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DEVELOPMENT OF ITALIAN RAILWAYS IN THE PERIOD 2002-2015, INCLUDING HIGH-SPEED RAILWAY LINES

Summary. The article discusses the development of the Italian railways between 2002 and 2015, taking into account the investment expenditure allocated to the growth of this transport mode in the period under investigation, as well as within a time horizon extending until 2026. The research has been complemented by an analysis of economic conditions. The paper describes the organizational structure of the Italian national railways, namely, the FS Group and its subsidiary companies, which manage the different sectors of the supply chain, rendering various services and supporting the activities undertaken across the group. Specific trends observed in passenger and cargo transport are analysed, with high-speed railway services given special consideration.

Keywords: railway transport; passenger transport services; cargo transport services; high-speed railway lines

1. INTRODUCTION

Italy is ranked as the ninth largest economy in the world and the fourth among the five largest economies in the EU, which comprise Germany, the UK, France and Spain [9]. The most important Italian economic sectors are the service and industrial sectors. The service

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sector accounts for nearly 75% of total GDP and about 65% of nationwide employment. The largest share in generation of GDP among various service sector activities is attributable to proceeds from wholesale, retail and transport operations. Italian industry accounts for 25% of the added value generated across the entire economy and provides jobs to around 30% of the workforce. The most significant industrial subsector is production, which, in this country, mainly specializes in the manufacture of high-tech products. The remaining part of total GDP is generated by agriculture, employing around 4% of the entire domestic workforce.

Compared to other EU countries, the Italian economy grew with relatively little momentum in the period 2002-2016 (Italy's growth rate was among the lowest in Europe). That said, it should be noted that one of the main reasons behind this state of affairs was the poor condition of public finance, which invariably maintained negative rates, as well as political instability and a lack of structural reforms. Being a part of the euro area has also prevented Italy from managing its balance of payments well by effectively adapting the foreign exchange rate. The country secured itself against crisis regarding its balance of payments and deficit by having joined the Trans-European Automated Real-time Gross Settlement Express Transfer System, which is a leading European transfer system owned and operated by Eurosystem. However, the persistently high unemployment rate in Italy highlights not only the weakness of the Italian labour market, but also growing international competition. Moreover, the country is heavily divided between the highly industrialized and well-developed north, where about 75% of all goods are produced, and the less developed southern part, which far more dependent on the agriculture.

2. ORGANIZATIONAL STRUCTURE OF THE ITALIAN RAILWAYS

Italy is relatively well developed in terms of the network of motorways, regular roads and railway lines; however, the transport infrastructure is evidently denser in the urbanized north than in the south [16]. The most important component of the Italian transport infrastructure is the roads, whose total length was estimated at 182,360 km in 2015 [5]. Another significant element of the transport infrastructure is the system of railways with a total length of 24,435 km (including 16,788 km in regular service) and 1,350 km of railways that can be used by high-speed trains (Fig. 1) [15].

The Italian national railway carrier, Ferrovie dello Stato S.p.A. (FS), has been operating since it was founded in Rome in 1905. After restructuring processes were completed in 2001, related to the implementation of EU directives on the liberalization of European railways, FS received the status of a holding, which was appointed to manage the railway infrastructure and made responsible for passenger and cargo transport. The FS Group incorporates 12 companies managing different sectors of the supply chain, along with ancillary businesses rendering various services and supporting the activities undertaken across the group (Table 1) [15].

The Italian railway network is also used by smaller regional operators, such as Ferrovie Nord Milano, Ferrovie del Sud Est and Sardinii Ferrovie della Sardegna, with the latter providing railway services on the island of Sardinia. They are predominantly private companies.



Fig. 1. Network of railway lines in Italy [18]

Tab. 1

Structure of the Ferrovie dello Stato Italiane group [15]

Company name	Range of operations	Shareholding structure
Busitalia-Sita Nord	Local, both urban and suburban, public bus transport services, mainly provided in Veneto, Tuscany, Umbria and Campania, ensuring convenient transfers by railway and road transport	Subsidiary company (FS holds 100% of shares)
Centostazioni	Responsible for managing and revamping 103 medium-sized railway stations	Subsidiary company (FS holds 60% of shares, 40% of shares owned by Archimede)
Fercredit	Financial services rendered internally to the group's entities	Subsidiary company (FS holds 100% of shares)
Ferservizi	Support for management processes implemented across the group's entities, market research, administration and IT services, etc.	Subsidiary company (FS holds 100% of shares)
FS Sistemi Urbani	Development and sales of the group's assets, particularly residential estates and other real property	Subsidiary company (FS holds 100% of shares)
Grandi Stazioni Immobiliare	Revamping and managing large railway stations	Company owned and managed by the French-Italian consortium of Antin-Borletti-ICAMAP (holds 100% of shares)

Grandi Stazioni Rail	Management of 14 main railway stations, including two for high-speed trains, along with their revamping	Subsidiary company (FS holds 100% of shares)
Italcertifer	Supervising and defining the framework of conformity and safety for the railway sector, conformity assessment procedures against interoperability (notified body operating under Directive 2008/57/EC on the interoperability of the rail system within the European Community), certification of entities responsible for maintenance of freight cars (ECM), organization of training courses for railway operators interested in rendering railway services in the Italian market	Independent joint stock company
Mercitalia	Development of intermodal and multimodal transport, management of logistics infrastructure and provision of logistic services in the country and abroad	Subsidiary company (FS holds 100% of shares)
Netinera	Business operations in the German market comprising supervision of German businesses offering services under their own brands, mainly in the passenger and cargo transport sector, as well as in road transport, logistics, repair and maintenance of vehicles and maintenance of railway infrastructure	Subsidiary company (FS holds 51% of shares, 49% of shares owned by the Franco-Luxembourger company Cube Infrastructure)
Rete Ferroviaria Italiana	Railway infrastructure management, including rendering railway lines available to carriers, providing related services and collecting charges on that account, maintenance of railway infrastructure to ensure safe railway traffic, managing investments in expansion and development of railway lines, as well as train operation-related equipment	Subsidiary company (FS holds 100% of shares)
Trenitalia	Domestic and international operator of passenger transport (high-speed, long-distance and regional services) and cargo transport, including maintenance of rolling stock	Subsidiary company (FS holds 100% of shares)

3. RAILWAY INFRASTRUCTURE

Since 2001, the Italian railway infrastructure has been managed by Rete Ferroviaria Italiana (RFI), an entity operating pursuant to a temporary licence act signed in 2000 between the Italian Ministry of Transport and the national railways (DM 138 T of 31 October 2000), which is valid until 2060 [8]. The company thus established has been obliged to produce investment plans together with the state administration in order to ensure that the infrastructure is developed and the railway network maintained [15]. The plans are settled and accounted for under a contract known as the *Contratto di Programma*, a document drawn up in five-year intervals (with an option of annual adjustments). The planning of the infrastructure upgrades is closely linked to surveys, analyses, assessments and forecasts regarding the operational and engineering improvements of the investments planned, as well as pursuing strategic goals, legal regulations and transport, economic and financial conditions into consideration, all of which aim to ensure that train traffic safety standards are met [15].

According to the properties of individual lines, the Italian railway network has been divided into the following classes:

- Main lines (*fondamentali*) characterized by high rail traffic intensity and high infrastructure quality, meeting international standards, covering all the main lines connecting the largest Italian towns (their total length is 6,367 km).

- Complementary lines (*complementari*) characterized by lines of lower traffic intensity, connecting medium-sized and small regional points; most of them feature single tracks, some of which are non-electrified (9,466 km).
- Links (*di nodo*), that is, lines of supplementary function and lines within metropolitan areas (with a total length of 955 km).

Tab. 2

Italian railway system as of the end of 2016 [15]

Railway lines in service – 16,788 km (1)	
Railway line classification	
Main lines	6,367 km
Complementary lines	9,466 km
Links	955 km
Railway line type	
Double-track lines	7,647 km
Single-track lines	9,141 km
Railway electrification	
Electrified lines, including:	12,023 km
- double-track lines	7,570 km
- single-track lines	4,453 km
non-electrified lines	4,765 km
Total route length 24,435 km	
Conventional lines	23,085 km
High-speed railway lines (2)	1,350 km

(1) Including 67 km of cross-border lines

(2) For lines featuring ERTMS (except for the Treviglio-Brescia line)

Most of the Italian railway network has been electrified (12,023 km). Trains are powered by a 3 kV DC overhead catenary system on conventional lines and a 25 kV 50 Hz AC system on new lines used by high-speed trains.

In 2015, there were 981 km of new lines dedicated to high-speed trains in Italy (Table 3); however, as originally assumed, they were connected to existing lines at many points.

Tab. 3

Italian high-speed railway lines in 2015 [11]

Section	Maximum speed (km/h)	Year of commissioning	Route length (km)
Existing lines			
Rome-Florence (stage I)	250	1981	150
Rome-Florence (stage II)	250	1984	74
Rome-Florence (stage III)	250	1992	24
Rome-Naples	300	2006	220
Turin-Novara	300	2006	94
Novara-Milan	300	2009	55
Milan-Bologna	300	2008	182

Florence-Bologna	300	2009	77
Naples-Salerno	250	2009	47
Milan (Treviglio)-Brescia	300	2016	58
Total			981
Under construction			
Genoa-Milan (Treviglio)	250	2020	76
Planned lines			
Brescia-Verona	300	>2020	139
Verona-Padua	250	>2020	82

4. RAILWAY PASSENGER AND CARGO TRANSPORT

For many years, the Italian administration has been consistently implementing a policy of supporting railway transport development. The actions undertaken in this respect are mainly focused on creating an attractive offer to encourage users to make use of passenger and cargo transport services, especially on international routes, which matter particularly to the Italian economy.

Both passenger and the cargo services are provided using the same railway lines. However, on account of the slower freight trains compared to passenger trains, cargo traffic takes place during selected time windows, as per a detailed schedule prepared on an annual basis.

The largest Italian railway carrier is Trenitalia, a company rendering passenger and cargo transport services on regional and long-distance lines, such as those extending across country borders, connecting Italy with Austria, Belgium, Germany and Switzerland, and including high-speed services. Trenitalia was founded in 2000 as a consequence of implementing the EU regulation on separating transport services from the infrastructure. The company runs a rolling stock of 650 locomotives, 3,800 cars and 700 lightweight sets [8].

An analysis of the transport performance in the period 2002-2015 implies a higher share of passenger transport services in the total railway transport volume (Table 4).

Tab. 4

Italian railways' transport performance in the period 2002-2015 [17]

Year	No. of passengers (billion passengers/km)	Including high-speed trains* (billion passengers/km)	Volume of goods (billion tonnes/km)
2002	48.3	7.08	20.7
2003	47.7	7.43	20.3
2004	45.6	7.93	22.2
2005	46.1	8.55	22.8
2006	46.4	8.91	24.2
2007	46.0	8.82	25.3
2008	45.8	8.88	23.8
2009	44.4	10.75	17.8
2010	43.3	11.61	18.6
2011	46.0	12.28	19.8

2012	45.8	12.79	20.2
2013	47.7	12.79	19.0
2014	48.9	12.79	20.2
2015	51.1	No data	20.8

* Transport services comprise all traffic, both on lines exclusively dedicated to high-speed trains and on conventional lines (including with tilting trains capable of running at 200 km/h)

The volume of transport services measured by passenger transport performance in the period 2002-2015 was maintained at a relatively stable level. A slump occurred in the period 2009-2010 as a consequence of the global economic crisis. The aforementioned does not concern high-speed trains' transport performance, which, except for 2007, has systematically increased, year by year. An analysis of this state of affairs implies that the declines typically applied to regional services. A trend similar to that observed in passenger transport also emerged in the period under investigation in terms of cargo transport performance. Starting from 2011, in spite of insignificant deviations, the volume of cargo transport services has been systematically growing.

High-speed lines are used by trains running as fast as 300 km/h, i.e., Frecciarossa ETR 500 and Frecciarossa 1000, the latter being a new fast train operated by Trenitalia, which is safe and environmentally friendly, and capable of running at the maximum speed of 400 km/h. These trains are equipped with a state-of-the-art technological system for train tracking and supervision (ERTMS/ETCS), as well as a predictive diagnostics system; they are also suitable for all European high-speed railway lines.

Frecciarossa services lines connect the following cities [12]:

- Turin-Milan-Reggio Emilia AV-Bologna-Florence-Rome-Naples-Salerno, with optional northward extension of the route to Brescia and South Taranto
- Venice-Padua-Bologna-Florence-Rome-Naples-Salerno
- Trieste/Udine-Venice-Padua-Vicenza-Verona-Brescia-Milan-Turin
- Milan-Reggio Emilia AV-Bologna-Rimini-Ancona-Pescara-Foggia-Bari



Fig. 2. High-speed railway lines serviced by Trenitalia and inter-station travel times [15]

Furthermore, the following trains run on Italian railway lines:

- Frecciargento – running on both high-speed and regular lines between Rome and Venice, Verona, Bari or Reggio di Calabria, reaching a speed of 250 km/h
- Frecciabianca – trains running at high speeds (up to 200 km/h) on regular lines (outside the high-speed network) and connecting large cities in all Italian regions

Besides Trenitalia, high-speed railway services have also been provided since 2012 by a privately owned company of Nuovo Trasporto Viaggiatori. The business owns 25 Alstom AGV (ETR 575) electric multiple units running under the system name of Italo, which can reach a speed of up to 300 km/h. In October 2015, the company signed a contract with Alstom for the delivery of eight brand new non-tilting Pendolino trains capable of speeds of up to 250 km/h. The contract is scheduled to be completed in 2017.

The Italo high-speed trains service four lines (covering 13 cities and 16 stations) [17]:

- Turin-Salerno, stopping in Milan, Reggio Emilia (Mediopadana station), Bologna, Florence, Rome and Naples
- Venice-Salerno, stopping in Padua, Bologna, Florence, Rome and Naples
- Brescia-Naples, stopping in Verona, Bologna, Florence and Rome

The ongoing expansion of high-speed railway lines increases both the volume and the quality of Italian railway transport services, as well as improves integration with the European railway network, thus contributing to the sustainable development of the national railway transport system.

5. EXPENDITURES ALLOCATED TO THE RAILWAY SECTOR

The Italian railways are partially financed from the state budget. They are also co-financed by the EU, for instance, to ensure the interoperability of the European railways by establishing railway connections along the corridors routed by the EU under the new policy approved by the European Parliament and the Council in 2013 [3].

Since 2013, in accordance with Decision no. 4/2012 of the International Economic Planning Committee (*Comitato Interministeriale per la Programmazione Economica*), the relationships between RFI and the state have been regulated by the following two acts (instead of a single agreement, as before):

- Framework Programme Contract for Services (*Contratto di Programma – Parte Servizi*, CdP-S), whose main object is financing maintenance of the national railway network, both resulting from regular wear of the infrastructure and arising from extraordinary needs for refurbishment or replacement of parts or entire subsystems, which determine the increase in the utility value of the given item of assets, while, at the same time, improving reliability, performance, efficiency and safety
- Framework Programme Contract for Investments (*Contratto di Programma – Parte Investimenti*, CdP-I), which was concluded as a means to develop sustainable plans of expenditure for infrastructural investments related to safety and adaptation to legal requirements, for the implementation of new technologies to improve the quality of services and increase the efficiency of the existing lines, and for the construction of new and revamping existing railway networks.

The Italian government has long been allocating considerable amounts to railway transport sector projects, whose primary goals were to finance investment programmes and to cover operating costs of the entire network, as well as local railway transport costs.

In 2012, the investments in railway transport totalled EUR 3.55 billion, including [1]:

- EUR 2.24 billion allocated to the conventional railway network
- EUR 498 million for development of high-speed lines
- EUR 725 million for transport-related interventions

In 2013, investments were made totally EUR 3.89 billion overall, including 60% from state subsidies [13]. The allocated funds were consumed in the following manner:

- All the state budget subsidies were allocated for revamping the conventional network
- EUR 627 million for high-speed lines
- EUR 552 million for rolling stock purchase and replacement

The 2014 investment expenditure for the railway sector totalled EUR 4.26 billion, including EUR 1.5 billion allocated from the group's profit and EUR 2.76 billion from public financing sources [14]. They were distributed as follows:

- EUR 2,853 million for infrastructural interventions performed by RFI, including EUR 2,726 million for the conventional network and EUR 127 million for the Turin-Milan-Naples high-speed line
- EUR 694 million for projects related to the transport services rendered by Trenitalia S.p.A.
- EUR 417 million for investments performed by other companies in the group

Railway-related investments made in 2015 [10] totalled EUR 5.5 billion, including EUR 2.5 billion allocated from the group's own funds and EUR 3 billion from the state budget. These amounts were split between the following projects:

- EUR 3,553 million for infrastructural interventions performed by RFI, including EUR 3,408 million for the conventional network and EUR 145 million for the Turin-Milan-Naples high-speed line
- EUR 1,432 million allocated for the investments of Trenitalia S.p.A., around EUR 44 million placed in Netinera Deutschland, and nearly EUR 38 million in Busitalia, the group's subsidiary company operating within the Italian road transport sector

The funds planned to be spent in 2016 amounted to around EUR 9 billion. In accordance with the strategy of developing the national railway system, these funds were to provide for the continuation of investments made previously in the following areas [15]:

- EUR 648 million for the extension of programmes related to safety in tunnels situated in active seismic zones and in areas exposed to hydrogeological hazards, and for noise reduction at railway intersections, as well as a number of other activities aimed at reducing rail- and road transport-induced noise.
- EUR 344 million for upgrading technological line equipment and railway machinery in order to make them adaptable to the growing demand for mobility, as well as decommissioning technologically obsolete and redundant equipment.
- EUR 381 million for revamping investments aimed at eliminating bottlenecks in the metropolitan areas of Turin, Milan, Venice and Palermo, and for the continuation of the "Stations" plan whose goal was to improve access to services at railway stations, as well as for raising the quality and efficiency standards of the railway network operated in metropolitan areas.

- EUR 255 million for raising the quality and efficiency standards of the railway network in terms of infrastructure and technology on the Genoa-Turin and Milan-Rome-Naples lines.
- EUR 355 million for improving the performance of cargo transport lines, with special consideration given to transport services rendered within individual sections of the transport corridors cutting through Italy, including the Rheine-Alpine corridor, the Scandinavian-Mediterranean corridor and the Baltic-Adriatic corridor, and for strengthening the competitiveness of railway transport linked with seaports (Ravenna) and terminals (including in Milan).
- EUR 3.231 million for the Fortezza-Ponte Gardena railway tunnel construction project under the Brenner Pass and, among other goals, the completion of works intended to double the track speed on the Messina-Catania Giampilieri-Fiumefreddo and Termoli-Ripalta routes.
- EUR 2.701 million for various purposes, including the extension of the high-speed railway network, the continued construction of the railway tunnel under the Brenner Pass and the completion of the upgrade of one of the Naples-Bari line sections.

Within the 2007-2013 financing period, the EU allocated EUR 880 million for co-financing of the Italian railway infrastructure under the TEN-T network [4]. In the period 2014-2020, Italy will make use of co-financing under 13 transport projects for which the EU will allocate more than EUR 1.5 billion, including for the aforementioned tunnel under the Brenner Pass (EUR 302.8 million) or upgrading the Chiasso-Milan railway line (running from the south to the Gotthard Tunnel) [2].

6. DEVELOPMENT PROSPECTS FOR THE PERIOD 2017-2026

The FS Group has adopted a 10-year development plan (2017-2026) to be implemented in five strategic areas: integrated infrastructure, mobility, logistics, digitization and infrastructure expansion [8]. The plan is based on the assumptions that EUR 94 billion will be invested and the group's annual revenues will double. More than a half of the aforementioned funds, i.e., EUR 58 billion, is already available, while EUR 23 billion will be allocated from FS' own funds and a further EUR 35 billion will be subsidized by the state government under the *Contratto di Programma – Parte Servizi*.

The *integrated infrastructure* area comprises railway investments of EUR 62 billion, including EUR 33 billion to be spent on the conventional network and EUR 24 billion on the development of the high-speed railway system, as well as the completion of the Italian part of four TEN-T transport corridors shared with other European countries. A further EUR 5 billion will be allocated to the deployment of state-of-the-art technologies in the infrastructure, making it possible to increase volumes of passenger and cargo transport services. The planned activities will also contribute to improving the efficiency of the railway network, reducing transfer times owing to new routes, and primarily increasing railway safety. What will also be perceived as a crucial aspect of these operations is the reduction of transport costs, thanks to the implementation of environmentally friendly solutions.

In the *mobility* area, the FS Group is planning to offer “collective door-to-door mobility” services. This scenario assumes that the share in the passenger transport market will rise from 6% in 2015 to 25% in 2026 through participation in tenders and, as far as possible, acquisition of other operators. The use of public transport will be fostered by the continued comprehensive replacement of the old rolling stock with technologically advanced vehicles,

thus improving the travelling comfort not only on long- and medium-distance services, but also on regional lines. Passengers will be provided with an opportunity to search for convenient transport connections using online platforms.

The development plan also includes individual actions to be undertaken in the *integrated logistics* area, which is assumed to be able to increase the share of cargo transport in the use of the railway infrastructure. The planned investments will consume EUR 1.5 billion (including EUR 1.1 billion to be spent on rolling stock purchases, EUR 300 million on the development of terminals and logistics, and EUR 100 million on ICT). The increase in revenues is expected to reach EUR 2.1 billion in 2026 (where the 2016 forecast assumed revenues of EUR 1 billion). One of the companies incorporated in the FS Group, i.e., Mercitalia, will continue its operations via three other businesses, namely, Mercitalia Rail, Mercitalia Logistica and Mercitalia Terminal. All the efforts to be undertaken are assumed to increase the importance of intermodal services, simplify dispatch and, primarily, make the procedures binding for logistic operators more uniform.

In the *digitization* area, adequate digital platforms will be developed and rendered available, enabling users to comprehensively plan entire journeys both in Italy and abroad, including journey completion. Consequently, customer experience will be enhanced by such services as travel companions, internal station mapping, electronic wallets, delay messaging or video chat.

The FS Group has always attached considerable attention to further growth in international operations. The services rendered abroad currently account for 13% of the total revenue, but it has been assumed that this revenue stream should increase its share to 23% by 2026. In order to achieve this goal, the following objectives are planned to be pursued in the *international expansion* area:

- The FS Group entering domestic railway markets of countries without well-developed infrastructure as a general contractor for investments in railway lines, including high-speed lines
- Disseminating the high quality of services offered in the Italian high-speed system across railways of third-party countries that own high-speed railway lines
- Introducing sustainable forms of (road and rail) transport dedicated to passengers in cities where infrastructural projects implemented by the group have been completed

7. CONCLUSION

The Italian railways are among the most technologically advanced systems in the world. Operations by the FS Group are mainly focused on safety and technology, while their goals are pursued by maintaining direct and constant balance between the technologies used, the management of working conditions and the specific organization of activities aimed to ensure the ongoing implementation of state-of-the-art technological solutions and improvements. The advanced equipment and systems currently used on the Italian railway network are heavily diversified, while also being integrated, depending on the line characteristics and traffic type (either passenger or freight, either long-, medium- or short-distance services). The regular financing of the FS Group from the state budget ensures a high quality of its services and enables it to use technologically advanced rolling stock.

The FS Group strives to improve the results they achieve within the Italian network, thus strengthening its position in Europe and in foreign markets. FS remains active in the Mediterranean region as well as in Eastern Europe, the Middle East and other continents,

particularly focusing on using its Italian experience in individual countries and implementing technologies involving Italian excellence on railway networks. The services it mainly renders in the international market cover engineering, management and logistics of passenger transport, infrastructure, and railway stations.

The group is known for its attention to environmental protection and concentrates on minimizing the negative environmental effects of transport by implementing technologies that reduce emission of noise and electromagnetic radiation, preventing water and soil pollution, conducting investment activities with respect to the specificity of protected areas and their biodiversity, and raising environmental awareness of customers, employees, suppliers and competitors. The group also takes responsibility for adhering to the legal regulations relevant to its field of operations and displays initiative in its attempts to improve them at a European, national and regional level. The group's efforts to ensure compliance with the standards imposed upon it are subject to periodic assessments.

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