's quarterly accounts, point 13(a), page 100. https://www.adifaltavelocidad.es/documents/34745/4849378/EEFF+ADIF+AV+-+RL+30.09.2023+con+informe.pdf/c98834c9-8e6c-99be-3bd1-f16ed9979570?t=1702472220260

132. Therefore, in the oversight of the first charging proposal following the adoption of this Communication, the CNMC will require that the proposed mark-ups allow the average efficient operator to deliver the optimal demand for each segment in an efficient and cost-effective manner, using, based on the data set out in Appendix II:

- The average costs of railway undertakings for the last three financial years considering a level of utilisation that allows, during the period in which the mark-ups are levied, reasonable growth in demand and does not drive passengers away from the rail mode.

- The average revenues resulting from the prices to achieve optimal demand according to the market study.

133. Consequently, ADIF and ADIF AV should:

- Review the current market segmentation in accordance with a market study.

- Justify that the mark-ups are efficient according to the Ramsey-Boiteux pricing methodology and that they allow reaching the optimal demand in each segment.

- Justify that the mark-ups allow the average efficient operator described in Appendix II to provide sufficient services to satisfy the optimal demand of each segment in a cost-efficient manner while achieving a reasonable utilisation of the trains.

134. Finally, the first implementation of the Communication will lead to a substantial change in the charging structure. Railway undertakings should be consulted during the process, including the market study, so that they are aware of the possible modifications that will apply, in accordance with Section 7 above.

9. CONCLUSIONS

135. The CNMC has jurisdiction to rule on the legality of infrastructure managers' charges, as established by Community and Spanish legislation and confirmed by both the CJEU and the Spanish National High Court.

136. The purpose of this Communication is to provide transparency to the principles that will guide the CNMC's action in the analysis of the costs directly incurred by the operation of the rail service and the mark-ups, provided for in Articles 96(4) and 97(5)(3) of the Railway Sector Act.

137. Spain is the European country with the most extensive high-speed network in Europe, although with a low level of use despite the significant increase in passenger numbers due to the recent liberalisation of passenger transport and the emergence of competitors in the three main high-speed corridors.

138. Despite the low intensity of use, railway charges in Spain are relatively high, being on average the second highest in the EU after France. For high-speed services, charges in Spain are similar to those in Germany on the Madrid-Barcelona corridor, while in Italy they are significantly lower than those on the Madrid-Barcelona and Madrid-Sevilla/Málaga corridors and similar to those on the other high-speed lines.

139. Given the relevance of mark-ups for the costs of railway undertakings, on routes where a mark-up is applied, railway undertakings face significant demand risks. In comparison, air and airport charges allow for a profitable operation with relatively lower occupancies.

140. The signing of the agreements between the Ministry of Transport and the infrastructure managers prior to the adoption of the Indicative Strategy means that the funding of infrastructure is not fully aligned with the objectives pursued, particularly with regard to modal shift objectives.

141. European legislation has assimilated directly allocable costs—the only costs that can be recovered through charges without a market study—to marginal costs. For their calculation, international experience shows that econometric models provide greater reliability and robustness in identifying non-eligible costs. ADIF and ADIF AV apply the subtraction methodology, subtracting non-eligible costs from total costs, resulting in direct costs that are more than double the European average and 50% higher than those of the country with the second highest costs.

142. The CNMC has carried out an econometric study with the aim of establishing the relationship between traffic and preventive maintenance operating costs, concluding that the percentage variable with traffic is 25%. This result is consistent with international comparisons and places direct costs in Spain in line with those of other countries with similar network characteristics.

143. Therefore, the CNMC will analyse the legality of the direct cost that the Spanish infrastructure managers propose to allocate to charges, based on the elasticity of cost to traffic calculated in accordance with the econometric model described in Appendix I, which will be updated annually. The CNMC will give ADIF and ADIF AV access to the econometric model so that they can calculate the directly allocable cost of maintenance and may propose improvements that must be justified on the basis of the provisions of Regulation 2015/909.

144. The regulatory framework allows infrastructure managers to levy mark-ups on the directly allocable cost to fully recover costs, provided that (i) the market can bear them, (ii) they are based on efficient, transparent and non-discriminatory principles, (iii) they ensure the optimal competitiveness of rail market segments while respecting the productivity increases achieved by railway undertakings, and (iv) they do not exclude market segments that *"can pay at least the cost directly incurred as a result of operating of the railway service, plus a rate of return which the market can bear".* The CJEU requires the assessment of whether the market can bear a mark-up to be based on a market study.

145. The allocation of costs to the different segments is generally done using the Ramsey-Boiteux pricing methodology, although some countries include an additional market test to ensure that each specific segment can bear the amount of the cost to be recovered.

146. To assess the legality of proposals to levy or modify a mark-up, infrastructure managers should provide a market study that identifies the relevant market segments, as well as the volume of activity, demand characteristics and price elasticity for each segment. On the basis of this study and a collection target, the Ramsey-Boiteux methodology should be applied to ensure an efficient allocation of non-eligible costs.

147. The mark-up resulting from the application of the Ramsey-Boiteux methodology will be considered acceptable to the market if: (i) as a result of the implementation of the mark-up and its pass-through to final prices, in accordance with the estimated price elasticity, the demand for the segment does not decrease and (ii) the rail mode remains competitive with other modes of transport.

148. The infrastructure managers may carry out this analysis over a multi-year period. To do so, ADIF and ADIF AV shall establish the period during which their proposed mark-up will remain stable (reference period) and provide a forecast of demand growth. ADIF and ADIF AV may apply or modify a mark-up provided that, during the reference period, the pass-through of the mark-up to final prices does not result in a reduction of demand for the segment concerned, considering the demand forecasts, and the efficiency gains of railway undertakings are respected.

149. It would be advisable for ADIF and ADIF AV to convene two consultation meetings with railway undertakings. The first meeting should take place before the formal start of the procedure, so that the infrastructure managers may know, on a preliminary basis, the points of view of those obliged to pay railway charges. In addition, when a substantial change in the structure or level of existing charges

is envisaged, the consultation process should be brought forward and even include additional meetings.

150. In the first charging proposal following the adoption of this Communication, in which direct costs and mark-ups will be revised simultaneously, ADIF and ADIF AV should:

- Review the segmentation of the rail market according to a market study.

- Justify that the mark-ups are efficient according to the application of the Ramsey-Boiteux methodology and enable to reach the optimal demand in each segment according to the results of the market study.

- Justify that the mark-ups allow the average efficient operator described in Appendix II to provide sufficient services to satisfy the optimal demand in each segment in a cost-effective manner while achieving reasonable utilisation.

APPENDIX I. ECONOMETRIC MODELLING OF MAINTENANCE COSTS

A. Econometric Model Approach

151. To develop the econometric model for determining the cost elasticity to traffic, international best practices have been applied, such as the above-mentioned CATRIN project of the European Commission and practices followed by other European infrastructure managers.

152. The idea underlying this study is that traffic (both its volume and nature) is a relevant variable in explaining the costs incurred by infrastructure managers for the maintenance, renewal and operation of the rail network (Nash, 2005[75]). Consequently, an econometric model can identify the extent to which an increase in traffic leads to an increase in these costs, controlling for the effect of other factors, such as the technical characteristics of the track, thus isolating the marginal cost of the network. This approach makes it possible to identify the effect of traffic on maintenance costs arising from wear and tear and to separate it from maintenance costs arising from other causes, such as the passage of time or the dimensioning of the network.

153. Experience from other studies shows that the relationship between traffic and infrastructure costs, particularly maintenance costs, does not follow a linear relationship (increasing proportionally to the increase in traffic), but varies at different levels of traffic. In fact, most econometric studies apply non-linear functional forms, such as the log-log transformation of variables (log-log models[76]). As noted by Odolinski and Nilsson (2017[77]), these models provide a better fit than linear models, consistent with the nature of maintenance activities, whose output is more likely to respond to relative traffic increases than to absolute increases.

154. Other studies choose to use more complex and flexible non-linear functional forms. For example, Andersson (2007[78]) assumes a translog production function

[75] Nash, C. (2005) Rail Infrastructure Charges in Europe. Journal of Transport Economics and Policy, 39(3), 259-278.
[76] This transformation involves using the logarithm (generally the natural logarithm) of the observations of the variables to be transformed.
[77] Odolinski, Kristofer and Nilsson, Jan-Eric. "Estimating the marginal maintenance cost of rail infrastructure usage in Sweden; does more data make a difference?" Economics of transportation 10 (2017): 8:17.
[78] Andersson, Mats. "Fixed effects estimation of marginal railway infrastructure costs in Sweden." (2007)

and applies a translog model[79]. These models, in addition to explaining a non-linear relationship, provide an estimate of the elasticity of cost to traffic that varies for different levels of traffic and allows for cross-elasticity with respect to other relevant factors.

155. This study analyses the different modelling using cost information from the infrastructure managers' analytical accounts, as well as traffic information and technical variables at the network stretch level. This makes it possible to estimate the relationship of these variables at the different sections of the infrastructure and to provide a measure of the marginal cost of maintenance.

B. Data Processing: Adjustments to Accounting and Traffic Information

156. The econometric model is based on the operating[80] maintenance, upkeep and repair costs of the elements making up the rail network, which are included in divisions 21 and 28[81] of the ADIF and ADIF AV cost model. Corrective maintenance costs have been excluded[82] because they are considered in their entirety as non-eligible costs by the infrastructure managers under Article 4(1)(j) of Regulation 2015/909.

157. According to the 2022 analytical accounts, the costs considered for the analysis represent 68% of the total costs of the maintenance divisions and 60% of the total infrastructure costs[83].

[79] The translog function, in addition to taking the values of the logarithm of the observations of the explanatory variable of interest, replaces the variable itself with a polynomial of a given degree and includes interactive terms between different variables. This transformation provides a different elasticity depending on the values of each observation.

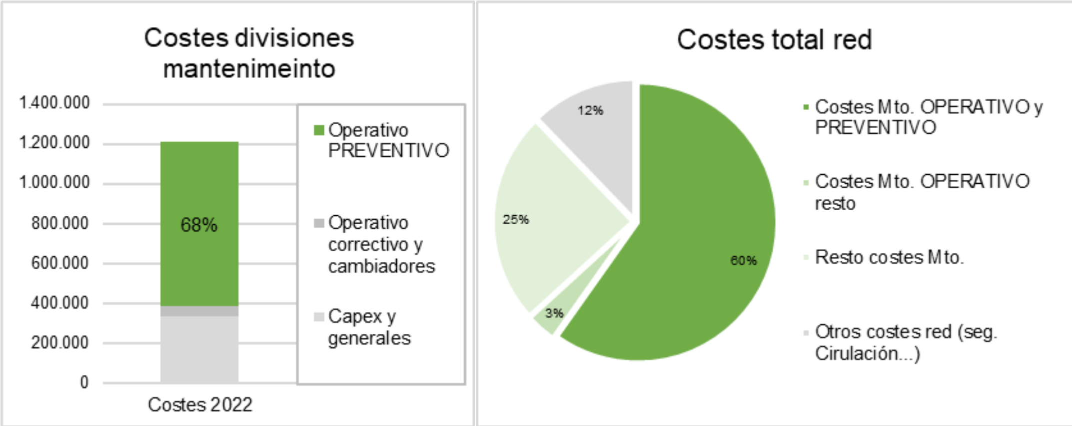
[80] These costs comprise the cost elements grouped under the headings of personnel costs, supplies, external services and materials, agreements and transfer costs.

[81] Also included are the costs of Division 31 (operational until 2019), which encompassed the maintenance costs of the metric gauge network.

[82] According to the ADIF and ADIF AV cost model, preventive maintenance includes the *"programming, execution and monitoring of actions aimed at maintaining the quality level of the facilities, reducing the probability of failure or deterioration of the functions of an element, as well as the control and management of infrastructure risks"*, while corrective maintenance includes the *"actions necessary to carry out maintenance after a failure in order to restore the element to a state that allows it to perform the required functions at the quality level of the facilities"*.

[83] Financial costs are not included.

Graph 12. Weight of costs included in the model.



Source: CNMC based on that from ADIF and ADIF AV's analytical accounting for 2022.

158. Maintenance costs are allocated to different specialities, which are sets of elements that make up the rail network—such as track and infrastructure, overhead catenary, electrical substations, telecommunications and signalling—for each of which an econometric model has been estimated (see Paragraph 81).

159. The econometric study includes data from 2017 to 2022 and takes as the unit of observation the stretch of track which, in the conventional network, constitutes the smallest unit for which the ADIF and ADIF AV accounting model directly allocates costs. On the high-speed network, on the other hand, maintenance costs are allocated by corridor and must be distributed by stretch according to kilometres. As will be explained below, this implies a limitation to the study.

160. A database has been constructed for the econometric modelling based on the information supplied by the infrastructure managers, which required adjustment.

161. Firstly, as mentioned above, the allocation of maintenance costs on the high-speed network is not carried out directly at source, but rather results from the allocation of costs according to the length of the stretch[84]. Therefore, the allocation does not reflect the actual performance of maintenance work on each stretch but is the result of an allocation according to the proportional weight of each stretch on the route. This feature makes it impossible to establish a causal relationship between the traffic carried by each stretch and the cost recorded. Thus, the cost observations on the high-speed network correspond to the sum of the values of its stretches or, in the case of technical variables, the maximum observed value of the variable except for length.

[84] This is due to the fact that the maintenance of the high-speed network is fully outsourced and the contracts with the awarded companies are usually allocated to a corridor, without identifying the specific stretch on which the work is carried out.

162. Secondly, the information submitted included a small number of stretches with negative costs, which, although it may result from accounting adjustments, does not make sense economically. This, in turn, leads to a distortion of the results obtained in the econometric regressions, distorting the relationship between traffic and maintenance costs. Consequently, those stretches with negative costs have been removed from the analysis.

163. Thirdly, the information provided by ADIF and ADIF AV includes network stretches with positive cost values even in the absence of traffic. In these cases, the costs of these stretches are independent of the traffic variable. Therefore, including them in a regression model which aims precisely to explain the variability of costs as a function of traffic makes no sense. Their consideration, moreover, significantly distorts the results obtained[85]. As a result, it has been decided to eliminate them, although, as will be explained below, they are treated separately in the calculation of the marginal cost.

164. Lastly, in a small number of stretches, the values of certain technical control variables were not available, so they have been replaced by the average value of the observations of the same stretch in the available years, in order to ensure that the values are stable.

C. Definition of the Model's Variables

165. According to the literature analysed and based on the information provided by the Spanish infrastructure managers, the study uses cost information and traffic and technical variables at the stretch or corridor levels to estimate the effect of rail traffic on the cost of network maintenance.

166. The econometric models used take the annual costs of each stretch or corridor as the dependent variable, reflecting, as indicated above, the preventive maintenance operating costs allocated to divisions 21, 28 and 31 of the ADIF and ADIF AV accounts for each speciality.

[85] The inclusion of observations that record a positive cost in the absence of traffic reduces the significance of the traffic parameter as an explanatory variable for maintenance costs and creates a bias in the residual of the model, whose distribution is far from normal. This problem is minimised by eliminating these observations as outliers.

167. The variables used to measure the traffic carried on each stretch or corridor are train-km[86] travelled and train-km travelled with electric traction[87], depending on the type of traffic relevant to each speciality[88].

168. In order to determine the technical particularities of the railway stretch or corridor, the econometric models developed consider variables such as the length and maximum speed of the stretch, as well as binary variables that indicate whether the stretch is high-speed, double-track or contains a station, all of which are used to reflect the different intensity of wear and tear of the traffic on the infrastructure. Finally, dummy variables identifying the years 2018 to 2022 are included to correct for possible temporal effects or unobservable characteristics.

169. The original data provided by the Spanish infrastructure managers include information on the operating cost of preventive maintenance for a total of 6,851 observations corresponding to the stretches for the years 2017 to 2022. However, since not all specialities are present in all stretches and after the adjustments made, the final number of observations is different in each model, depending on the speciality concerned.

Table 12. Number of observations by speciality

Speciality	Year						
	2017	2018	2019	2020	2021	2022	Total
Track and infrastructure	858	863	866	881	886	912	5266
Overhead catenary	599	609	622	625	648	662	3765
Signalling	846	859	866	868	886	913	5238
Substations	457	429	531	531	636	663	3247
Telecommunications	811	802	805	814	861	901	4,994

170. The descriptive analysis of the variables used in the estimation after making the adjustments described above is presented below.

Table 13. Descriptive analysis of available variables

	Mean	Standard deviation	Minimum	Maximum
Costs by speciality				
Track and infrastructure (€)	384,360.7	1,800,247.7	1.7	38,047,342.3

[86] Unit of measurement representing the displacement of a train over one kilometre.
[87] The choice of one or the other varies according to the speciality, since each type of traffic is relevant to explaining the wear of the different elements of the network.
[88] Thus, for the overhead catenary and electrical substations specialities, the variable train-km travelled with electric traction is used, since the remaining traffic, which does not make use of these infrastructure elements, is not expected to cause any wear and tear on them.

Overhead catenary (€)	116,994.8	475,941.8	1.0	9,858,143.5
Signalling (€)	240,097.3	2,196,708.6	1.1	48,386,850.4
Substations (€)	41,667.5	127,368.5	1.0	2,815,054.0
Telecommunications (€)	55,137.0	372,379.1	1.0	11,292,911.1
Traffic variables				
Train-km travelled	228,108.3	889,791.5	1.2	18,676,576.4
Train-km travelled with electric traction	195,495.9	884,583.4	1.0	18,668,394.6
Technical variables				
Length (m)	16,961.1	50,877.4	42.0	899,393.0
Maximum speed (km/h)	116.9	44.3	0.0	300.0
Dummy high-speed	0.0	0.1	0.0	1.0
Dummy double-track	0.5	0.5	0.0	1.0
Dummy station	0.9	0.2	0.0	1.0

D. Selection of Applicable Models

171. For the estimation of the model[89], the ordinary least squares (OLS) methodology has been followed and the different combinations of explanatory control variables initially considered relevant have been analysed, selecting the model that best fits each of the specialities, according to its significance and explanatory power (adjusted R^2).

172. Moreover, in line with other similar studies, non-linear functional forms corresponding to log-log and translog models have been estimated[90].

173. The specific modelling and relevant explanatory variables differ for each of the specialities that make up the railway infrastructure due to their inherent characteristics. Below is a table with the different models considered.

Table 14. Econometric models by speciality

	Infrastructure specialities				
	Track and infrastructure	**Overhead catenary**	**Electrical substations**	**Telecommunications**	**Signalling**
Model	Translog	Log-Log	Log-Log	Log-Log	Log-Log
Traffic variable	Train-km	Electric train-km	Electric train-km	Train-km	Train-km

[89] The econometric regressions were carried out using R Studio software and the associated packages.
[90] For the translog modelling, only the non-linear traffic factors (third-degree polynomial) were analysed, without taking into account the interactive terms with other variables.

Technical variables	Length, maximum speed, D_station, D_double-track, D_A-lines	Length, maximum speed, D_station, D_double-track, D_A-lines	Length, D_A-lines	Length, maximum speed, D_station, D_A-lines	Length, maximum speed, D_station, D_double-track, D_A-lines
Year variables	D_2018-2022	D_2018-2022	D_2018-2022	D_2018-2022	D_2018-2022

174. The choice of the specific model for each of the specialities varies in terms of functional form (translog or log-log) and variables included, as the analyses performed show differences in terms of statistical significance and overall fit.

175. As for the control variables included, the length variable stands out, as its omission generates an upward bias in the estimated parameter for the variable of interest (traffic). As might be expected, longer stretches belonging to the same line accumulate more traffic measured in terms of train-km travelled and have a higher cost. Consequently, it is necessary to control for the length of the stretch to determine that the effect of traffic on cost reflects a causal relationship and not merely a spurious relationship determined by the greater absolute weight of longer stretches.

176. The effect of technical variables related to the maximum permitted speed, classification as high-speed lines and the identification of stretches with stations and double-track has also been analysed. Additionally, dummy variables have been included to identify the observations corresponding to the years 2018, 2019, 2020, 2021 and 2022[91].

177. The inclusion of the dummy variable identifying high-speed lines attempts to control for the particularities of the observations corresponding to the high-speed network, as well as for the methodological decision to group the observations at the corridor level mentioned above. This variable is statistically significant and has a positive effect in most of the models of the different specialities, which means that its inclusion is necessary to avoid possible biases produced by the transformation of the data.

178. Regarding the type of traffic, the variable train-km recorded on each stretch is used, except for the specialities of overhead catenary and electrical substations, for which it is appropriate to use the variable train-km travelled with electric

[91] The reference year is therefore 2017. These variables make it possible to determine whether there are unidentifiable patterns that result in significantly different observations in the years to which the specific observations correspond compared to the base year.

traction, since only this type of traffic could wear out the elements that make up these specialities.

179. The functional form adopted for the track and infrastructure speciality is a translog model because it assumes a more complex non-linear relationship than the mere transformation into logarithms. That is, it implicitly assumes that the level of wear of the network (and consequently, the marginal maintenance cost) varies for different ranges of intensity of infrastructure use. This modelling approach is also statistically significant for all specifications and provides greater explanatory power for the variability of maintenance costs (higher adjusted R^2). The model chosen for this speciality is as follows:

$$\ln coste_i = \alpha_i + \beta_1 . \ln tren.km_i + \beta_2 . (\ln tren.km_i)^2 + \beta_3 . (\ln tren.km_i)^3$$

$$+ \beta_4 . Línea\_A_i + \beta_5 . \ln longitud_i + \beta_6 . Estación_i + \beta_7 . Víadoble_i$$

$$+ \beta_8 . Vel.máx_i + \beta_9 . 2018_i + \beta_{10} . 2019_i + \beta_{11} . 2020_i + \beta_{12} . 2021_i + \beta_{13} . 2022_i + \varepsilon_i$$

180. This result is consistent with the expected relationship between traffic and wear of track elements, which are exposed to the effects of physical contact with rolling stock. Thus, the elasticity of the cost to traffic varies for each observation depending on the level of traffic[92].

181. For the remaining specialities, a log-log model is adopted, as translog modelling is not meaningful. This implies that the most appropriate functional form for these specialities is the log-log transformation, which provides a better fit. The following table shows the results of the estimated econometric models:

Table 15. Results of econometric models by speciality

Speciality	**Track and infrastructure**	**Overhead catenary**	**Signalling**	**Substations**	**Telecommunications**
Functional form	Translog	Log-Log	Log-Log	Log-Log	Log-Log
Constant	3.017 ***	0.012	1.604 ***	-1.029 ***	1.168 ***
Ln_train-km/ *Elasticity*	*0.269*		0.250 ***		0.225 ***

[92] This modelling has been used in other similar studies. See, among others, footnote 78 and Frontier Economics. "*Estimation des couts marginaux d'entretien du reseau ferre national*" [Estimation of the marginal maintenance cost of the national railway network] (2017).

Ln_electric train-km/ *Elasticity*	-	0.189 ***	-	0.243 ***	-
Ln_train-km	-0.360 *				
Ln_train-km^2	0.057 ***				
Ln_train-km^3	-0.002 **				
Dummy A-Lines	0.698 ***	-0.152	1.454 ***	-0.408	0.959 ***
Ln_length	0.815 ***	0.823 ***	0.485 ***	0.881 ***	0.537 ***
Max. Speed	-0.003 ***	0.002 **	0.006 ***		0.002 ***
Dummy Year 2018	0.123 **	-0.024	0.067	0.040	0.092
Dummy Year 2019	-0.090	-0.681 ***	-0.123	-1.746 ***	-0.700 ***
Dummy Year 2020	-0.019	-0.950 ***	-0.343 ***	-2.015 ***	-0.931 ***
Dummy Year 2021	0.315 ***	0.175 **	0.702 ***	-0.468 ***	0.076
Dummy Year 2022	0.255 ***	-0.090	0.763 ***	-0.508 ***	-0.045
Dummy Station	0.661 ***	0.519 ***	0.672 ***		0.877 ***
Dummy Double-track	0.352 ***	0.497 ***	0.462 ***		0.189 ***
Adjusted R2	0.666	0.453	0.461	0.323	0.378

Note: *** p-value < 0,01, ** p-value < 0,05, * p-value < 0,1. The results shown have been corrected for the presence of heteroscedasticity.

E. Robustness of the Model

182. This section deals with the robustness tests of the different econometric models. The estimates made for the Track and Infrastructure speciality are presented below, as it is the most representative and has the greatest weight in total costs, although the conclusions can be applied to the other specialities.

- *Variable selection and omission bias*

183. The variables that may be relevant to the proposed modelling are identified on the basis of the literature review mentioned in Section 5.2. The initial selection of potential explanatory variables assumes that, in order to explain the effect of traffic on maintenance costs, other variables which also have an effect on costs and are correlated with traffic must be considered. It is therefore necessary to include these variables in order to control for their effect and to avoid the possible presence of an omission bias that distorts the estimation of the elasticities.

184. The variable whose inclusion produces the largest change is stretch length. As can be seen in the table below, its inclusion[93] in Model (2) causes a reduction in the parameters associated with traffic, both in the log-log and translog models. The same result is obtained when, instead of including the dependent (maintenance costs) and explanatory (traffic) variables in absolute values, they are included in relative terms, i.e. euros and train-km per kilometre of track.

[93] This variable is included in its transformation into logarithms, following the structure of the different models. The interpretation of this coefficient is therefore an elasticity.

Table 16. Estimation of models for Track and Infrastructure.

TRACK_INFRA	(1)		(2)		(3)		(4)		(5)	
	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog
Constant	5.30797***	10.45161***	1.60755***	3.98250***	1.53647***	4.06358***	1.24665***	3.71527***	0.99083***	3.01748***
Ln_train-km/ *Elast (translog)*	0.56944***	*0.670*	0.27558***	*0.344*	0.28873***	*0.361*	0.27964***	*0.369*	0.21693***	*0.269*
Trans_1		-1.03975***		-0.38905*		-0.42615**		-0.38891**		-0.35952*
Trans_2		0.14988***		0.06064***		0.06614***		0.05872***		0.05743***
Trans_3		-0.00425***		-0.00163*		-0.00180**		-0.00147*		-0.00169**
Dummy A-Lines	2.44007***	2.10237***	0.47808***	0.32102	0.69052***	0.59657***	0.82501***	0.61923***	0.62638***	0.69828***
Ln_length			0.77910***	0.74829***	0.79550***	0.76674***	0.75535***	0.72562***	0.85588***	0.81520***
Max. Speed					-0.00189***	-0.00235***	-0.00172***	-0.00218***	-0.00279***	-0.00293***
Dummy year 2018							0.12723**	0.12354**	0.12491**	0.12251**
Dummy year 2019							-0.08159	-0.09129	-0.08341	-0.09005
Dummy year 2020							-0.01092	-0.00107	-0.02836	-0.01915
Dummy year 2021							0.32383***	0.33072***	0.30748***	0.31510***
Dummy year 2022							0.25768***	0.26422***	0.24851***	0.25470***
Dummy Station							0.66483***	0.66952***	0.66285***	0.66089***
Dummy Double-track									0.43547***	0.35161***
Adjusted R2	0.4460	0.4758	0.6406	0.6463	0.6418	0.6481	0.6547	0.6614	0.6630	0.6661

*Note: *** p-value < 0,01, ** p-value < 0,05, * p-value < 0,1. The results shown have been corrected for the presence of heteroscedasticity. The Elast (translog) parameter shows the overall simple elasticity obtained by substituting traffic data for each stretch.*

185. The inclusion of stretch length as a control variable significantly increases the explanatory power of the model, with an increase in the adjusted R^2 coefficient of approximately 20 percentage points (compared to the first estimate), indicating the goodness-of-fit of the model.

186. The inclusion of the stretch length is therefore necessary to avoid an omitted-variable bias. The practical reason for this effect is that longer stretches of the network accumulate a higher absolute traffic volume (measured in train-km) for the same number of trips. By the same token, these stretches also have higher levels of maintenance costs in absolute terms. Consequently, omitting this variable would result in an overestimation of the effect of the traffic variable on the maintenance costs and would not reflect a causal relationship.

187. As for the other variables, their inclusion has no significant effect on the variable of interest, with the inclusion of the dummy variable ‘double-track’ leading to a slight decrease in the parameter associated with traffic. In conclusion, Model (5)[94] in its translog formulation is the model with the best overall fit and should therefore be adopted as the reference model in this speciality.

188. The same has been done for the other specialities, selecting for each of them the model with the greatest explanatory power and with the variables which are statistically relevant.

[94] See
Table **16**.

Table 17. Estimation of models for Overhead Catenary.

CATENARY	(1)		(2)		(3)		(4)		(5)	
	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog
Constant	4.05261 ***	7.55671 ***	0.10592	1.97659 ***	0.28822	2.04694 ***	0.35370	2.01830 ***	0.01188	1.16838 **
Ln_train-km-e/ *Elast (translog)*	0.54169 ***		0.26963 ***		0.25367 ***		0.25194 ***		0,18925 ***	
Trans_1		-0.11868		0.05395		0.12457		0.12951		0.17524
Trans_2		0.01138		-0.00664		-0.01954		-0.01843		-0.02165
Trans_3		0.00161 *		0.00129		0.00183 **		0.00173 **		0.00158 **
Dummy A-Lines	2.51637 ***	0.34756	0.21604	-0.80624 ***	-0.09438	-1.31183 ***	-0.00693	-1.16427 ***	-0.15180	-1.04620 ***
Ln_length			0.79719 ***	0.73513 ***	0.75259 ***	0.68336 ***	0.71682 ***	0.65279 ***	0.82281 ***	0.75355 ***
Max. Speed					0.00321 ***	0.00363 ***	0.00348 ***	0.00386 ***	0.00208 **	0.00269 ***
Dummy year 2018							-0.03280	-0.03063	-0.02390	-0.02386
Dummy year 2019							-0.69145 ***	-0.69054 ***	-0.68095 ***	-0.68216 ***
Dummy year 2020							-0.94154 ***	-0.91606 ***	-0.94996 ***	-0.92871 ***
Dummy year 2021							0.17689 **	0.19098 ***	0.17516 **	0.18586 ***
Dummy year 2022							-0.09684	-0.08827	-0.09004	-0.08507
Dummy Station							0.52816 ***	0.50406 ***	0.51924 ***	0.50686 ***
Dummy Double-track									0.49736 ***	0.39300 ***
Adjusted R2	0.294	0.327	0.409	0.417	0.411	0.419	0.445	0.452	0.453	0.457

Table 18. Estimation of models for Signalling.

SIGNALLING	(1)		(2)		(3)		(4)		(5)	
	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog
Constant	4.35285 ***	9.35172 ***	2.07414 ***	5.50340 ***	2.34873 ***	5.22508 ***	1.88316 ***	4.67520 ***	1.60414 ***	4.04330 ***
Ln_train-km/ *Elast (translog)*	0.55327 ***		0.37233 ***		0.32048 ***		0.31706 ***		0.25006 ***	
Trans_1		-0.83944 ***		-0.41934 *		-0.29931		-0.25373		-0.21730
Trans_2		0.11136 ***		0.05513 *		0.03780		0.03035		0.02798
Trans_3		-0.00247 **		-0.00079		-0.00024		0.00008		0.00006
Dummy A-Lines	3.62258 ***	2.64430 ***	2.41582 ***	1.59493 ***	1.57102 ***	0.77521 ***	1.66680 ***	0.76971 ***	1.45365 ***	0.82651 ***
Ln_length			0.47961 ***	0.42908 ***	0.41502 ***	0.37550 ***	0.37723 ***	0.33629 ***	0.48502 ***	0.41281 ***
Max. Speed					0.00749 ***	0.00690 ***	0.00763 ***	0.00704 ***	0.00650 ***	0.00641 ***
Dummy year 2018							0.06617	0.06396	0.06724	0.06531
Dummy year 2019							-0.12341	-0.13277 *	-0.12267	-0.13064 *
Dummy year 2020							-0.32474 ***	-0.29715 ***	-0.34265 ***	-0.31376 ***
Dummy year 2021							0.71677 ***	0.73028 ***	0.70169 ***	0.71812 ***
Dummy year 2022							0.77083 ***	0.78451 ***	0.76329 ***	0.77720 ***
Dummy Station							0.67408 ***	0.68873 ***	0.67249 ***	0.68390 ***
Dummy Double-track									0.46239 ***	0.29719 ***
Adjusted R2	0.3388	0.3654	0.3956	0.4085	0.4107	0.4212	0.4537	0.4648	0.4609	0.4673

Table 19. Estimation of models for Substations.

ELECTRICAL SUBSTATIONS	(1)		(2)		(3)		(4)		(5)	
	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog
Constant	2.53334 ***	6.15905 ***	-1.75590 ***	-0.11736	-1.79539 ***	0.12524	-1.02869 ***	0.40126	-1.18971 ***	0.37121
Ln_train-km-e/ *Elast (translog)*	0.54861 ***		0.24358 ***		0.24713 ***		0.24257 ***		0.23502 ***	
Trans_1		-0.08152		0.13270		0.12988		0.07584		0.08594
Trans_2		0.00549		-0.02151		-0.02090		-0.00621		0.00761
Trans_3		0.00180		0.00184		0.00181		0.00102		0.00110
Dummy A-Lines	2.09676 ***	0.05660	-0.30291	-1.41000 ***	-0.22975	-1.37999 **	-0.40786	-1.17235 **	-0.34068	-1.15130 **
Ln_length			0.87057 ***	0.82498 ***	0.88073 ***	0.82811 ***	0.88075 ***	0.84494 ***	0.89360 ***	0.82716 ***
Max. Speed					-0.00074	-0.00022			-0.00070	0.00002
Dummy year 2018							0.03986	0.04382	0.04258	0.04387
Dummy year 2019							-1.74584 ***	-1.73562 ***	-1.74341 ***	-1.73580 ***
Dummy year 2020							-2.01542 ***	-1.98242 ***	-2.01288 ***	-1.97840 ***
Dummy year 2021							-0.46779 ***	-0.45460 ***	-0.46314 ***	-0.45034 ***
Dummy year 2022							-0.50752 ***	-0.49825 ***	-0.50168 ***	0.49478 ***
Dummy Station									0.18566	0.16616
Dummy Double-track									0.06504	-0.04489
Adjusted R2	0.1658	0.1825	0.2506	0.2544	0.2505	0.2541	0.3234	0.3262	0.3238	03257

Table 20. Estimation of models for Telecommunications.

TELECOM	(1)		(2)		(3)		(4)		(5)	
	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog	Log-Log	Translog
Constant	4.03023 ***	10.05789 ***	1.29750 ***	5.56696 ***	1.37944 ***	5.51578 ***	1.28608 ***	5.23676 ***	1.16794 ***	5.39296 ***
Ln_train-km/ *Elast (translog)*	0.48364 ***	0.690	0.28259 ***		0.26700 ***		0.25197 ***		0.22459 ***	
Trans_1		-1.21249 ***		-0.73254 ***		-0.70900 ***		-0.66452 ***		-0.67326 ***
Trans_2		0.13773 ***		0.07411 ***		0.07055 **		0.06420 ***		0.06469 **
Trans_3		-0.00315 ***		-0.00126		-0.00115		-0.00093		-0.00090
Dummy A-Lines	2.61291 ***	1.52580 ***	1.20223 ***	0.30390	0.94548 ***	0.11800	1.04913 ***	0.19432	0.95868 ***	0.18014
Ln_length			0.55374 ***	0.49447 ***	0.53422 ***	0.48215 ***	0.49281 ***	0.44234 ***	0.53701 ***	0.42388 ***
Max. Speed					0.00227 ***	0.00156 ***	0.00263 ***	0.00194 **	0.00218 ***	0.00209 ***
Dummy year 2018							0.09258	0.08799	0.09194	0.088635
Dummy year 2019							-0.70063 ***	-0.71230 ***	-0.70045 ***	-0.71277 ***
Dummy year 2020							-0.92363 ***	-0.88740 ***	-0.93107 ***	-0.88315 ***
Dummy year 2021							0.08053	0.09761	0.07577	0.09997683
Dummy year 2022							-0.04281	-0.02416	-0.04468	-0.02284
Dummy Station							0.87699 ***	0.87037 ***	0.87734 ***	0.87067 ***
Dummy Double-track									0.18942 ***	-0.07174
Adjusted R2	0.2519	0.2901	0.3305	0.3496	0.3318	0.3502	0.3765	0.3940	0.3776	0.3941

- *Heteroscedasticity*

189. One of the assumptions of the linear regression model is that the error variance (u), conditional on the explanatory variables, is the same for all values of the explanatory variables (homoscedasticity). If this assumption is not met, then the model exhibits heteroscedasticity.

190. Homoscedasticity is not necessary to ensure that the estimated coefficients are unbiased, but it does ensure that the OLS estimators have certain efficiency properties. The Breusch-Pagan test, whose null hypothesis is that the homoscedasticity assumption is satisfied ($H_0 \colon Var(u|x) = \sigma^2$), is performed in order to test whether the variance of the residuals of the estimated models is constant for each value of the explanatory variable.

191. The results of the Breusch-Pagan test show the presence of heteroscedasticity in all models. However, the models presented are corrected for this as they have been re-estimated using robust standard errors[95], which allows us to obtain efficient statistics or contrast tests that analyse the statistical significance of the estimators obtained.

- *Normality of the Error*

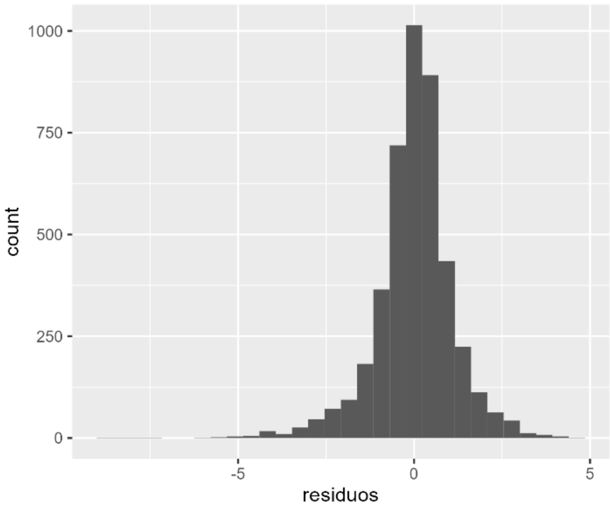
192. Another aspect to assess is the normality of the error. According to the theoretical hypotheses of the multiple linear regression model, if the error is not normally distributed, the *t* and *F* statistics will not show *t* and *F* distributions, respectively.

193. The Shapiro-Wilks test, whose null hypothesis proposes a normal distribution of the residuals, is performed to test the normality of the residuals. This test rejects the null hypothesis, suggesting that the residuals do not follow a normal distribution.

194. However, the analysis of the frequency histogram of the residuals, shown in the figure below, reveals that although the distribution of the observations of the residuals is slightly skewed, it does not deviate greatly from a normal distribution.

[95] The HC3 specification of the 'lmtest' package in R Studio was used to correct for heteroscedasticity.

Graph 13. Histogram of the residuals for the Track and Infrastructure Model.



195. On the other hand, as pointed out by Wooldridge (2009), even when the assumption of normality is not met, the t and F statistics follow distributions that are approximately t and F distributions, at least when the samples are large enough[96]. Thus, in a scenario with a large number of observations, the non-normality of the error is not an obstacle to ensuring the consistency of the estimators.

196. Therefore, given the large number of observations and after an analysis of the histograms, the CNMC concludes that the residuals of the model are close to a normal distribution and the results obtained can be said to be consistent.

- *Multicollinearity and Autocorrelation*

197. Multicollinearity occurs when explanatory variables that are correlated with each other are included in the model. The higher the sample correlation between the explanatory variables, the higher the variance of the OLS estimators. Multicollinearity is not a violation of the assumptions of the multiple linear regression model except when perfect multicollinearity occurs, i.e. when an explanatory variable is a constant or is an exact linear relationship of one or more other variables in the model.

198. However, multicollinearity can become a problem by increasing the variance of the estimators, which can lead to statistical inference problems. This implies that, in case of a high degree of multicollinearity, the statistical significance of a parameter may be incorrectly dismissed.

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[96] Wooldridge, J. D. (2009). *Introducción a la econometría. Un enfoque moderno [Introduction to Econometrics. A Modern Approach].* Cengage Learning.167.

199. While there is no consensus on the exact threshold at which multicollinearity becomes problematic, all else being equal, a reduction in the correlation between variables is generally desirable. The indicative measure provided by Wooldridge (2009) is used to measure the presence of multicollinearity in the models described, using as a threshold a value greater than 10 for the variance inflation factor (VIF). The VIF values of the explanatory variables used in Model (5) in

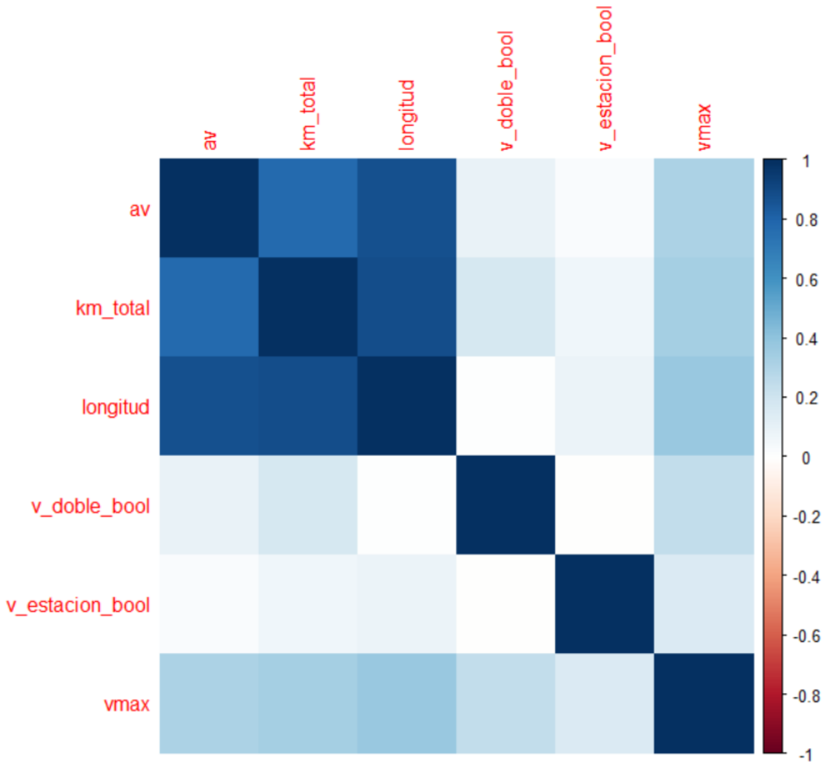
200. Table **16** are well below this threshold.

Table 21. VIF measure of explanatory variables

Model Variance Inflation Factor (5)					
Ln_Train-km	**A-lines**	**Ln_length**	**Max speed**	**Year 2018**	**Year 2019**
2.42	1.14	2.52	1.68	1.67	1.68
Year 2020	**Year 2021**	**Year 2022**	**D_Station**	**D_Double-track**	
1.69	1.70	1.71	1.18	1.57	

201. In addition, the correlation matrix between the different variables shows a low sample correlation between them, with the exception of the length and the 'A-lines' dummy variable, whose correlation is moderate, which is explained by the grouping of the high-speed stretches at the corridor level.

Graph 14. Correlation matrix for the Track and Infrastructure speciality



202. In conclusion, the models analysed can be considered not to present a multicollinearity problem. The contrast statistics are therefore efficient.

203. Meanwhile, although the structure of the data used is cross-sectional and not panel data or time series, there could be an autocorrelation process that explains the maintenance cost based on the observations of the cost in previous years or even the traffic in those years.

204. To this end, the effect of including the value of the maintenance cost in the previous year as an explanatory variable was estimated. In this model, the effect of traffic is approximately halved, and the new explanatory variable is statistically significant. However, significant stability in traffic levels and maintenance costs is observed across years for the different stretches. This leads to a high correlation between these variables and the variables reflecting the value of the previous year. Consequently, their inclusion may distort the real effect of traffic on costs.

205. Similarly, the inclusion of the previous year's traffic as an explanatory variable has the same effect of halving the impact of the variable of interest. In this case, however, neither variable is statistically significant, although their combined effect is equivalent to the effect of traffic without this new variable. Nonetheless, the lack of significance is due to a high collinearity between these variables, as the

sample correlation between the two variables exceeds 98%, again reflecting the stability of traffic levels at the stretch level.

206. In conclusion, the CNMC considers it appropriate to estimate the model without the inclusion of these variables, as the high correlation between them introduces multicollinearity in the model and distorts the estimates, which may lead to a misinterpretation of the effect of traffic on maintenance costs.

F. Estimation of Elasticities and Calculation of Marginal Costs

207. The parameters associated with the variable of interest are obtained from the models described above. These parameters allow the calculation of the elasticities (ε_i)of the cost to traffic for each speciality. The initial elasticities of the model are estimated as the partial derivative of the estimated function for the traffic variable and are applied to the raw data from the ADIF and ADIF AV accounts for the relevant year.

208. In the case of log-log models, the elasticity corresponds to the traffic variable estimator itself, which is constant for all network stretches. The translog model, on the other hand, requires an additional transformation. In this case, the partial derivative of the function with a third-degree polynomial requires replacing the traffic variable with the data recorded in the relevant year for each stretch in order to determine the elasticity for each one of them. The elasticity thus obtained is, therefore, variable for each stretch according to the intensity of use and the reference year. Finally, the initial elasticity in the translog models is calculated as the weighted average of all observations, according to the cost of each stretch.

- Elasticity of the log-log model:

$$\varepsilon = \frac{\partial \ln Coste_i}{\partial \ln Tren.km_i} = \widehat{\beta_1}$$

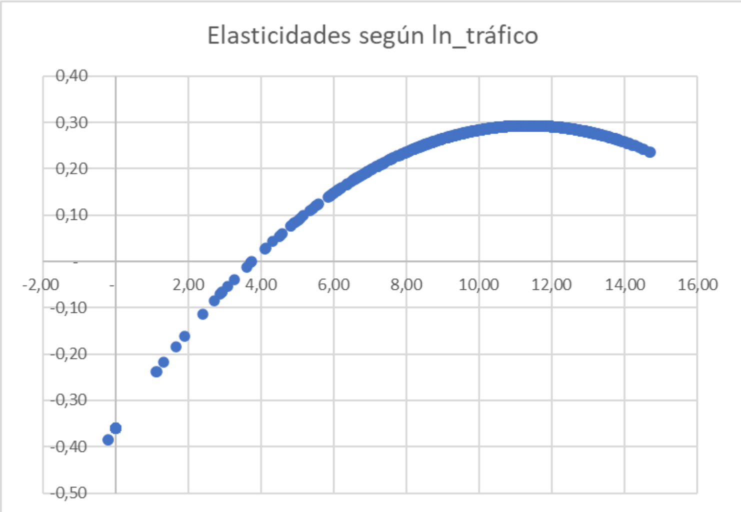
- Elasticity of the translog model:

$$\varepsilon_i = \frac{\partial \ln Coste_i}{\partial \ln Tren.km_i} = \widehat{\beta_1} + 2 * \widehat{\beta_2} lnTren.km_i + 3 * \widehat{\beta_3}(lnTren.km_i)^2$$

209. To obtain the overall elasticity of each speciality in the network as a whole in the translog model, adjustments must also be made to those stretches where the elasticities are outside the economically meaningful range due to the implicit functional form of the model. As shown in the graph below, when calculating the elasticity function with the traffic values of each stretch for the year 2022, in a small number of observations the traffic log is close to zero, which results in a negative elasticity value. A negative elasticity value does not make economic

sense, as it implies that the increase in traffic leads to a reduction in maintenance costs. Consequently, it has been decided to replace this elasticity with the minimum value of the positive elasticities observed in the other network stretches.

Graph 15. Range of track and infrastructure elasticities by stretch in 2022 according to the logarithm of recorded traffic.



Source: Estimates of the translog econometric model in the Track and Infrastructure speciality with traffic data for 2022.

210. Once the elasticities have been estimated for each of the specialities, the marginal cost for each of them can be calculated. First, the marginal unit cost is calculated as the product of the elasticity and the total operating cost of preventive maintenance allocated to each stretch in the ADIF and ADIF AV accounts, according to the following formula:

$$Coste\ Marginal_i = \varepsilon_i * Coste\ del\ tramo_i$$

211. However, as explained in Section B of this appendix, it was observed in all years that there were a small number of stretches where no traffic was recorded, but where maintenance costs were allocated. These observations were removed from the database used for modelling as they distorted the estimation of the econometric models. To determine the marginal cost on these stretches, it was decided to set the applicable elasticity to zero, since the absence of traffic does not allow any relationship to be established between the allocated cost and the wear and tear caused by rail traffic. In fact, in these cases, the allocation of maintenance costs is probably the result of periodic actions carried out regardless of the presence of traffic.

212. Finally, the total direct cost or total marginal cost of the operating cost of preventive maintenance for each year is obtained as the sum of the marginal

costs of all the stretches that make up the General Interest Railway Network (RFIG in its Spanish acronym) for each of the specialities. This makes it possible to obtain the final average elasticity as the percentage of eligible costs in relation to the total costs allocated to the network as a whole.

$$\text{Coste directo total} = \sum_{i=1}^{N} Coste\ Marginal_i$$

213. The following table gives a summary of the obtained estimators, the initial elasticities and the final elasticities, applied to the data of the last available year.

Table 22. Eligible costs by speciality in 2022

	Track and infrastructure	Overhead catenary	Signalling	Electrical substations	Telecommunications
Functional form	Translog	Log-Log	Log-Log	Log-Log	Log-Log
Traffic parameters					
β_1	-0.360	0.189	0.250	0.243	0.225
β_2	0.057	-	-	-	-
β_3	-0.002	-	-	-	-
Initial elasticity (%)	26.9%	18.9%	25.0%	24.3%	22.5%
Eligible costs (final elasticity) (%)	**27.4%**	**17.9%**	**24.7%**	**21.7%**	**21.8%**

G. Oversight of Direct Costs in the Reference Year

214. The percentages shown in the table above correspond to the final elasticities obtained from the data for the last available year (2022). In order to provide greater consistency to the estimates obtained, the CNMC will review the charging proposals and update these percentages for the following financial years by including observations from the most recent financial years closed at the time of the proposal. To this end, the infrastructure managers must provide the information listed in Appendix II, following the specified format, as well as any other information that is considered relevant for this purpose.

215. Thus, the models may be adjusted in terms of selected variables and functional form if the inclusion of new observations leads to changes in the explanatory power of the model as a whole (adjusted R^2) or in relation to the statistical significance of individual variables.

216. To determine the eligible operating costs of preventive maintenance, i.e. the direct cost derived from these operations that can be passed on to the charges,

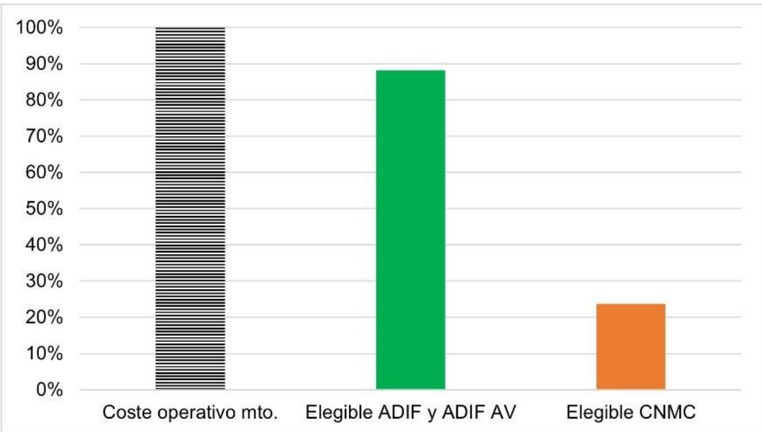
the final elasticities shall be applied to the data of the reference year used to justify the infrastructure managers' charging proposal. As stated in Article 3(5) of Regulation 2015/909, the costs used for this purpose may be based on payments made or costs forecast by the managers. In the first case (historical costs), the final elasticities already show the percentage of eligible costs, as the last closed financial year is the one used to calculate the elasticities. In the second case (estimated costs), given that it is not possible to obtain the percentages of eligible costs for a future year, the percentages corresponding to the latest available year shall be applied to the total amount of the estimated preventive maintenance operating costs, which shall be communicated by the infrastructure managers and shall differentiate between the amount corresponding to A-lines and the amount corresponding to non-A-lines.

H. Results Obtained

217. Below are the results of the total direct cost resulting from the application of the model presented and the difference in terms of unit direct cost compared to the estimates provided by the infrastructure managers on the basis of their current model.

218. Using 2022 data as a benchmark, the total direct maintenance operating cost[97] would be reduced to 23% of the total recorded cost, compared to 88%[98] as calculated by the current ADIF and ADIF AV model.

Graph 16. Percentage of direct cost over maintenance operating cost.



Source: CNMC based on ADIF and ADIF AV's costs for 2022.

[97] Including both preventive and corrective maintenance costs.
[98] As explained above, ADIF and ADIF AV subtract, as non-eligible costs, the cost of corrective maintenance and certain preventive maintenance costs for periodic inspection and verification operations, as well as the costs of the electrical substations as a whole.

219. This reduction in the direct cost associated with infrastructure maintenance operations results in a reduction of the total direct cost. In unit terms, the effects of the proposed econometric model imply a significant reduction in the amounts for all services, both on A-lines and non-A-lines.

APPENDIX II. AVERAGE EFFICIENT OPERATOR

The cost structure used to construct the average efficient operator identifies the main cost items incurred by operators in the provision of rail services such as marketing and sales costs, staff costs (train drivers and others), costs of charges, costs related to the depreciation (or lease, where appropriate) of rolling stock, maintenance and cleaning costs, energy costs and other costs.

The table below shows, by way of example, the items and the source of the information to be used to derive the reference values for the VL1 service.

ITEM COST	SOURCE
Marketing and sales	Operator cost
Driving staff	Operator cost
Other personnel costs	Operator cost
Charges	Miscellaneous
Art. 97 Mod A	*Current NS*
Art. 97 Mod B	*Current NS*
Art. 97 Mod A	*Current NS*
Total Art. 97	*Current NS*
Art. 97 Addition Mod B BCN	*Current NS*
Art. 97 Addition Mod B AND	*Current NS*
Art. 97 Addition Mod B LEV	*Current NS*
Art. 97 Addition Mod B Others	*Current NS*
Art. 98 Mod A	*Current NS*
Art. 98 Mod B, C and D	*Operator cost*
Rolling stock depreciation	Operator cost
Rolling stock lease	N/A
Maintenance and cleaning MR	Operator cost
Electric Traction Energy	ADIF NS
Other costs	Operator cost
TOTAL COSTS	

Costs based on operator data shall be average values for the last three years in train-km or seat-km by cost type, excluding outliers[99]. Costs for which a double composition leads to an increase in the total cost of the journey (rolling stock, energy and addition to mode B of the Article 97 charge) have been calculated per

[99] Abnormally high values are excluded if they exceed the sum of the average plus the standard deviation.

seat-km. The remaining costs, for which a double composition leads to efficiency gains, have been calculated per train-km.

For items where it is possible to obtain a benchmark based on public values, such as the network statement (NS), these values are used. Energy costs are calculated using the formula contained in the ADIF AV network statement, taking into account trains with regenerative braking. The weight values needed to calculate these costs are taken from the most representative train models in each corridor. This is used to calculate the average cost per seat-km.