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Table of contents

Abstract	4
Introduction	6
Liberalization of passenger services in the Spanish, German and Austrian railway sector	8
Railway industry in Europe, infrastructure, high-speed rails, competition among railway companies	10
Liberalization of the high-speed rail industry, a creation of the private sector in the railway industry.....	11
History, liberalization process and current situation in Germany	14
Österreichische Bundesbahnen (OEBB)-Infrastructure Group	21
Liberalization of Spanish railway structure	24
History of High-Speed Rail development in Spain.....	25
Price Elasticity and Demand for Spanish High-Speed Rail.	30
Costs of building HSR Infrastructure	34
Service costs	38
HSR Perspectives.....	44
Low-cost Airlines, history, pricing strategy, development	45
Airline Industry formalization and history	46
Pricing strategies and their main factors	49
Competition between low-cost and full-cost carriers.....	52
Spanish low-cost carrier Vueling Airlines	53
Iberia: flag carrier airline of Spain	56
International Airlines Group	58
Air Europa	59
Competition between airlines and high-speed rail on Madrid - Barcelona route.....	60
Competition between low-cost airlines and high-speed rail.	63
Model of ticket price formalization of high-speed rail and low-cost carriers.....	67
Analysis of Variance	69
Statistical Model of price formalization in Iberia	71
Statistical Model of price formalization in Air Europa	73
Train ticket price formalization.....	75
Conclusion.....	78
References	82

Abstract

An objective of the current thesis is to understand, why low-cost carriers' tickets are cheaper than high-speed rail tickets. On this purpose multi-faceted research on factors influencing price formalization in high-speed rail and low-cost carrier, industries have been done. As an object of the study connections on the Barcelona-Madrid route were selected. We have designed a model, providing insights into fundamental relations among price formalization factors of two industries. The statistical model has shown the degree of effect of variables onto ticket price formalization. Competition between low-cost carriers and high-speed rail became stronger during the last few decades. Secondary data has consistently shown, that infrastructure for high-speed rail is very expensive, and requires much time invested in its development. Due to technical changes railway industry became stronger and introduced a new value proposition on the transportation market - high-speed rail. After the 1990s most of the European Union countries started liberalization of the railway industry. This industry in many countries is under government protection. Liberalizing the railway industry, countries aimed to make railway industry more attractive for the private sector, but till now the airline industry provides ROI in a shorter time. Liberalization of the airline industry has influenced the competition, and price formalization in this industry. Our results clarified these shifts as well as which factors influence or do not influence ticket price formalization of low-cost carries and high-speed rails.

Deutschsprachiges Abstract

Ziel dieser Arbeit ist es darzulegen, aus welchen Gründen Flugtickets günstiger sind als Bahntickets. Hierzu wurde eine umfassende Untersuchung der verschiedensten Einflussfaktoren auf die Formalisierungen der Preise im Bereich der Hochgeschwindigkeitsbahn und in der Luftverkehrsindustrie durchgeführt. Für diese Arbeit wurde als Vergleich die Strecke (Flug und Bahn) Barcelona-Madrid herangezogen. Das in der Arbeit befindliche statistische Model soll die grundlegenden Faktoren, die die Preisformalisierungen der beiden Industrien beeinflussen, zeigen. Der Wettbewerb zwischen den Fluggesellschaften und den Hochgeschwindigkeitsbahnen hat in den letzten Jahrzehnten stark zugenommen. Unrichtigerweise wird oftmals davon ausgegangen, dass für dieselbe Strecke Bahntickets günstiger sein sollen als Flugtickets. Dies konnte durch verschiedenste in diese Arbeit aufgenommene Untersuchungen widerlegt werden.

Sekundärdaten haben durchwegs gezeigt, dass die Infrastruktur für Hochgeschwindigkeitszüge sehr teuer ist und vor allem die Errichtung und Erhaltung derselben viel Zeit in Anspruch nimmt. Aufgrund technischer Veränderungen wurde die Eisenbahnindustrie stärker und führte ein neues Wertangebot auf dem Transportmarkt ein - Hochgeschwindigkeitsschienen.

Vor allem in den 1990er Jahren begannen eine Vielzahl der Länder der Europäischen Union mit der Liberalisierung der Eisenbahnindustrie. Damit wollen diese Länder die Eisenbahnindustrie für den Privatsektor attraktiver machen. Dennoch scheint die Flugindustrie für viele private Unternehmer attraktiver zu sein.

Introduction

This paper examines the price formalization, and connection between the formalization of railway and aircraft fares, in these two industries. The environment changes with the growth of high technologies. Nowadays people can move from one place to another quickly and uncomplicated. Transportation and traveling segment are a highly-formalized industry now, which offer customers each day new and relative cheaper products. Competition in transportation and traveling business is high. During the last decades, in long-distance travelers prefer more air than train transport system. Due to innovation on the transportation market air transportation has a big competitor like high-speed in long-distance. If in the last two decades, the airline industry has increased by 5 percent, then the High-Speed Rail industry has grown by over 15%. In European Union, more investors participate in creating new infrastructure in High-Speed Rail industry.

Congress of the European Union and almost all counties in the European Union want to reduce air transportation and increase railway transportation. One reason for these changes is minimizing environmental pollution, and connect small countries and cities with the other metropolises. After liberalization of the railway industry, and an introduction of high-speed rails to the transportation market in some countries, the competition between high-speed rails and airlines was added.

Airline industry has changed a lot in the last two decades. Low-cost carriers, which offer flight without such comfort as that offered by full-cost airline companies, enter transportation market, and they are flying not only to main airports but also to secondary airports. The main competitors are low-cost carriers and high-speed rails. However, it is difficult to compare these two business models, since they have different technological aspects, ownership, and pricing models, they fulfil the passenger needs differently, etc. But at the same time, as we have pointed out above, in Europe low-cost airlines, and high-speed rail are competing for the same segment of the transportation market.

Domestic price formalization strategy, used in many European Countries is an important tool, for that technological innovation in transportation market, rail and air transportation companies and consumers are the decisive factors. Rail and air industries are complementary not only with transportation but also with tourism industries. There is a direct dependency between railway and airline industry development and importance of tourism to the local

economy. For a new Technology implementation, we need all external and internal factors, like product characteristic, supply and demand relation, competitors, revenue management, research management, etc.

With the help of the price response system, the organization can track changes of competitors' fares, which means are over million changes daily, and lead an agile strategy with fares, responsive to the supply and demand on the market. It is a break-through in pricing policies, because the number of competitors in the air transportation industry, trying to achieve leadership in the same price category can be as high as 15 and more, and they compete with the trains too. With the price formalization, the European Union has initiated changes in the business model of airlines industry in Europe.

This part will discuss the difference between price formalization model for high-speed rail, and low-cost carriers in Spain. Spain has the largest infrastructure for high-speed rails, and aircraft industry is mostly represented by low-cost carriers. Spain has over 46,56 million population with 3,166 million people, living in its capital, Madrid, and 1,7 million living in Barcelona. In this two cities tourism is of a high importance.

The following thesis aims to show, which factors will change the price of HSR and LCC tickets, furthermore making us understand the importance of investment in the high-speed rail industry. We discuss, which extra factors or their changes influence price formalization. Production level changes depend on which companies regulate HSR industry if it is protected by the government or is privately owned. Next factor is the type of customers, mostly traveling the route, their price or time sensitivity, most typical for those traveling for leisure in the first case, and on business in the latter. It involves factors of supply and demand, for instance, the number of companies offering the same service, and high season or low, influencing demand, expressed in the number of travelers. All the above and many other factors impose their effect on price formalization.

Liberalization of passenger services in the Spanish, German and Austrian railway sector

Liberalization of the railway market in the European Union has started after 1990. During the last 25 years, private railway companies had a possibility to enter the railway market. During the last two decades, the government was trying to keep this situation under control and regulate price formalization of train tickets. So far, we can detect full liberalization only in few countries. In most countries, railway companies are under the protection of the country government. Governments regulate price formalization, which type of service can the railway company offer, and how railway cargo service will work. In Europe, there are only a few private railway companies. Most of the European railway companies are regulated by holdings, and holdings are mostly under governmental protection.

Railway industry is not so attractive for the private sector, because the demand for long-distance railway journey is low. New railway infrastructure needs big investments, which the private sector is not ready to make. Due to these arguments, private railway companies in most European countries make a service only in a short distance railway market. In a long-distance railway, market share the working process only railway companies which under government protection. Not perfect liberalized railway industry has Austria, Spain, Germany, Italy, and more other countries of Europe and in the world. This industry has an oligopoly structure. In Austria, the main railway company is OEBB holding. In long-distance OEBB has competitors, but they are few. From Austria to Germany OEBB holding has only one competitor, and it is Deutsche Bahn, which is like OEBB under government protection. Ticket prices are similar, there is no difference between service and offers of these two companies, and perfect competition exists between them. An example of perfect liberalization is the transportation industry in England and Switzerland with more than two competitors at the railway transportation market. Spain offers large infrastructure of high-speed railway. There is the same situation as in Austria or Germany. In long-distance Spanish biggest railway company RENFE has no barriers and competitors. The biggest competitors of RENFE are different Spanish low-cost carriers, which are cheaper than high-speed rail ticket of RENFE on some routes. This situation is not optimal for the country's economy that's why Spanish government constructed large high-speed railway infrastructure. Nowadays the main goal for most the European countries is to make the railway industry more attractive for travelers and investors, aiming at the highest demand. Till last decade they have not used yield management for high-speed rail ticket price formalization. Spanish government opens the first high-speed rail route for the private sector, and it is "Levante" corridor. This corridor

connects the following cities with each other: Madrid, Cuenca, Albacete, Valencia, Alicante, Murcia.

The government of Spain wanted to let new private companies enter the railway industry. Many companies do not want to enter this business because of Operating and Maintained costs. New high-speed rail company can lease all necessary materials, machines, different vehicles from RENFE. They want to analyze a new situation, and see how it works, how will tickets prices change, etc. Only then the government can decide if they need a perfect competitor market in the railway industry or if the monopoly is better for this industry.

It is obvious that Germany cannot speak about full liberalization as it is in the United Kingdom or like some other European countries. In the domestic short distance, railway competitors are chosen with the tender scheme. In the long distance, the Deutsche Bahn is the main railway company in this area. The government prevents the entrance of new companies' in the long run railway area. That's why here we cannot discuss the liberalization of the German railway market. German railway structure has a vertically integrated model. This segment is under government control, and it is Public Service Obligation(PSO).

(https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=jei2017&paper_id=74)

Railway industry in Europe, infrastructure, high-speed rails, competition among railway companies

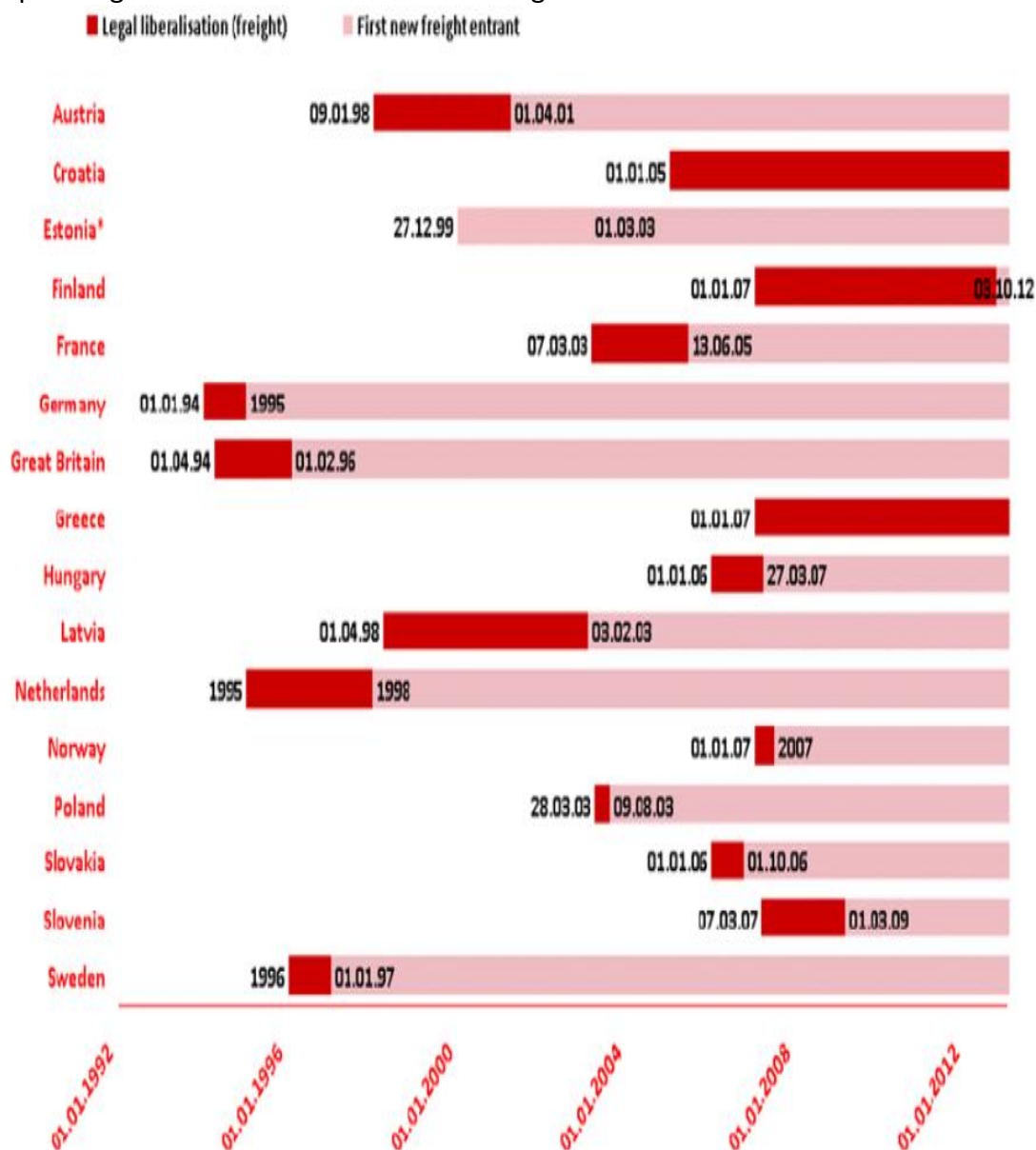
In 1991, European Commission ratified the regulation 91-440, which would help European countries to regulate the competition, and the network of railway industry among 25 European countries. The main goal was to create real competition in the railway industry between European countries, and the common railway infrastructure for all European countries. European Congress noted that railway transport has great competitors like busses, cars, airlines. All road and air transportation methods were more popular, and useful in the early 90s than the railway. During the last 20 years countries of the European Union changed all infrastructure of the railway industry. Nowadays, nobody in big countries or cities like Spain, the United Kingdom, Italy, Austria can imagine their daily commuting without railway or trams. With the help of new technology, Airline companies became a new competitor of the high-speed rail, which has commercial success in some European countries especially Italy and France. In a long-distance transportation, the railway is not as successful, as on short routes. First, journey duration is longer, than a flight, and as much expensive, as a flight. High-speed railways were a perfect solution to this situation. The most popular high-speed rail routes are Madrid-Barcelona, Paris-London, and Paris-Amsterdam.

Considering further development of railways, European Government has a roadmap with a target of over 50 percent of all domestic goods within EU countries transported by train. To reach this goal a lot of changes must be made in railway structure and infrastructure:

- Increase high-speed rail capacity in Europe;
- Increase security at trains, on the railroads and stations;
- Operating sector, control sector, and infrastructure of high-speed rails must be separated from each other.

Liberalization of the high-speed rail industry, a creation of the private sector in the railway industry

Graph 1. legal liberalization and first new freight entrant

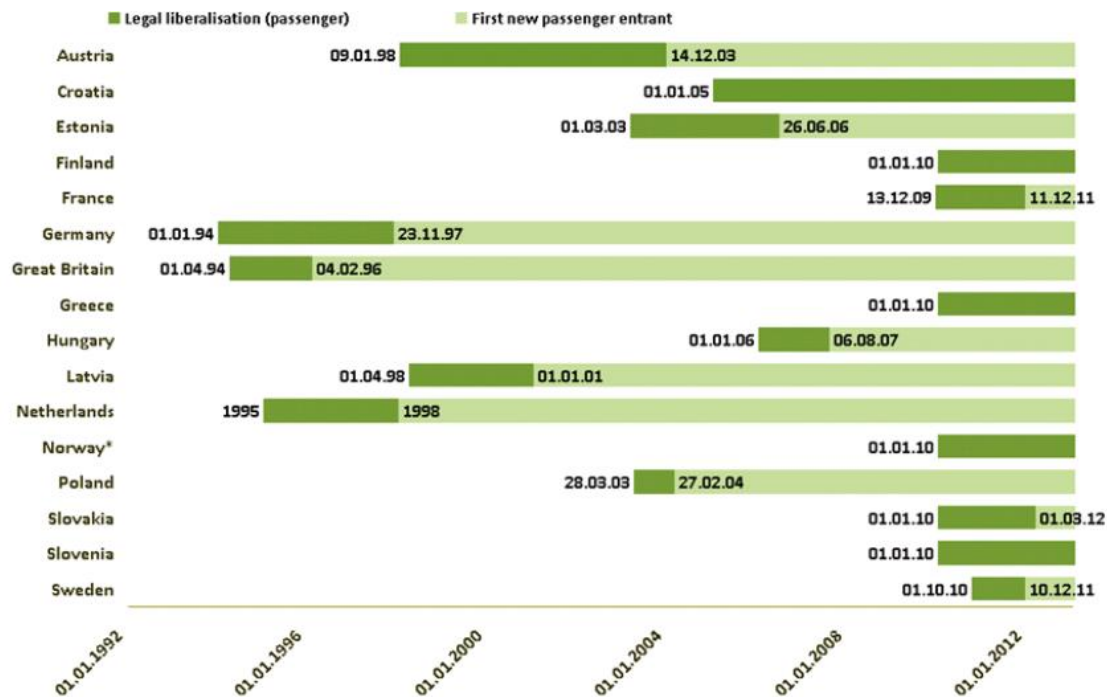


Source: (Independent Regulators' Group – Rail, 2013) (<https://www.itf-oecd.org/sites/default/files/docs/competition-European-rail-sector.pdf>)

In Austria liberalization of high-speed railway industry for transporting goods, started at 1998. Most of the private companies enter at the railway market for more than twenty years ago, but till now we do not have in Europe stable, and perfect liberalized market neither at good transportation market nor in passenger transportation railway market. Railway transportation segment till now in Greece is not liberalized. In Finland, it has started in 2012.

This graph shows that the railway industry in Europe is not consistently liberalized. The start of the process was vigorous, still, all countries need to work further on it to achieve fully liberalized railway industry.

Graph 2. Legal Liberalization and first new passenger entrant



Source: (<https://www.itf-oecd.org/sites/default/files/docs/competition-European-rail-sector.pdf>)

Liberalization in passenger transport railway industry started again in most European countries in the late 1990s. First countries were Great Britain, Germany, Nederland. First new passenger transportation railway company in Austria enter at the Austrian railway market at 2003. In Austrian railway passenger, transportation railway industry is only a few private companies, and only on short or middle distances.

The situation with the liberalization of passenger transportation railway industry is worse in Croatia, Slovenia, Finland and in Norway. Till 2012 in the local monopolistic railway transportation market, only railway companies under governmental protection own the railway passenger transportation market. There was no competition on the market, and railway companies managed price formalization. In early 2000, many new private companies enter at the railway market, and till now the main goal for all European Countries is to make railway market attractive for the private sector, with many competitors in long, middle and

short-distance railway transportation sector. Only in this way they can achieve a strong market in this part of the industry. Entrance barriers in the railway market are high, because of capital intensity leading to sunk costs in case of failure, entrance cost, and exit costs. In railway industry "hit-and-run entry" is not possible. Due to this and many other reasons competition, perfect competition like in the airline industry is impossible.

Railway industry in each country is regulated by an independent agency responsible for all changes, renovations of railway infrastructure. Its main goal is to get more private railway companies in this industry and maintain sane competition. Office of Rail Regulation in the UK handles railways sector. Railway industry in Great Britain is under ORR control after 2013 and till now. They control and give license all private companies which want to enter this industry. Without license of ORR companies cannot enter this industry. ORR handles security on railroads, stations, and trains, they check the trains, railway networks, etc.

All European countries have reformed the railway industry after its liberalization. In France after liberalization of the railway industry the railway activity regulatory authority is responsible for all changes and regulation in the railway industry. All European Countries made reforms and got new laws and regulation for Railway industry.

(<https://www.itf-oecd.org/sites/default/files/docs/competition-European-rail-sector.pdf>)

History, liberalization process and current situation in Germany

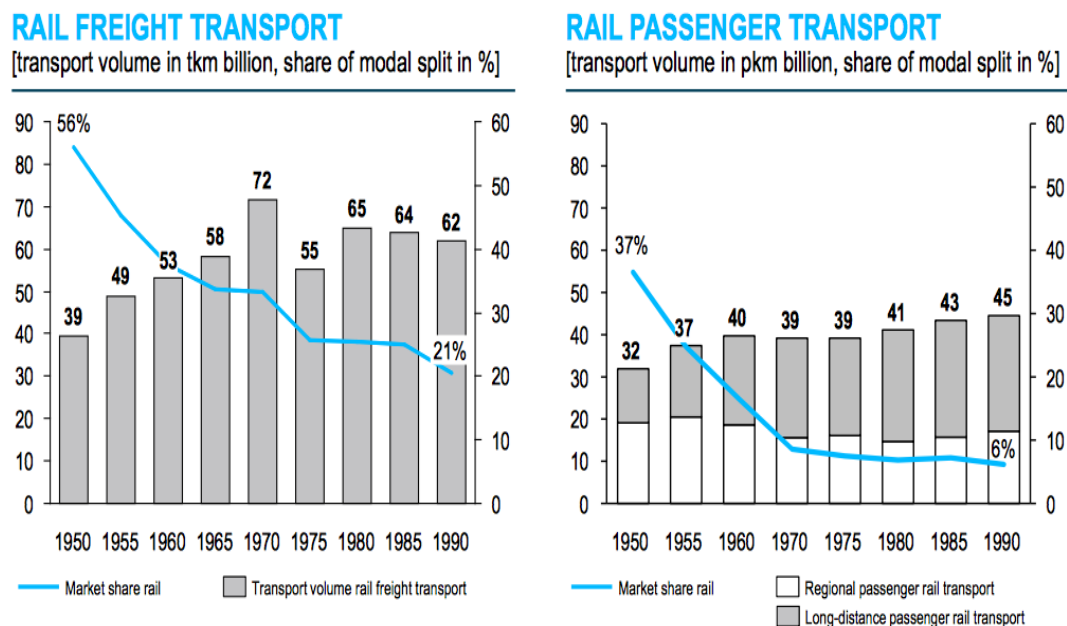
After the second world war and till 1990 Germany had 2 railway companies. In the German Democratic Republic, which was controlled by the Soviet Union, only one railway company German Reichsbahn worked, after the second world war they have kept the name of the railway company, and they worked under this name till reunification of Germany. After the second world war in Federal Republic of Germany, which was the German under USA occupation, was changed the name of the public railway company. Till the end of the war in 1945, Germany had only one public railway company, which was under the protection of the government. The Federal Republic of Germany renamed the Reichsbahn to Bundesbahn. Reichsbahn and Bundesbahn worked separately for over 30 years, and after the reunification of the Federal Republic of Germany and the Democratic Republic of Germany to Germany, the government has started to take measures in 1994 to change railway system. *(Source: https://en.wikipedia.org/wiki/History_of_rail_transport_in_Germany)*

Early 90s German government started investment in the railway industry. They renewed railway infrastructure, build and formalized building new railroads, reconstructing trains and buying modernized trains, achieve vehicles and railroads work protection machines. The government started a new program against pollution, climate protection, and the same time noise control. Before reunification of the two railway companies, the financial situation was unstable for Reichsbahn and Bundesbahn, because transport value reduced in the late 1980s, and with this financial situation of railway companies got worse.

Graph 3: Development of Freight and passenger transport volumes at Bundesbahn

Bundesbahn transport volumes increase until 1990 less strongly than the market as a whole – intermodal market share dropped sharply

Development of freight and passenger transport volumes at Bundesbahn



(https://www.deutschebahn.com/resource/blob/1177650/513446b9bd04725fb289a7b609be2941/20-years_outline-data.pdf)

These two graphs show the situation from 1950 to 1990 of Bundesbahn. Market share is related to transportation value of Bundesbahn. In the 1950s, market share was 56%, but transportation value only 39 billion km. During the time this relation change and market share decreased. 1990 it was only 21%, which is 35% less than in 1950. Railway transport value increased from 39tkm billion till 72tkm billion in 1970 and then again decreased till 62tkm billion.

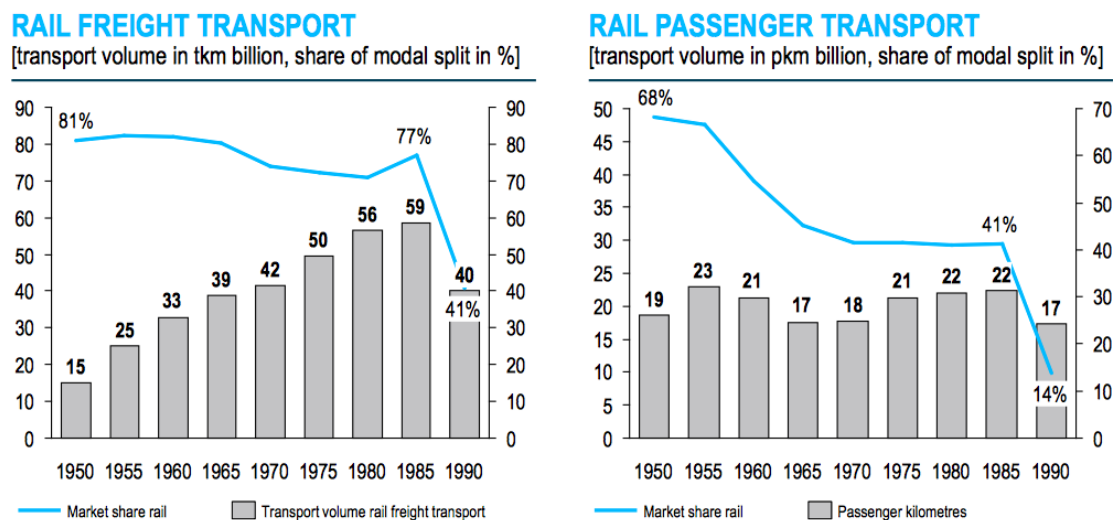
Second part of the graph shows the relation between rail market share to regional and long-distance passengers. During this period from 1950 to 1990 percentage of long-distance passenger rail transport did not change, but short and middle-distance passenger rail transport grows up. Rail market share was falling down fast during few decades. At the end of the correction it has been at 6 percent, having lost over 31 percentage points in 40 years. The

main reason that during this period railway market share went down, had outdated trains, old infrastructure. During this period railway company has not changed anything in service and infrastructure.

Graph 4: Development of Freight and passenger transport volumes at Reichsbahn.

Up until reunification Reichsbahn had a high market share – in 1990 a steep decrease in freight and passenger transport was seen

Development of freight and passenger transport volumes at Reichsbahn



(https://www.deutschebahn.com/resource/blob/1177650/513446b9bd04725fb289a7b609be2941/20-years_outline-data.pdf)

In German Democratic Republic railway situation, better than in German Federal Republic. The Graph shows that at the beginning in 1950 rail market share of rail freight transport was 81 percent, it was more than in German Federal Republic.

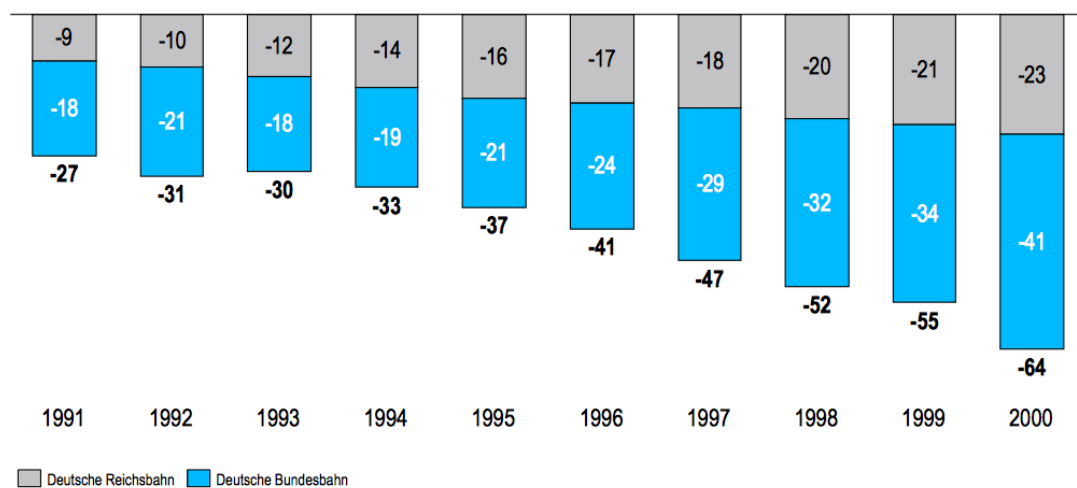
With the time rail transportation value was growing fast - from 15 tkm billion to 33 tkm billion in the first 10 years, plus 18 tkm billion during the period from 1959 to 1960. In 1995, market share in rail freight transport has achieved the maximum value of 59 percent although during the five years from 1985 to 1990 political situation was turbulent in Germany. And later, due to many reasons, related to a reunification of Germany market share of rail freight transport crashed from 41% to 14%, over 27 percentage points in five years.

After 1990, the government of Germany has got a new plan which will help to make the situation in the railway industry better. To meet the right decision, they have made a budget scenario for the next ten years. Till 2000 German railway companies would have a dramatic situation they would need huge investments and special Deutsche Bundesbahn.

Graph 5: development scenario from 1991 till 2000.

Germany's railways were in dramatic state – public budget required to support them up to year 2000 would have been DM 400 billion

Future scenario in budget plan for 1991 to 2000 [in DM billion]



(https://www.deutschebahn.com/resource/blob/1177650/513446b9bd04725fb289a7b609be2941/20-years_outline-data.pdf)

Due to this future scenario and valuation of this two companies, the government of Germany leads this two companies together how it was before the second world war. Only leading this two companies together is not enough for getting positive income. They got a new business plan how they can restart this industry and made it profitable. The main goal was to increase railway traffic in a way they need it to reform all railway structure in Germany. The government wanted to have a complete railway reform, with it they can increase rail traffic. They have initiated reconstruction and expansion of infrastructure. German government changed also change regulation laws of railway industry.

The situation during these years in German Railway industry complete changed. After these changes in German railway transportation situation, Deutsche Bahn nowadays has a perfect budget situation compared to the situation of Bundesbahn and Reichsbahn for 20

years. Deutsche Bahn has nowadays much more competitors than for 20 years other two railway transportation companies together, but it makes much more profit than railway companies for a few decades ago. Annual report of Deutsche Bahn for 2017 shows that they made more profit in 2017 than in 2016. It is more than 6,8 percent more than in last year. In 2017, they did 12,7 percent more interstation than in 2017, but they had in 2017 8,4 percent more passengers. EBIT in 2017 was 10,6 percent more than in 2016. Deutsche Bahn AG has the same problems which have every company in the railway industry. The main problem for each railway company in the world is that travelers prefer HSR only in a short or for some middle routes, but for long-distance travelers prefer to travel by airplane or by bus. This tendency is more common because of low-cost carriers. For a long distance mostly traveling by train is more expensive than by airplane and mostly the journey by high-speed rail takes longer than by airplane. Due to these facts is understandable why high-speed rails do not have many passengers in the long routes.

First, for price-sensitive passengers, low-cost airlines ticket is cheaper than high-speed rail ticket. Second, for time-sensitive passengers is not optimal because by train it takes more time to arrive to the destination than by airplane. That's why all railway companies need to reform price formalization strategy in a long distance. Difference between price formalization in short or middle distance and long distance is that in in the first case companies have competitors, but in a long distance they do not have private railway company as a competitor, that's why they do not pay so much attention to it. In 2002 Deutsche Bahn AG has tried to change this situation and used PEP management especially for a long-distance ticket price formalization. This management was already used in some railway companies in the European Union, and it has proven to be effective. PEP price formalization scheme also the United Kingdom. They use this system because this system helps to maximize using of train capacity, therefore getting a better income. It is virtually having the same structure and same final result as the yield management. There are many differences between PEP management and regular price formalization management for railway companies. (http://www.jrtr.net/jrtr38/pdf/f50_lin.pdf)

Companies should not account ticket price due to the distance of trip - short, middle, long or kilometers, rather they need to get such a price that will increase the passenger demand. Which the help of this system they could increase the percentage of train capacity used. PEP management postulates for using special railway true customers' card. Passengers pay the card issue cost to get this card. With the help of this card, customers became a part of railway family and they could buy tickets with this card, no matter which direction and they will get a

minimum 25 percent discount. Early bookers who have BahnCard if they book more than 2 tickets automatically get over 25 percent rebate. Normally passengers, without this PEP price management system, get a discount for early booking, but if later the passengers change or cancel the trip they either get some money back or get no money back. PEP price management system suggests minimizing these fees.

The main idea of BahnCard is to acquire new customers and keep old customers. This strategy would increase passenger demand for long and short or middle distances, which will increase income.

With the PEP management, customers pay 50 percent less than without this price formalization management, due to new prices companies will get much more customers, demand will increase and train capacity will be used optimally.

In 2002 PEP management was unsuccessful in Germany because of many reasons. 2002 economic situation in Germany was bad, they had economic crises, unemployment percentage was high, people did not have extra facilities for traveling. PEP management was a new and complicated concept to be understood by passengers. The marketing department of Deutsche Bahn AG was unsuccessful, they did not do promotions about their new management program. Due to this, they have not attracted a lot of new customers. The management system was based on yield management, but they did not use all aspects and details of yield management. Time management is one of the basic elements in yield management, which they have not used before. When the person books the ticket, the time the trip starts, or the day of the week, and more details are important for yield management. PEP management has not implemented them and German government has seized to use this program after one year.

Till now price formalization system of Deutsche Bahn AG is not perfect, especially for long-distance transportation routes, but there is an improvement to be seen in the last ten years, due to implementation of some good points from PEP management and yield management and investment in a new price formalization management which is more effective than the former one. The company researched the market deeply and has found out that only 17 percent of passengers are time sensitive, and over 30 percent of passengers are price sensitive. This market segment is of higher importance for railway companies. Thus, Deutsche Bahn is focusing on a bigger price-sensitive market segment. The rest, about 50 percent of travellers in Germany, can freely choose time and tripe direction. Price sensitive and time flexible

customers make up a big and important segment for railway companies, this type of customers is responsible for the increase in demand. For these two types of passengers, it is essential to set up some program which will maintain their loyalty to the only railway service. BahnCard is one of the best solutions. First passengers pay to get this card, then they can use this card and they will always get a discount for buying tickets. For a long distance, they get a bigger discount than for a short distance. This tactic will help to keep price-sensitive passengers and some part of time flexible passengers.

PEP management was used in Germany only for one year, then they have canceled this program. They took only BahnCard service from PEP management, and nowadays there are programs for many travelers. If person books a ticket early enough they will get over 25% promotion, also they get other promotions, which is especially for flexible and price-sensitive passengers.

The whole picture shows that Germany has not fully liberalized railway industry, like Sweden. In domestic and short or middle-distance routes private railway companies can enter the market only if they win a governmental tender. This is why Deutsche Bahn does not constantly have other competitors from the private sector. Railway market segment is under government control and it is a Public Service Obligation.

(https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=jei2017&paper_id=74)

Österreichische Bundesbahnen (OEBB)-Infrastructure Group

The history of the Austrian railway goes back to the 1419. After 1867 when the Austrian Empire combined with the Kingdom of Hungary the situation with the railway Market goes down. Some small railway companies could not exist anymore, they went into bankruptcy, with it k. k. Staatsbahnen (kkStB), or also k. k. Österreichische Staatsbahnen (Imperial-Royal State Railways) was founded. Since 1918, the Austrian railway is under state control. The entity forms have passed following changes:

1918 Deutsch-Österreichische Staatseisenbahn (DÖStB)

1919 Österreichisch Staatsbahn (ÖstB)

1923 Bundesbahn Österreich (BBÖ)

Railway industry has always been important for the country economic stability. During the Second World War Germany, which has changed and shaken the stability of all railroad system in Austria, controlled the Austrian Railways.

(https://de.wikipedia.org/wiki/Geschichte_der_Eisenbahn_in_Österreich)

After the second world war, the government of Austria has built a new railroad system with the reconstruction of the old system. It has received the new name Österreichische Bundesbahnen (OEBB). During some decades, Austrian railway industry has sustained its position at the international railway market. ÖBB Holding is under governmental protection and controls all public transportation segments and sectors in Austria. Also, Austrian railway industry is under control of ÖBB Holding, which is also competent for utilization of machines from Austrian public transportation system in a cost-efficient way.

The oebb-infrastructure group belongs to the Oesterreichische Bundesbahnen-Holding AG. This holding is responsible for ensuring availability and utilization of railway infrastructure (cost-effective way).

(https://blog.oebb.at/backend/wpcontent/uploads/2013/11/OEBB_infra_annual_report2012.pdf)

The group has over 1200 traffic stations in Austria. They operate around 4,000 passenger trains per day.

Plans of Austrian government, that will positively affect ÖBB, include an increase in demand for high-speed rails because they produce over 13,9 g/pkm of CO₂, many times less emissions

than other vehicles and over 20 times less than an aircraft. These numbers are decisive for ecological roadmaps and EU goals of 2020 and 2050.

Moreover, the railway is powered with electricity and over 90% of it is obtained from hydropower. Residual 10 percent comes from renewable energy sources and natural gas. That means that Austrian and European customers using ÖBB rail transportation are avoiding more than 3 million tonnes CO₂ emissions per year. At the same time, for the long destination their trains are preferable, because they are exclusively comfortable, provide great passenger services, moreover arriving on time at all stations.

Table 1: ÖBB passengers' development.

Passengers(per year)		466mil
Train passengers		235mil
Local transport		201mil
Long-distance transport		34mil
	domestic	23mil
	international	11mil
Tran passenger kilometers (per year)		10,7bn
	Local transport	5,1bn
	long-distance transport	5,6bn
Goods transported (tonnes per year)		111,7mil
Full-load transport		110,1mil
Contracted logistics		1,4mil
	Shipments (number)	
	Items Shipped (number)	

Source: "Statistisches der ÖBB" (https://presse.oebb.at/file_source/corporate/presse-site/Downloads/Publikationen/Annual%20Reports/OEBB_GB2017_en.pdf)

In this table, we can see that from 466 million passengers per year 466 million are train passengers. Long distance transport passengers are 16,69% less than for local transportation passengers. In these 34 million passengers per year are only 11 million international travelers. In train passenger-kilometer, we see that difference between local and long-distance transport is only 8,9%. So, local transport is more often on the road than a long-distance train, because of average the distance kilometer).

It worth mentioning, that ÖBB company has not only passenger's railway service but also the bus passenger service, S-Bahn and goods railway transportation. ÖBB company has a well-structured tickets sales structure. In each train station, there are more than 5 ticket machines

which provides instructions in 7 languages and for impaired persons. Due to the automatization, the company cuts labor costs and uses the space of the station more efficiently, at the same time, making ticket purchase comfortable for international customers.

Table 2: Train Tickets.

Tickets sold (per year)	100%	34mil
At ticket Machines	66,20%	22,5mil
From ticketing agents	22%	7,5mil
Via internet/smartphones/tablets	10,90%	3,7mil
Other sales channels	0,90%	0,3mil

Source: “Statistisches Der ÖBB” (https://presse.oebb.at/file_source/corporate/presse-site/Downloads/Publikationen/Annual%20Reports/OEBB_GB2017_en.pdf)

Yet another important aspect is punctuality of the trains, which in long-distance passengers' transportation achieves a rate of 87,6%, being higher compared to air transportation. We will analyze effects and reasons of this in the following part of this thesis. For local passenger transport punctuality is even higher than long-distance, achieving 97,1%.

Considering liberalization, the same situation as in Germany can be detected, we cannot discuss fully liberalization, only progress made in this direction. Only 33% of railway transportation market is liberalized. In the local market a big competitor is WESTbahn, but in the European market OEBB works with the Deutsche Bahn, equal to Austrian railway structure, which has a vertically integrated mode, and is under government control.

Liberalization of Spanish railway structure

In Spain first railway was built in 1848, connecting Barcelona and Madrid, proceeding during a few decades to connect all important cities with Madrid. First railway operator in Spain was the Iberian Peninsula, the next entrant was the railway company RENFE, currently the biggest and most important player on the Spanish market. Spanish railway industry is big with over 15,000 km railroad all over the country and only 3,000 km of high-speed railways only. Spain has a great high-speed rail infrastructure. After liberalization of this industry Ministry of Development Group Foment manages railway industry in Spain.

In 2015 government of Spain amended a new law 39/2003 (17/11/03) which will help to change and reform of the railway market. One of the main problems of liberalization of the railway market was countries' heterogeneity of regimes. It took so much time before they get a consequence. The next problem was how can they change EU regulation 2012/34/E, because they wanted till 2019 have a total liberalization of the railway market. One more problem was investment, since the government of Spain does not have enough money for this project because with the liberalization they have to change all system- station, navigation, control system, new HSR, Personal, etc. That's why they thought how can they get this money where can do savings and which routes they can cut at all, and they want to start the liberalization using tenders. In the long-distance HSR companies with the help of tender will get the competitive place in the railway market. The next and the biggest problem in Spain is corruption. It can prevent licensing and tender processes. It is doubtful that full privatization and liberalization will be achieved till 2019. Railway has a particular configuration, different from that of airplanes, cars or buses, suitable to service only HSR, and it is expensive in maintenance. This configuration is used by the main HSR company, who invest so much money in this business. If some other company will enter this business, then it will be difficult, because in this business we can not use the same system use for airplanes. Two HSR cannot drive which can do planes. They can fly at the same time in the same direction, but using different sky highways. This is one of the most important reasons why it is so easy to have a liberalized airplane market and monopoly or oligopoly in the railway market. Here is only one solution, maximization of consumer surplus, avoid loser or winners' game between competitors, do not let the leader sheep at the market.

History of High-Speed Rail development in Spain

To begin with, it needs to be outlined that there are two major types of HSR systems. OECD distinguishes two types of freestanding systems. Also, the latter type comes in several specific configurations and mixes of conventional and HSR systems. In this chapter we will discuss, for instance, the AVE in Spain, where normal rail passenger services are also allowed to use tracks constructed for HSR.

Most important interrelated issues and factors of the HSR development included in the early years of the industry's establishment are:

- solving the problem of separation between fast and slow trains increases the capacity of rail infrastructure
- speed, competitive with air transportation, especially in the segment of business travelers, demanding a one-day return if the journey is approximately 600 km,
- Promoting private sector of the rail supply industry.

With the growth and aging of the industry, as well as of competing means of transportations, governments and investors, depending on the specifics of the national HSR systems, had to face other, more diverse and different for every national market, issues. They include journey time reliability, economic development, environment but in Spain, due to its political model with the regions, aspiring to have more autonomy, the most relevant one is political integration and centralization. When developing a state program and following it, authorities specify the objectives, which affect service design. Aiming to achieve the highest possible speed, the focus must be on non-stop services between centers of business life, targeting one-day round trips with distances of approximately 500 km. Another option, fulfilling the same aim is night services, if distances between major cities of the country exceed 500 km. Depending on the marketing profile of the customers, other factors might be more important and then there is demand, suitable for the development of longer routes with more intermediate stops. In this part of the thesis we will consider characteristics of the HSR industry in Spain from the above points of view.

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In 1980 the government has started to plan the high-speed rail industry in Spain. The argument for the new railway structure was that in railway industry in last 2 decades' demand goes down was that each year more people does not want to travel by train. They do not have necessary means to invest and their economic cycles imply to receive ROI sooner. The project was named NAFA, meaning New Rail Link to Andalusia, was started with the purpose to strengthen the economy of southern Spain. The first route of HSR was open in 1992 and on 14 April 1992 was daily 6 HSR services. In April 2017, they celebrate 25 years of HSR, with the more than 3,100 km all over Spain. The first journey was with the SVE HSR between Seville and Madrid. In this 25 years, the Spanish economy in the south was growing, with the help of HRS. Since 1992 HSR networks grow more than 2630 km, with the help of HSR passengers can reach more than 47 cities in Spain. Next technical innovation is huge tunnels. One of the longest tunnels in the world is in Spain. Guadarrama Tunnel is 28,4 km long, and this tunnel was built for high-speed rails. Another tunnel similar to the latter is Pajares with the length of 24,9 km. (Source: https://en.wikipedia.org/wiki/Madrid-Seville_high-speed_rail_line)

In technical and ERTMS (the European Traffic Management System) view of HSR industry Spain is a leader in Europe. ERTMS system is the leader system in the railway signaling infrastructure. Network management is at the high level in Spain. They are using the DaVinci system, which is the leader management system in the World. This problem helps to have efficient technical trainings, ensure safety, it is a very effective program and easy to use. It is one of the most innovative HSR systems in the world, with innovative railroad, station, and control system and design. That is why HSR industry of Spain is rated as the second in the world after China and the best in Europe. Spanish high-speed rail system makes Spain to a worldwide reference model.

There is a monopoly in the high-speed rail industry. RENFE was and is the main HSR company in Spain. RENFE started his AVE (Shuttle) service from Madrid to some cities, first to Puertollano, then to Malaga, Cordoba, etc. in 1993 the AVE shuttle run 300,00 km/h. They wanted to increase the speed because with it demand will increase.

Table 3: Technical Characteristics.

TECHNICAL CHARACTERISTICS	
Maximum speed	330 Km/h
Potency	8.800kWw
Seat	318
Services	Madrid-Zaragoza-Lerida
Road width	1.435 mm (European)
Electrification	25 Kv 50 Hz
Safety and signaling system	ASFA, LZB, ERTMS

Technical characteristics of Ave trains. Source on: El País webpage (2005)

RENFE uses the high-speed rail AVANT, ALVI, and MSR ALTARIA. In short and middle distances RENFE uses Alteria MSR and in the long-distance HSR. In the long distance the main competitors are different low-cost airlines. Spanish statistic company shows that each year more people prefer to travel by HSR than by plane.



AVE High-Speed Train in Spain (2013). Source: LPG webpage

In Spain, we can see international and local routes. Madrid-Barcelona line has started to work in 2008. This route is one of the most important routes in Spain and all over the world and thus relevant for our study on the latest achievements in the transportation industry. Each day over 20 trains are running through this route. If the journey was nonstop, train passengers could reach Madrid in less than 2 hours and 32 minutes, with stops - in 3 hours 25 seconds. HSR develops the speed of more than 621km/h. As we see in 2005, the maximum speed of the HSR was only 330km/h and 10 years later it is much higher. Nowadays the maximum speed HSR is 621km/h, and it is not the limit. The main idea and purpose of the Spanish government was to connect the main cities in Spain with the capital. (AVE High-Speed Train in Spain (2013))

International HSR lines connect Spain with Portugal and France. Madrid-Barcelona-Paris will connect the two capitals, allowing the travel time of only 3 hours, thanks to the collaboration of Spanish RENFE and French SNCF companies. This collaboration is good for both companies and countries' economies. For passengers traveling by HSR it will be more convenient than a flight. After this route is taken in exploitation, next destinations can be

opened towards the borders to Switzerland and Italy. These countries also have a very strong HSR system.

Madrid – Lisbon route connects capitals of Spain and Portugal, being very important for these two countries. Night trains should allow passengers to have a comfortable journey. In this route construction of the rails and infrastructure was started late 2008, but due to many issues its end is planned by 2023. Night train on this route could be also cheaper than an airplane ticket.

Price Elasticity and Demand for Spanish High-Speed Rail.

Economic and technical development, passengers' demand, regional economic situation, new low-cost airlines, railway passenger journey time - are factors, that have forced Spanish government to think about creating the high-speed rail network system. In 1992, it has built the first high-speed rail in Spain, which has changed the travel situation in all countries of the European Union. According to the report of OECD, highlighting the resource due to cost-based analysis investments, business travelers prefer to travel by HSR. Thus, the rail industry authorities in Spain focus on the services, allowing efficient travel time, on income levels of business users and, consequently the value they put on the saved travel time. Consequently, prognosis concentrates on the capacity of the business travel market and factors of its growth and the probable extent to which it can grow.

There are two opposite positions about the use and the role of economic prognosis in the assessment of HSR schemes. One of them is called “build and see” in the report of OECD and is used in Spain, due to lack of resources to compute all the outcomes, when large increases in the HSR network are to be observed, with multiple extensions of the lines under construction. In fact, Spain has the third biggest network in the world with the second biggest length of tracks under construction.

If slowly integration of private sector in the railway industry had been chosen to develop HSR network, the private sector funding would be easier to involve with gradual increase of accrued investments, but the massive start of construction implied reliance onto public debt and expected high revenues in future. In Spain, chosen the second option, costs of the whole infrastructure, technology, employees, vehicles influence the ticket price. In the first few years demand was higher than in the last ten years. That's why in February 2013 RENFE has implemented new high-speed rail tickets pricing model and reduced HSR ticket prices by over 11%. In short and middle distance railway passengers demand was low, because of high competitors like other public vehicles, car, and buses. In the long distance, competitors of high-speed rail are low-cost airplane companies. Low-cost airlines in some direction are cheaper than high-speed rail ticket. With airplane travel time is less than with the HSR, but it has a big downside. Airports are always outside the city, then passengers need to get a vehicle (taxi, car or train) to get to the city. Railway stations are always in the city centers, which is a big advantage for the travelers. First years Renfe company had only fixed prices depending on the train, class and time of travel. With the time, they recognize that passenger demand goes down and they have to get some new pricing system. Years later they involve discount pricing

system. This system does not help much to increase the demand. In February 2003, they changed the coordination of the pricing system, which included following steps: Renfe reduced the price of passenger tickets by more than 11% and in long connections even by over 15%. Tickets to middle-speed rails like Alvia or Avant become much cheaper, due to governmental subsidies. Renfe implemented new promotional tickets, which reduce tickets price up to 70%. The discount was strongly dependent on the demand. Ticket discount depending on how far in advance passenger's ticket was booked. Tickets price changed if the ticket was canceled or the date of the trip was changed, then the person had to pay much more than it was. This system was analogical with the yield management used for the airline tickets, but it was not as complete as the airlines' yield management.

- A bonus system for the passengers who often travel on the same route.
- Tickets prices dependent on the age. If the passenger is between 14 and 26 years old, he pays 30% less.
- Passengers will return the 50% of tickets' price, that they have already paid, if the high-speed train arrives 15-30 minutes in late, if it is more than 30 minutes than passengers will get 70% of paid high-speed rail ticket.

(Source: Annual report RENFE 2016)

The results are demonstrated in the following table.

Table 4: competition between HSR and Airplanes.

Corridor	Services	Surface Distance (km)	HSR Demand Variation (%)	Airplane Demand Variation (%)
Northeast	Madrid–Barcelona (B, C, A)	621	+16.0	–14
	Madrid–Zaragoza (B, C)	307	+10.0	na
	Zaragoza–Barcelona (B, C)	314	+9.6	na
South	Madrid–Seville (B, C, A)	472	+8.2	–32
	Madrid–Cordoba (B, C)	344	+9.0	na
	Madrid–Malaga (B, C, A)	500	+9.5	–30.7
Madrid–Toledo	Madrid–Toledo (B, C) ^a	80	–1.2	na
Northwest	Madrid–Segovia (B, C) ^a	90	–4.8	na
	Madrid–Valladolid (B, C) ^a	190	–3.4	na
West	Madrid–Valencia (B, C, A)	400	+7.4	–3.7
	Madrid–Cuenca (B, C)	195	+12.0	na
	Madrid–Albacete (B, C)	321	+19.2	na
Long-distance journeys	Barcelona–Seville (C, A)	1,093	+88.0	–18
	Barcelona–Malaga (C, A)	1,121	+47.0	–22.7

NOTE: B, C, A = bus, car, and air transportation available; B, C = bus and car transportation available; na = not applicable.

^aAVANT trains are available.

Source: *Price Elasticity of Demand on the High-Speed Rail Lines of Spain impact of the New Pricing Scheme* Alejandro Ortega Hortelano, Andres Felipe Guzman, John Preston, and Jose Manuel Vassallo <https://core.ac.uk/download/pdf/84138665.pdf>

This table shows us how new management can change passengers' demand. The distance between Madrid and Barcelona is 621 km, and passengers have 4 option to arrive to Barcelona - by car, bus, HS, and airlines. Thanks to the new management, the situation has changed a lot: HSR demand Variation increase 16% and Airplane demand variation decrease 14%. With the help of this program, more young people (age category 14-26 years old) prefer to travel by train. On all over the passenger demand value increase in each direction where a person can travel by high-speed rail, but passenger demand on routes Madrid-Seville, Madrid-Cordoba, Madrid-Malaga lose their valu, because passengers could travel in these routes only by AVANT train (speed is only up to 250km/h) which are middle-speed rail. In short distance people prefer to travel more by bus or by car and this is a big segment of customers since many people living near Madrid and commute to work in Madrid. In long-distance journeys like Barcelona-Seville or Barcelona-Malaga passenger demand value has increased up to 88 % thanks to the perfect strategy. With the help of right management passenger demand for HSR can grow up, the main competitor for high-speed rail are different low-cost airlines. They have advantage, because they are cheaper than high-speed rail, if we compare regular prices, airlines are more comfortable for many passengers than then high-speed rail, an

airplane is quicker than high-speed rail, but most airports are outside the cities and train stations are often the center of the city. High-speed rail in Spain is saving energy and increasing sustainable mobility for 25 years of its successful experience. In new legalization process, national railway company Renfe was split into ADIF- the infrastructure manager and RENFE Operadora — transport operation. But till now both companies are to 100% state-owned.

Table 5: National high speed and convention all Railway.

National high speed and conventional Railways in the last years (2007-2016)	
Employees	13,041
Rail network	15,296km
Managed Traffic	2,1 million trains a year, 5,775 a day
Numberof passengers	468 million a year

Source: HIGHSPEEDD RAIL IN SPAIN: SAVING ENERGY AND INCREASING SUSTAINABLE MOBILITY ALONG 25 YEARSSUCCESSFULL EXPERIENCE

In Spain, there are more than 47 high-speed train station, which is much more than in Germany and Austria together. For high-speed rail stations the PPP system is used.

Costs of building HSR Infrastructure

High-speed rail needs require specific infrastructure, very often the same infrastructure of trains, which commercial speed is below 250 km/h cannot be used. Middle speed rails and railways have the same signaling, roadway level crossings, sharp curves systems. High-speed rail needs more technical powerful signaling and powerful electrification systems. To build a new infrastructure for high-speed rail, we need to calculate specific costs.

High-speed rail infrastructure building costs, like building a new station, railroads, platforms, infrastructure building cost is about 30% of total cost, but sometimes is about 50% of total cost. Most European countries have isolated high-speed rail infrastructure. Like high-speed connection lines between airport and big cities (CAT service in Austria), or isolated infrastructure between two big cities (Barcelona-Madrid).

Table 6: Constriction for High-speed rail.

Belgium	16.1
France	4.7 – 18.8
Germany	15.0 – 28.8
Italy	25.5
Japan	20.0 – 30.9
Korea	34.2
Spain	7.8 – 20.0
Chinese Taipei	39.5

Construction costs per route km of new high-speed lines (Million Euros, 2005 prices)

Source: Campos, de Ru, and Barron, 2009 Campos, J., de Rus, G., & Barron, I. (2009). Economic analysis of high speed rail in Europe. Fundacion EEVA.

Referring to Campos, de Ru, and Barron, who discovered the wide range of possible construction costs of 1 km HSR lines (see the above table), we point out that France, Spain and China show the lowest costs. High capital costs are required to create the technical

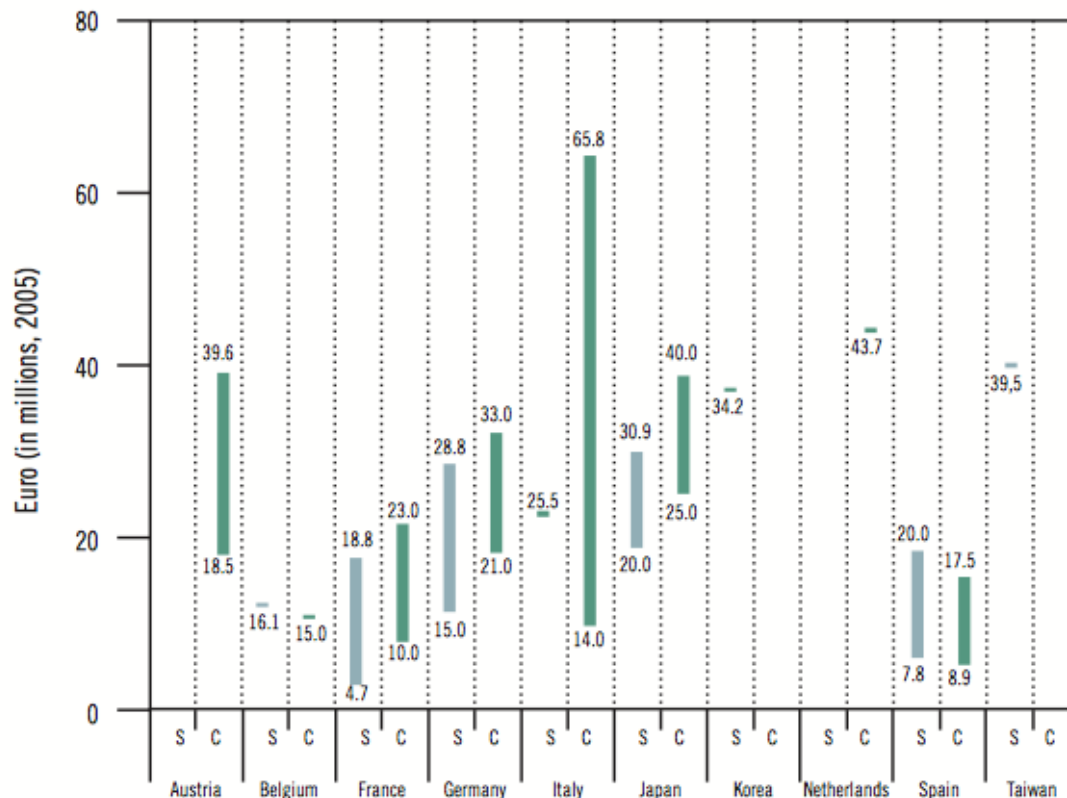
characteristics, necessary for high speeds, such as the grade separation, curvature, and gradient.

It can be, that the mixed evidence is explained by the mediating facto, because not only inter-related design operating speeds and gradients are driving the cost. Nash (2015) emphasizes also population density, affecting land costs and positively related to additional expensive construction works, such as bridges, viaduct, and tunneling. Mountainous landscape is also positively related with costs, as we can judge by Chinese Taipei with over 76% of the track elevated and 14% laying in a tunnel.

(Spurce: ITF Round Tables. The Economics of Investment in High-Speed Rail. International Transport Forum 2014)

Another important issue is the central area access provided by existing rail, decreasing the HSR costs, like it does in France. If conventional rail operations are underground, there is more expansion room for HSR without opportunity costs being included into overall expenses of the project.

Graph 6: Infrastructure costs depend on the geographical structure.



(Source: https://w3.grupobbva.com/TLFU/dat/inf_web_economic_analysis.pdf)

S - in Service

C - in construction

Infrastructure costs depend of geographical structure, allocation structure of population, material costs, etc. In the above figure, we can see average cost (in millions) per kilometer of building HSR infrastructure by countries.

As we see in Austria construction of the first HSR infrastructure started in 2006. In 2005, it was in construction. Planning, and land cost are not including in this graph. Average costs are much higher than in other European countries. It is because of its geographical, and technical situation in Austria. They build more tunnels. Next important factor is country population. Which areas are more populated, urban cities, etc.

In France, the average cost of building high-speed rail infrastructure is much lower than in other countries. It is because of special building technic. They do not build tunnels, instead of

this it they use steeper grades. France and Spain are leaders in this industry. They are progressing in this industry for a much longer time than many other countries. Austrian wanted to change the structuring method because infrastructure costs will be always high.

Some intangible costs are incurred also by greenhouse gases, and this type of costs is especially controversial. Thus, offsetting emission costs is already included in the price, set by the carbon producers, which is part of material costs and consequences of capital costs of the project. The same point of view is accepted for electricity as part of service costs. Controversy is caused by the fact that the greenhouse gas emissions mostly depend on the primary source of energy used to generate the electricity, so it is not a problem of HSR systems, as only alternative electricity generation can decrease the carbon blueprint along the whole value chain.

Another cost, incurred to the governments, is the cost of the reduced tax. On the one hand, the society benefits from reduced traffic-jams and pollution, normally caused by road traffic, and on the other hand, the loss of taxes, usually paid by the car-owners, is an opportunity cost.

Service costs

In this part of the thesis we consider maintenance costs, as a part of HSR operating costs. Firstly, operating cost of HSR is higher than those of conventional railways, due to higher energy, and maintenance costs. Next, design of the new line should analyze possible trade-offs between fix and variable costs, construction, and operating ones. A good example demonstrating such compromises is a solid concrete track and a ballasted one. The first construction requires less and cheaper in maintenance due to its higher resistance and stability, but the concrete construction is more expensive than the ballasted track. However, the concrete track has greater carbon intensity, which should be also added when calculating the final cost of the project. Place of service costs in overall building and operating costs of a high-speed line are shown in the following table together with the typical values.

(Source: for this part: https://mpra.ub.uni-muenchen.de/12396/1/02_The_cost_of_building_and_operating_a_new_high_speed_rail_line.pdf)

Table 7: Service cost for high-speed rail.

Capital costs	
Infrastructure construction	6 000-12 000
Rolling stock (40 units)	600
Total	6 600-12 600
Operating costs p.a.	
Infrastructure maintenance	32.5
Rolling stock maintenance	36.0
Energy	35.7
Labour	19.8
Total	124

Typical costs of a 500 km high-speed line (million euros, 2004 prices).

Source: de Rus and Nash (2009). Campos, J., & De Rus, G. (2009). Some stylized facts about high-speed rail: A review of HSR experiences around the world. Transport policy, 16(1), 19-28.

Most of the European countries have a vertical integration of a railway system. It implies creation of companies, holdings, which will control also the investment and expenses in the railway industry. In the European Union, the countries with vertical integration are Austria, Spain, and Germany, Italy, France and others. Operating cost for each country is different s depends on the type of train, electrification, signaling, how much money they spend for telecommunication, cost of labor, security, etc. Further we discuss only the main operating costs for the railway companies. If we study the figures, we see that

- over 60% of operating cost is incurred by maintenance of track. Maintenance cost of the track depends on the type of the vehicle, how many seats the train has, how much energy it requires, its speed, and others.
- 20-35% of operating cost is signaling. This position depend on which signaling innovation uses the holding. Innovative signaling systems are very expensive. In the European Union only, few countries are using new signaling systems. More 60% of signaling systemise new in France and in Spain.
- 5-10% of Operating cost is for electrification. It also depends on which type of the train, distance, depends on the route (if there are tunnels or not), etc.

In the two below tables we can see the maintenance cost for railway companies in four leading European countries. As mentioned above, the maintenance cost of a track depends on its diverse characteristics, and capacity of the high-speed rail.

Table 8. Comparing different HSR in different countries.

Country	Type of train	First year of service	Seats	Average distance (km)	Seats-km (thousands)	Maximum speed (km/h)	Estimated acquisition cost (€ / seat)
France	TGV Réseau	1992	377	495,000	186,615	300 / 320	33,000
	TGV Duplex	1997	510	525,000	267,750	300 / 320	—
	Thalys (*)	1996	377	445,000	167,765	300 / 320	—
Germany	ICE-1	1990	627	500,000	313,500	280	65,000
	ICE-2	1996	368	400,000	147,200	280	—
	ICE-3	2001	415	420,000	174,300	330	—
	ICE 3 Polyc.	2001	404	420,000	169,680	330	—
	ICE-T	1999	357	360,000	128,520	230	—
Italy	ETR 500	1996	590	360,000	212,400	300	37,000
	ETR 480	1997	480	288,000	138,240	250	42,300
Spain	AVE	1992	329	470,000	154,630	300	—

Source: https://w3.grupobbva.com/TLFU/dat/inf_web_economic_analysis.pdf

According to this table, we see all the range of capacities, available in these countries. In high-speed rail industry France is one of the leaders. They had a huge structure also before 1990. As we see in this table during these five years from 1992 to 1997, they change trains capacity. In 1997 in the high-speed rail market enter the new type of train “TGV Duplex” which has twice more seat places than the high-speed train “TGV Réseau”. This tendency shows that demand of high-speed rail increases during these five years that's why they change the type of train.

- Average distance from 1992 to 1997 increased by 1,06%
- Seats/km from 1992 till 1997 increase 1,435%
- Passenger train seats places increase from 377 to 520
- Main speed stays same - at the level of 300/320 km/h.

If we compare Germany and France that we see that in Germany is another situation. In the 1990s Germany has ICE-1. TGV Réseau is much faster than ICE-1. ICE-1 has much more seat places than TGV Réseau. In the table, we see that ICE-1 has twice more seat places for kilometer than TGV Réseau. Start for the high-speed rail in Germany was encouraging, but with the time Deutsche Bahn Holding notes, that demand for high-speed rail decrease, and they had changed the whole structure of this industry. In 1996 in Deutsche Bahn has purchased new trains ICE-2. ICE-2 has the same speed as ICE-1, but it has much fewer seats

than there are on average ICE-1. Start of high-speed rail in Germany was not so optimal, maintenance cost for the train was high. Estimated acquisition cost for ICE-1 is very high 65,00 €/seat, much more than for other train types. In 2001, started a new generation of high-speed rails. Germany acquires ICE-3. ICE-3 has 47 seat places more than ICE-2, its Maximum speed is 50 km/h more. Average distance increased by over 20kilometerss.

ICE-T was created in 1999. It has only 357 seats, maximum speed is much less than for other ICE Trains, and average distance is less than for other Deutsche Bahn high-speed rails. This high-speed rail is only servicing the middle and the short connections. Demand on high-speed rails in a short distance is very low, therefore in a short distance Deutsche Bahn uses trains with less capacity.

At the beginning of high-speed rail industry in Italy, only two types of high-speed trains were used. They use ETR 500 for the long direction and ETR 480 for short and middle direction. These two high-speed rails have different capacities. ETR 500 has much more seats and Maximum speed is also higher.

Renfe uses AVE high-speed rail, which develops maximum speed of 300 km/h and provides more than 300 seats.

Table 9: Cost relation in different EU countries.

Country	Type of train	Operating costs			Maintenance costs		
		Per train (million)	Per seat	Per seat-km	Per train (million)	Per seat	Per seat-km
France	TGV Réseau	17.0	45,902	0.0927	1.6	4,244	0.008
	TGV Duplex	20.8	40,784	0.0776	1.6	3,137	0.005
	Thalys	24.8	65,782	0.1478	1.9	5,039	0.011
Germany	ICE-1	38.9	62,041	0.1240	3.1	4,944	0.009
	ICE-2	26.0	70,652	0.1766	1.4	3,804	0.009
	ICE-3	17.9	43,132	0.1026	1.6	3,855	0.009
	ICE 3 Polyc.	20.4	50,495	0.1212	1.7	4,207	0.010
	ICE-T	15.5	43,417	0.1206	1.8	5,052	0.014
Italy	ETR 500	34.1	57,796	0.1605	4.0	6,779	0.018
	ETR 480	21.1	43,958	0.1526	3.2	6,666	0.023
Spain	AVE	23.7	72,036	0.1532	2.9	8,814	0.018

Source: https://w3.grupobbva.com/TLFU/dat/inf_web_economic_analysis.pdf

This table shows us proportions of operating and maintenance cost in these four countries. In France, operating costs for the different types of high-speed rails are different.

- Operating cost for TGV Duplex is 3,8n million higher than for TGV Réseau. TGV Duplex has more seat places, therefore operating cost per seats and per seat-km for TGV Duplex is much smaller than for TGV Réseau.
- Maintenance cost per train is same for these two train types, but TGV Duplex is much bigger and has more seats than TGV Réseau, therefore maintenance cost per seat and per seat-km for TGV Réseau will be more than for TGV Duplex.

In Germany the situation is different:

- ICE-1 type of train has the highest operating cost of over 38,9 million. 12,9 Million more than ICE-2.
- ICE-1 has lower operating cost per seat than ICE-, because it has much more seat places.

ICE-T has less operating cost in this group. Compared with ICE 1 operating cost per train is 23,4 million less than for ICE-1. Per seat 18,624 lesser than for ICE-1. But maintenance cost per train for ICE-T is a bit higher than costs incurred by other types of ICE trains except for ICE-1.

Operating cost for the two types of high-speed rail in Italy is also different. Operating and maintenance cost for ETR 480 is less than for ETR 500, so unsurprisingly, maximum speed, average distance and seat places for ETR 480 are less than by ETR 500.

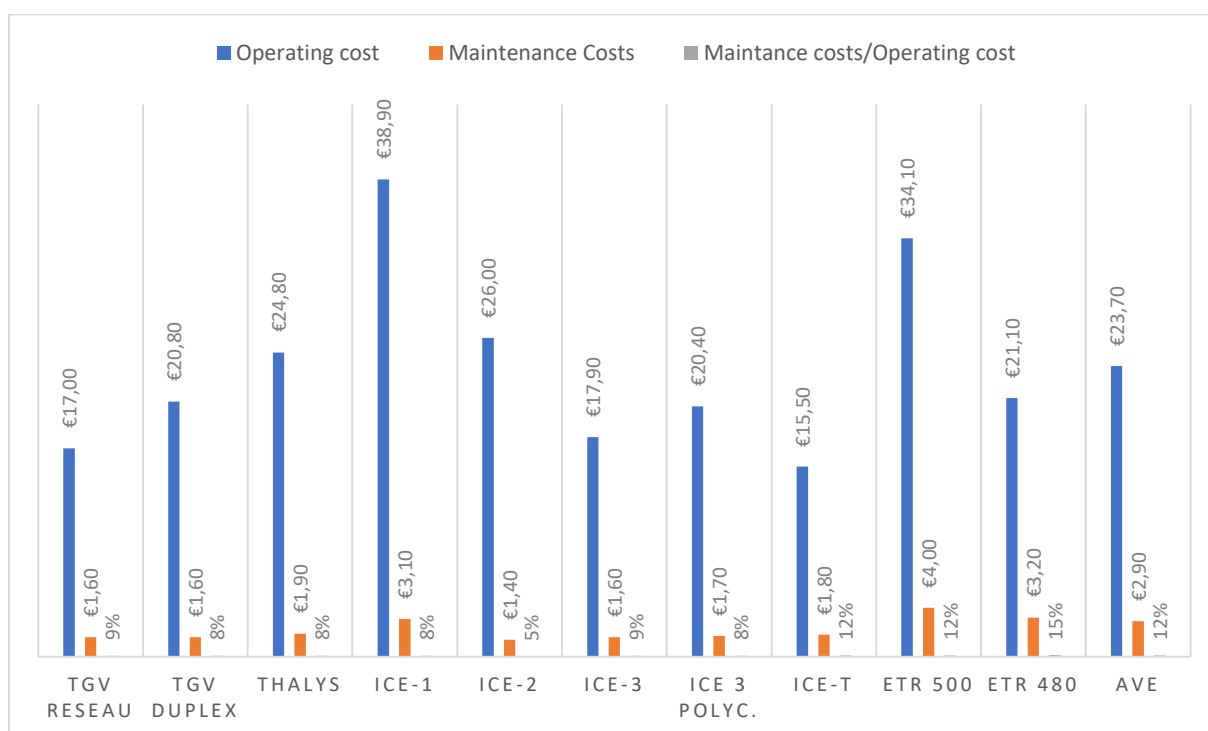
Table 10: Relation between two main HSR costs.

Country	Type of train	Operating costs			Maintenance Costs		Maintenance costs/Operating cost			
		Per Train (million)	Per seat	Per seat-km	Per Train (million)	Per seat	Per seat-km	Per Train (%)	Per seat (%)	Per seat-km (%)
	TGV Réseau	17,00 €	45,902	0,0927	1,60 €	4,244	0,008	9%	9%	9%
France	TGV Duplex	20,80 €	40,784	0,0776	1,60 €	3,137	0,005	8%	8%	6%
	Thalys	24,80 €	65,782	0,1478	1,90 €	5,039	0,011	8%	8%	7%
	ICE-1	38,90 €	62,041	0,124	3,10 €	4,944	0,009	8%	8%	7%
Germany	ICE-2	26,00 €	70,652	0,1766	1,40 €	3,804	0,009	5%	5%	5%
	ICE-3	17,90 €	43,132	0,1026	1,60 €	3,855	0,009	9%	9%	9%
	ICE 3 polyc.	20,40 €	50,495	0,1212	1,70 €	4,207	0,01	8%	8%	8%
	ICE-T	15,50 €	43,417	0,1206	1,80 €	5,052	0,014	12%	12%	12%
Italy	ETR 500	34,10 €	57,796	0,1605	4,00 €	6,77	0,018	12%	12%	11%
	ETR 480	21,10 €	43,958	0,1526	3,20 €	6,666	0,023	15%	15%	15%
Spain	AVE	23,70 €	72,036	0,1532	2,90 €	8,814	0,018	12%	12%	12%

Source: https://w3.grupobbva.com/TLFU/dat/inf_web_economic_analysis.pdf

With the help of the below graph it becomes clear that average Maintenance cost is 9,64% in Operating cost. Highest maintenance cost in operating cost has ETR 480, lowest Maintenance cost in operating cost has ICE 3.

Graph 7: HSR cost differentiation.



Source: https://w3.grupobbva.com/TLFU/dat/inf_web_economic_analysis.pdf

If France high-speed rail company will start to use some other train models, with less maintenance cost, than its operating cost, which will be either decreased. In ETR 480 maintenance cost is 15% of operating cost, which is a very high quote.

HSR Perspectives

The modern tendency, the growth, and transformation of business centers into polycentric cities dominating the economy, can be changed by means of high-speed rail, which reduces the opportunity cost of dislocation in a specific city. Workers can commute quickly and conveniently between their offices in a metropole and homes in medium-sized, especially eliminating necessity to include high urban living costs into complicated considerations of trade-offs. If HSR industry will in course of time forego the way of increasingly cheaper and faster travels, we forecast, that it will lead to growth of a new kind of cities - interregional urban agglomerations – preventing firms and skilled workers from concentrating only in big cities, which will promote development of the rural regions and the ones with mono-economy.

Looking in detail at the external cost of transportation competitors like the train, car, and aircraft, from the ecological point of view, we see that Train is much better than other transportation solutions. Comparing train's external costs (noise, air pollution, climate change, accidents) with the car and Air transportation solutions, we see that in the same route railway has less external cost than a car and air transportation solutions. If a car needs 40,2(euro/1,000 passenger-km) and Air 28,7(euro/1,000 passenger-km) for the route Paris-Vienna, then train needs only 11,7(euro/1,000 passenger-km). Another case is ICE-1, where maintenance cost is less, but operating cost is so high. *(source:https://mpira.ub.uni-muenchen.de/12397/1/01_A_review_of_high_speed_rail_experiences_around_the_world.pdf)*

If transport is too expensive, reduced distances are preferred, because speed is less available then, due to the reduction in purchasing power. Still, optimization of activity schedules imposes constraints on to choice of the mean of transportation. And since demand is responsible for supply creation, particularly, the development of technologies, HSR will not substitute the airplane, especially on long-distance routes. Very probably, demand for both HSR and air travel will stay high. The growth of HSR, as we can defer from our previous discussion, will inevitably depend on the policy, on the investment from the governments and on the energy policy, for instance, on possible restriction of fossil fuels usage. Anyway, as far we can judge the industry is far from its saturation point and following aging.

Low-cost Airlines, history, pricing strategy, development

When air transportation market was liberalized, the situation of transportation system has changed. After 1990, competition among airlines was increasing in the USA and Europe. Many low-cost airlines like Ryanair, EasyJet, WizzAir, AirEuropa, and some other companies have entered at the market. Ryanair was the first low-cost air transportation company that enter this market at 1995. A low-cost business model makes low-cost airlines more attractive for customers.

Low-cost airlines market is a strong substitute and a competitor for railways and regular airlines on the short or middle distance. In some routes like Madrid-Barcelona only low-cost airlines are flying, because the regular business airline cannot survive in this competition.

Business Model for them is simple and means the elimination of all unnecessary costs, like

- Eliminate comfort
- Only online check-in
- Flying to secondary airports
- Only carry-on baggage
- No free food on the board
- Offering a single-class product
- Keeping labor cost low

With the help of this cost reducing system, low-cost airlines have higher customer demand than full-cost airlines or high-speed rails. Success of low-cost airlines in the transportation market is guaranteed by their lower prices. In air transportation, profit maximization depends on revenue because in this business a lot of costs are fixed for the same period, and this issue is the focus of the next part of our thesis.

Airline Industry formalization and history

First airline company in the world was Luftschaffahrts AG created in Germany in 1909. After five years Luftschaffahrts AG started his first charter flights to Russia and USA. Later in 1919 Nederland and Columbia created their airline companies. KLM is a Dutch airline created in 1919 and this company till now is one of the leading companies in the European air transportation market.

(source: https://de.wikipedia.org/wiki/Geschichte_der_Lufthansa)

First airplanes were small and they can take only two passengers. The second world war has changed the history of airline industry, because before all airline companies in the world used only military airlines for cargo, passenger transportation or for mail. After second world war, American engineers brought at the airline market new civil airlines, which was perfect for passenger transport and for cargo and air mail.

First passenger airplanes were:

Boeing 377 designed in 1945 in the USA. This airplane has 100 seat places and could fly over six hours nonstop. The Boeing Company is till now very successful company in aircraft creating industry.

(Source: https://de.wikipedia.org/wiki/Boeing_377)

Douglas DC-6 was created in 1958 by Douglas Aircraft Company for long distances, and as Boing 377, Douglas DC-6 had 100 passenger places on the board. This aircraft created company was popular in the USA in the 1970s. Douglas Aircraft Company specialized in military aircraft. After 1980, the company had big investment problems, that's why The Boeing Company has bought Douglas Aircraft Company in 1997.

(Source: https://de.wikipedia.org/wiki/Douglas_DC-6)

Lockheed Constellation was created in 1953. During the first years it was popular and broadly used in Germany, nowadays they produce more military airlines than civil.

In the early 1990s flying was a luxury. Airplane tickets were very expensive. At the airline market was not so many airline companies like now. They had other ticket price formalization system. All airline companies were under government protection until liberalization airline industry in the early 1990s.

After liberalization, many private full cost airline companies and low-cost carriers enter the Airline market in Europe. Competition between low cost and full cost airline companies is very strong. At the same time, HSR became a strong competitor for airline industry.

Airline companies were the first to use revenue management for revenue maximization. Each company wants to make maximum profit for every single service and production. Airline companies aimed for each flight maximum income. This goal is possible to achieve only with the help of yield management. In airline business companies have a goal which is not minimizing cost of services, rather income maximization.

Revenue management is selling the right product, at the right time and place to the customer. In airline industry revenue management can get due to maximizing airplane capacity and seat places capacity. Full-price airline companies need to optimize the mix of sold tickets. For minimizing sold tickets revenue Airline companies use yield management.

Airline market has two types of customers' time-sensitive and price-sensitive customers. Most of time-sensitive customers are business travelers. For them, the price of the ticket is not so important, more valuable for them to be in the right place at the right time. Business passengers want to have more comfort during the flight. Some number of leisure travelers can be accounted to this group.

If companies are using revenue maximization management, then in the first place they need to do market research. They need to make market segmentation and understand the behavior of customers.

If person books a plane ticket more than one month before the flight, then this person is price sensitive, but of a person book a ticket less than one week before the flight then this person is time sensitive. That's why if we book two months earlier the same flight is cheaper than if we book it two days before.

Product differentiation is of importance for Airline companies offering different services. For business people or for time-sensitive travelers airline companies offer different types of services: they can choose a more comfortable seat place and extra services. This way for each type of customer full-cost airline companies and some low-cost airline companies have special different classes. Some LCC have only one class - economy, which is attracting price-sensitive passengers.

Price differentiation or setting is another aspect, meaning that travelers can choose which type of ticket they want to have. Different tickets have different prices. Customers can choose tickets which flexible data if they change the data or cancel they would not pay extra fees or will get money back. This system is simple each passenger can choose that ticket which he or she wants or able to pay. Extra services are then paid extra: if the person needs an express check-in, or if the person takes VIP seat place and service.

Forecast control is very important for yield management, always providing companies with information on how many seat places is available in each class, helping companies to understand which price they should set on the tickets. In yield management price of tickets is related to the availability of seat places. Price is also affected by the number of competitors on this connection, and by the price, competitors are offering for the same service at the same route and at the same time.

For yield management, there is no relation between income maximization and cost minimization. First, in each airplane there is a certain number of seats, airline management needs to take into consideration and due to this number, they change their revenue maximization tactic. However, the main target is to use all available seat places, and not to have free seat places, regardless in which class - VIP, business or economy.

In revenue management target is not to get so many sold plain pickets, with it to cover flight costs. No, in this management program does not exist to cover cost for flight, managers need not check it. Managers separate this two strategies and calculation points.

These three companies were first civil airplane manufacturing companies in the world. Till now there are most popular and useful civil passenger transportation airplane manufacturing companies for European Countries are Boeing, Airbus, and Lockheed Martin.

Airline companies are working with the price elasticity of demand. If airline tickets price would not be flexible, then there would be no circumstances for customers' price sensitivity. Low-cost Airlines and Full-cost Airlines have different pricing tactic. Low-cost Airlines have dynamic pricing system and they need to keep in balance load factor and operating cost.

(Source: <https://www.iata.org/policy/Documents/Benefits-of-Aviation-Spain-2011.pdf>)

Low-cost Airlines	Dynamic pricing model
Full cost Airlines	Different fare classes, overbooking model, customer loyalty schemes

Difference between value propositions of low-cost and full-cost carriers

Pricing strategies and their main factors

The CEO of The Boeing Company, the biggest aircraft manufacturer, adds that airlines must maintain and develop the pricing strategy due to changes in economic environment, keeping their price formalization model sensitive to types of customers, weekday, holidays, political situation, weather.

Business travelers are sensitive to flight duration, comfort, service. Leisure travelers are not sensitive to comfort, service or flying time, but for them the price of the ticket is important.

Most popular planning types according to Peter P. Belobaba (2009) are classified as follows:

- Fleet planning
- Route planning
- Scheduling development

The company itself can change tickets prices. First, the company decided did they want to be low-cost carriers of full cost airlines, which capacitate do they have, what kind of service can they offer to clients, with which airports can they have a contract and most important choosing routes, where they can fly.

Price-sensitive customers are flexible for time and places and prefer cheaper tickets, that's why they are looking forward to where, when it will be better and cheaper for passengers to travel. For these passengers, it is not important will the airplane arrive in main airports or in secondary airports and they need only basic comfort on the board during the fly. Because of these and some other important factors, full price airlines are working for business travelers, who are time-sensitive.

Competition plays a big role in this business. For sure demand change rickets prices, but competition between two or more companies play a big role in this industry. Each country

regulates this business differently, depending on the government regulation in different countries there are monopolies, oligopolies and ideal competition. Route Vienna-Frankfurt is a great example of a monopoly in this business. In this way are flying only two airline companies Lufthansa and Austrian Airlines. Austrian Airlines is a daughter company of Lufthansa. For the research purposes of this thesis, we have checked the ticket prices during one month and the result was that they have the same ticket prices and they are high.

Austrian Airlines and Lufthansa are not budget companies, they are full price companies. the whole market is shared by these two Airline companies. Most of the passengers are time-sensitive, Business Passengers. Price-sensitive passengers are flying from Vienna to Frankfurt because it is very expensive for them. Barcelona-Madrid route is another way around. In this route, there are only budget airline companies competing.

One of the main factors that change ticket prices is seasonality. In peak period demand goes up, ticket pieces either, and marginal cost became higher. Due to seasonality factor airlines industry can keep demand for the whole year in balance, that's why airlines industry shift demand from peak period to a regular period when demand is low.

Each airport in the world has a different contract with Airlines companies. Airline companies can always choose, with which airports to make the contracts. Main airports charge more for their services than secondary ones. Main points in the contract are:

- Starting and landing fee
- Charge for noise
- Airline parking fee
- Position in the airport fee
- Fee for passengers
- Personal fee
- Airplane charging fee
- Airport security fee
- Maintenance cost

Starting and landing fee depends on Maximum Take Off Weight, Airline company have to pay airport landing fee depending on the weight of the airplane. If the airplane weights 60-70 tons then Airline company pays on average 150-200 euro of landing fee in the European Union.

Next, airline companies pay noise surcharge for some big airplanes like Boing 747, Airbus 320, Airbus 350 and some other planes. Many airline companies are buying quieter airplanes to save money.

(Source: <https://www.wiin-aviation.de/kostenfaktoren-im-luftverkehr/>)

Airplane parking fee. Airplanes are working over 12 hours per day, but at night they have to park at the airport. Fee for parking depends on how much place does the plan need. Sometimes airports desire no fee for parking.

Passengers fee. Each airline company pays airport passengers fee 0,10 till 0,15 euro per capita in European Countries. They account this fee for using Airport services, terminals, toilets and for some other services.

Security tax. Airline companies need to pay for all security services in Airport. That's mean they need to pay for luggage security, personal security, etc. Security tax depends on the number of passengers, and amount of luggage they carry.

Airline companies also pay for personnel working on the ground: at the check-in, information office, security office, for instance.

(Source: <https://www.wiin-aviation.de/kostenfaktoren-im-luftverkehr/>)

Maintenance cost is a very important part of airplane security. Each airplane needs to get maintenance control each month. Without maintenance check out airplane not allowed to be on operation. Some big Airlines companies have their own Maintenance services. Small companies and budget airlines do not have their own maintenance service, they need to give this control function to other airport service companies.

GPS Air Traffic service. Airline companies use Airport GPS air traffic service for a safe landing and take-off. This service is provided by air traffic security. Companies undertake to pay extra fees if the plane will be not on time, for delay and for cancel of flights.

Airline companies are buying Avgas direct from airport. Some big companies have their own maintenance and petroleum services, but many companies use airport service. Avgas price during the time is fixed. Companies conclude a contract with the Airport, that freezes the price of Avgas for the time, stipulated in the contract. That's why Avgas price changes do not play a big role in ticket price formalization. Avgas price fluctuations are related to the currency exchange rate. Old airplanes use much more Avgas than new airplanes. In some direction, where passenger traffic is low, companies using small airplanes, due to it airline companies can reduce costs.

Competition between low-cost and full-cost carriers

Low-cost carriers have changed the environment of air transportation. Competition became harder, price formalization became more relevant and volatile. Rarely there is a single company, serving the connection.

After setting its prices within reasonable limits, the airline company would not use yield management and will pay attention to cost minimization and income maximization management, because its value offer and customer experience it sells are unique. Due to this reason monopoly airline company would try to cover the demand of time-sensitive passengers and at least half of the price sensitive or leisure travelers. The best example of this type of market is the Vienna-Frankfurt route. Airline companies want to cover time-sensitive and business traveler's needs.

On the market where only two independent companies offering the same services and goods market price will change but mostly for business class, but the price for an economy class will stay the same.

Situation change if on the market are only one low-cost carrier and one full cost airline companies. In this situation, the low-cost carrier offers only one type of product—only economy class and full cost airline offer two types of product — economy class and business class. Price formalization for business class and for an economy class will stay like it was in an oligopoly market with two full cost airlines companies. Full cost airline company will not change prices for economy class, but it can change prices for business class, to keep customers with it.

(Source: <https://papers.tinbergen.nl/04074.pdf>)

Spanish low-cost carrier Vueling Airlines

Vueling is a part of International Airlines Group like British Airlines. It was founded in 2004 in Barcelona. Vueling is Spanish low-cost airline companies. First few years this company fly only local airports, but during the first 4 years this airline company got a good reputation and now they are having more international routes. Vueling name comes from the Vuel which means in Spanish flight and -ing.

(Source: <https://en.wikipedia.org/wiki/Vueling>)

In 2008, the Government of European Union has settled to merger two Spanish low-cost airlines Vueling and Clickair. After big discussion, they decide that Clickair will be part of Vueling therefor Vueling get from Clickair all his airplanes Airbus A320-200 and personal.

With the time Vueling got new routes and a new home airport. Now Vueling has his basis not only in Barcelona but also in Madrid, Paris, and Amsterdam. Till 2012 Vueling had a big competitor Spainair. After the bankruptcy of Spainair got Vueling more power and become the largest local airlines company. In 2011, not only Spainair had problems but also Vueling. The price of petrol went up by 40% in the first quarter of 2011. Fuel for the company became a bigger part of the expense and at the same time demand went down because the first quarter of the year is low season for all airline companies. Higher bottom line and lower revenue have not allowed Vueling to make any profit, on the opposite, they had over 127 million euro of loss. They manage this situation remarkably, having cut a part of full cost. They cut personal cost, reduce flying, made optimal and interesting offers for customers, they introduce Vueling to Vueling flights, so passengers can fly from Barcelona to Madrid and then from Madrid with the same air company - to some other country. Thanks to this program and savings, Vueling got much more passengers than before. In the second part of 2011, the situation was better. Demand increased by over 17%, which helped the company to make profits.

(Source: <https://en.wikipedia.org/wiki/Vueling>)

Ticket revenue increased from 166,465 thousand euro in 2010 to 204,614 thousand euro in 2011. The price of avgas increased from 7721 dollars per tonne to 1,058 dollars. 2011 was hard for low-cost carriers, but in 2012 as we know Vueling took the Spainair market share and aircraft. In 2012, he became the major local low-cost Airline company. Revenue became from

863,5 million euro in 2011 to 1102,6 Million euro in 2012. As we know 2012 was very hard year for many international companies and for Vueling either. Revenue goes up to 27,7%. Net profit for Vueling in 2011 was 10,4 million euros and in 2012 was 28,3 million euros. It has shown more than a double growth of 172,9%. Till now Vueling is cutting all extra cost, in May 2018 246 Vueling flights were canceled because Pilots and other board employees wanted to become more salary. Each year more employees leave this company because managers want to cut cost everywhere and employees earn less money than they can get in some other low cost or full cost airline companies.

(Source: <https://en.wikipedia.org/wiki/Vueling>)

Annual report for Vueling in 2015 was great. They achieve target market, revenue, the increased capacity by 14%. The main reason that Vueling success is that there are using two types of aircraft. There are Airbus A320 and Airbus A321. There are only 8000 aircraft of model Airbus A320 in the world. First Airbus 320 was created in 1984, it has 168 or 180 seats, which is the perfect size for low-cost companies because there are flying only in small- or middle-length routes. Airbus A321 is suitable for middle and short distances. Aircraft can fly nonstop till 5.950 km, has maximum 220 seats. It is practical for airline companies, they can have business class seats, economy class seats and reach high gross income on the flight. Next important source of income is goods sold by attendants on the board, like sweets, perfumery, and jewelry, which can bring the company extra money. Vueling sells also onboard internet, which is new in the market, but they have already started in 2015.

*(Source: <https://de.wikipedia.org/wiki/Airbus-A320-Familie>;
<https://de.wikipedia.org/wiki/Airbus-A321-Familie>)*

Aiming to innovate for their customers, Vueling has implemented solution to make it easier to buy tickets, they need only to download Vueling app. With the help of this app, everybody can buy a ticket and get more points for the next purchase. As we see in the annual report of Vueling 60% of Vueling customers are flying from other European countries to Spain, that's why they are trying to make Vueling offers more attractive for customers on the international market. Nowadays the main problem to solve is seasonality. Traditionally, in low season, less capacity is used and personnel costs are reduced and in high season the number of flights is increased and the number of employees accordingly. More Vueling customers are from a price-sensitive market segment that is why they need to develop a market strategy concentrating on price reduction.

Javier Sanchez Prieto, chief executive Officer of Vueling, wanted to import every time something new in strategy. He means that due to innovation Vueling will always be a leader in the Spanish airlines market. Performance in 2017 compared with the one in 2016 is much better. Revenue of Vueling has increased by over 2.9% compared to 2016. Operating profit growth 213,3% is another positive indicator. In the future, the company wants to increase the operating margin from 12,7% to 15% by depreciating the leased assets. (*Source: Annual report and accounts 2017- International Airlines Group; pdf*)

Iberia: flag carrier airline of Spain

Iberia is the oldest and historical air company in Spain. His history started on 28 June 1927. The Spanish government was the investor of Iberia, and the airline was under government control. With the help of Iberia, people could fly from Madrid to Barcelona and back. The head office of Iberia was in Madrid.

During the second world war, Iberia was a part of German airline company Lufthansa. At 1939 Iberia started his regular flights to Lisbon. In 1940 Airline company has performed flights to Spanish North and Spanish West Africa.

(Source: [https://en.wikipedia.org/wiki/Iberia_\(airline\)](https://en.wikipedia.org/wiki/Iberia_(airline)))

From 1940 to 1946, Iberia was the only air company in Spain and owned the whole market. The government gave monopoly of airline industry to Iberia. Situation changed after 1946 when government change his decision and they open airline industry market for all private companies. Company used at that period aircraft DC-3 and DC-4. After second world war Iberia was the first airline company who flew from Europe to Buenos Aires. By means of these changes, political connection between these two countries were more stable. With the time, Iberia became more powerful and the company get the of Aviace Airlines. Iberia get two parts Local Iberia Airline and International.

In 1979s Iberia started his Cargo service. They bought two new types of aircraft Boeing 747, DC 9. Boeing 747 is like Jumbo-jet. Producing Boing 747 started in 1969, it has more than 460 seat places for long routes. DC 9 is much smaller and has only 75 seat places. DC 9 was produced since 1965. This vehicle was for short and middle distance. Buying Boing 747 was not a good idea for Iberia. First, they need to have a high demand, because this vehicle has over 700 seat places, then they had a big discussion with The Boeing Company, because of money, Iberia wanted to have his provision back.

(Source: [https://en.wikipedia.org/wiki/Iberia_\(airline\)](https://en.wikipedia.org/wiki/Iberia_(airline)))

For Iberia the 1980s were unsuccessful. They had PTA of over 9 million, which was terrible for the company. Demand was so low in 1982 that only 10% of all flies was booked. After the financial crisis in the company, pilots and other board personnel wanted higher payment, that is why they stopped to work for more than 3 weeks and all flies were canceled.

In 1990's situation was better than in 1980's. Iberia company wanted to get some financial help from government of Spain. Without this financial help, the company could not survive. They reduced working places, but it was not enough. In 2012 Iberia has signed a merger contract with British Airlines. Later AIG open Iberia express, which is a low-cost airline company for middle and short direction.

After 1990s Iberia was oriented to Airline Companies in Latin America. The Company bought stakes of 3 Latin America Airline Companies, like Aerolineas Argentinas, Ladeco and Viasa. Iberia gave the second life to Argentinean Airlines. They implemented know-hows that were not used in Latin America. After all changes government of Latin America note that the Iberia control whole situation in airline business in Latin America, which was not possible.

Iberia Express uses only Airbus A320 and Airbus A321, which are perfect for short and middle distance. They have on the board approximately 180 to 210 seat places, which is more than enough for low-cost carrier flying only on middle and short connections. For this aircraft, company do not need many personnel on the board.

For Iberia express Air France and Air Europa are big competitors. According to the annual report of Iberia in 2017 revenue of this company has grown by 6,8%, which is a great number for this company. They were more effective than Vueling because they have only 2,9% more and so Iberia has changed its place in AIG group. Operating profit in 2017 was 38,7% more than in 2016, which indicates that company performed well in 2017. From the point of view on flights' punctuality, which is very important for this business, Iberia has statistically 90,0% but Vueling only 79,9%. In 2017 Iberia became the most punctual airline in the world. Another important indicator is fuel efficiency, and statistically, Iberia has 83,3% Co2/km and Vueling - 84,5%.

(Source: [https://en.wikipedia.org/wiki/Iberia_\(airline\)\)](https://en.wikipedia.org/wiki/Iberia_(airline))))

International Airlines Group

International Airlines Group was founded in 2011. IAG airline holding, where include British and Spanish airline companies, like Vueling, Avios, Iberia, British Airlines, IAG Cargo, Aer lingues. International Airlines Group is registered in Spain, but head office is in United Kingdom.

International Airlines Group has in 2017 in top ten largest companies in the world. Revenue of IAG was more than 22.00 billion euro. It has all started in 2010 when British Airlines and Iberia created IAG Holding in Madrid. In 2012 holding bought Vueling. Which is Spanish low-cost Carrier. 3 years later they pay more than 1,5 billion euro and have bought Aer Lingus, which was the second biggest airline company in Ireland. Aer Lingus was under government protection. IAG had part of Austrian Niki Low-Cost Carrier. (https://de.wikipedia.org/wiki/International_Airlines_Group)

As they started IAG holding in the first year, they had only 485-million-euro net profit, and now situation is different - in 2017 they have made four times more than in the first year - net profit was 2021 million euro. In its annual report, the International Airlines group shows that they managed the business clear and correctly. Each year was better than previous year, net profit grows up, each year demand goes up, they have more passengers.

Air Europa

Air Europa is some of the largest airlines in Spain. The main Competitors of Air Europa are airline companies of AIG (Iberia, Vueling). Company was created in 1986 in Spain. This company was never under government protection that's why time to time has some financial problems. Air Europa enter to the Airlines business after liberalization airlines industry in Spain. 75% shares of Air Europa have Spanish bank 15% shares have ILG-Air Europe Group. After 1990, the company was sold. It was the first airline private company in Spain. In the 1990s company was very successful and they could enter to international business. They started to fly London-New-York route. Air Europa used aircraft Boeing 737, which is for 220 passengers and this vehicle is good for middle and sometimes for long distances.

(Source: https://en.wikipedia.org/wiki/Air_Europa)

Air Europa had part of stakes of Air Dominicana. It was the first Airline company who fly direct to China. Nowadays Air Europa flies to Frankfurt, Munich, Florida, Miami, Madrid, Mallorca, Brussels, etc.

After 2007 Air Europa became a part of Sky Team, created as an airline alliance in 2000. Nowadays Sky team includes over 20 airline companies as members. Sky Team members are all over the world lie Aeroflot, who join Sky Team in 2006, Air France, Delta Air Lines, Korean Air, and Airmexico were first companies who join Sky Team in early 2000. They are airlines from Czech Republic, Kenya, Saudi Arabia, Vietnam, Spain. Sky Team also has cargo service.

Competition between airlines and high-speed rail on Madrid - Barcelona route

Madrid-Barcelona route is one of the largest routes in Europe, not because of distance, but because of number of transported passengers a day. Distance between these two cities is more than 623,9 km, by car or by bus it is more than 6 hours, by high-speed rail is 2 hours and 30 minutes, by plane it is less than 1 hour and 20 minutes.

More popular and comfortable for passengers are air and high-speed rail transportation service. Daily there are more than 20 flights from Barcelona to Madrid. In this route, there are three Spanish airline providers: Vueling, Air Europa, and Iberia. All three providers are low-cost carriers. Mostly ticket price for this route is higher than airline ticket price. There is only one high-speed rail provider - RENFE.

Before high-speed rail entered the transportation system, a passenger would spend more than 5 hours traveling by train. First, high-speed rail was launched on this route in 2008 and became one of the biggest competitors for Airline industry.

Due to technological innovation in railway industry RENFE became new high-speed rails, which reduce the total journey time from Barcelona to Madrid, now it is 2,5 hours less than it was before, and at the same time, it became more enjoyable to travel by high-speed rail.

More than 60% of the population of Madrid and Barcelona are living near the city center, due to the source of Instituto Nacional de Estadística. That means that travelers before and after flight need to take the subway, car, train or bus for getting to the city center. The situation is different for train travelers, because most railway stations are located at the city center, passengers need not take other vehicle to get the city center.

All Spanish low and full cost companies do not have government protection. They pay all airport fees which require AENA operator. All airports in Spain, some airports in Cuba, Colombia, United Kingdom and in some other countries are under protection of AENA. AENA was founded in 1991. This holding manages security control at the airport, security of air traffic, etc.

RENFE high-speed rail company is under government protection. Management of RENFE must discuss all changes and future plans with government. ADIF company manages the railway infrastructure.

Barajas airport of Madrid is the biggest airport in Spain. Daily this airport has over 54 million passengers. El Prat Airport in Barcelona is second biggest airport in Spain. This airport was in 1918 opened. Daily it has over 47 million passengers. It is the main airport for Catalonia.

Public transportation is well connected with these two airports. By subway passengers can easily arrive to the airport, it will take no longer than 15 minutes, but terminals in Barajas airport are enormous and passenger need approximately 10 minutes' walk time to get from one terminal to the airport subway station.

El Part airport Barcelona till city center passengers can take the subway, bus or train which will take 15-20 minutes to the city center of Barcelona.

All this calculation shows that it takes passengers more than 2 hours to travel from the city center of Barcelona to the city center of Madrid. At the same time, passengers need to be at the airport minimum 30 minutes before the flight for registration, check-in, safety control, etc. All together travelers need more than 2hours and 30 minutes.

Flight duration is only 1 hour and 20 minutes, but all passengers need over 2,5 hours to travel from city center of Barcelona to the city center of Madrid.

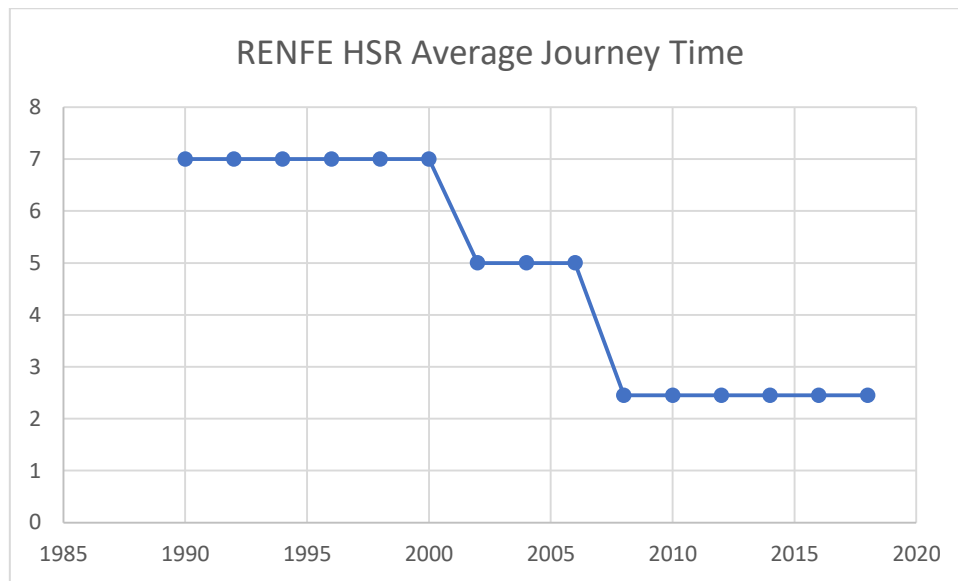
In Madrid and in Barcelona railway stations for high-speed rail are at the city centers or close to the city center. That's why total journey from city center of Barcelona till the city center of Madrid will take 2 hours and 30 minutes.

This information shows that which the help of high-speed rail or airplane passengers need approximately same amount of time for getting from city center of Barcelona to the city center of Madrid.

Over 50% of high-speed rail passengers are business travelers. Traveling by train is more comfortable because passengers need not to be at the station 30 minutes before the journey starts. They need not to pass the security control, to check in and what till the can take their seats. It is much easier if they travel by train, passengers need to be at the station 10 or 5 minutes before the trip and it is uncomplicated.

Therefore, there is no difference in journey duration between airplane and high-speed rail. During last 3 decades, technology in railway manufacturing was changing. This change is more visible on the graph

Graph 8. HSR average journey time



(Source: http://www.renfe.com/docs/2010_Economico_ing.pdf)

HSR change all traffic situation. Till 2000 Barcelona Madrid average journey time was over 7 hours. Management for RENFE wanted to change this situation that's why they bought new high-speed rails in early 2000s. With new Rails, situation was better. Situation changed and average journey was less than 5 hours. Nowadays passenger save over 5 hours for this route because average journey time is 2 hours and 45 minutes instead of 7 hours, which was in early 90s.

RENFE has over ten high-speed rails per day in Barcelona-Madrid route. Sure, that high-speed rail has more capacity than low-cost carriers, but at the same time, Eurostat shows that's much more people prefer to travel by plane than by high-speed rail, that is a reason why daily flights are much more than daily trains, although high-speed rail has much more capacity than an airplane.

In the 1990s in Barcelona-Madrid route, there was the only low-cost carrier - Vueling. Iberia was a full-price airline company, which time to time reduce his tickets prices for be compatible with other low-cost carriers. Iberia is significant with his great catering service on the board. Air Europa is new in this route and it has just 14 percent of daily flights, more 20 percent of daily flights has Vueling and 66 percent has Iberia. Air Europa has only 2 or 3 daily flights.

Spanish government want to change transportation situation in this route. They want that most passengers travel by train and to reduce the percentage of air transportation.

Competition between low-cost airlines and high-speed rail.

Competition between this low-cost Airlines and high-speed rail exists because of many factors and, first, because of historical factor and liberalization in the Airline business. Airline Industry started in the early 1990s. Before the liberalization in the airline industry, there were not so many airline companies. In each country only one or two carriers, which were under government protection. Rail industry are older than Airline industry. Till now railway industry is not completely liberalized. This is a reason why between different High-Speed Rail Companies or holdings are no competition. Each company has almost equal prices for the same routes.

Till liberalization Airlines market where no competition between High speed rails and full cost airlines. In middle and short routes was always better to take high-speed rail. First, high-speed rail in the short and middle distance are cheaper than full cost airlines. Second, total journey time, including waiting time, travel time, arriving to the city center, was almost the same. That is why so many people prefer to travel by train than by full cost carriers. For the long-distance flying was better than traveling by train. Total journey was shorter if passenger prefer airplane, and it was many saving either.

There are few people, who do not want to fly, for them, it is more comfortable to travel by train, or they want to reduce CO2 emissions or are afraid of flights, also socioeconomic characteristics of passengers are important.

In 1990 Airline market in Europe started liberalization program. With the help of liberalization many new private companies had a chance to enter this business, which changes the whole situation in European Airlines Market. In 1992 came first Low-Cost-Airlines. LCC was and now are the major competitor for full cost airlines and for high-speed rails. After LCC enter the transportation market, ticket prices for transportation change either. Airline industry started to use yield management for ticket price formalization. Last few years rail industry wanted to adopt yield management either, but till yet they do not have so correct adapted yield management.

The economic situation of infrastructure is very important. It matters if people have enough money to travel, how high is GDP, which main industry they have, population. Air and

railway industries support over 40,5 million job places. There is a positive relation between industry and air and rail traffic. For example, in Germany the biggest industrialized city is Frankfurt, where are big financial and industrial institution. Aerial and railway traffic are both high in Frankfurt. They have the fourth biggest airport in the world and big railway stations. In Frankfurt 70% of passengers are business travelers, they are time- sensitive, air or train ticket price is not so significant for them, it is more important to be on time at that place. From Austria, Vienna is only two airline companies flying from Vienna to Frankfurt and back. There are Austrian Airlines and Lufthansa. This route is monopolized. These two companies belong to one holding. Prices for a ticket for this route are same for both of companies, and it is high. Price for tickets is so high because, as we note later, 80% of travelers are time-sensitive, because of it this two airline companies offering higher ticket prices.

There is no high-speed rail connection in Vienna-Frankfurt route. There are two railway companies OEBB and Deutsche Bahn. Tickets for this route from this two companies are similar because there are both under government protection. Rail ticket prices are much cheaper than airline ticket price for this rout. Direction by plane is only 1 hour 20 minutes than by train it is 8 hours. The difference, which makes 6 hour 40 minutes is too much for time-sensitive passengers. Between airline ticket price and a train ticket, there is the price difference of over 150 euros, which is a lot for price-sensitive people. However, price sensitive passenger will travel by train, and time-sensitive passenger will travel by plan. In both industries (airline and trail) in this rout prevails monopoly. There are no low-cost airline companies for this rout.

In the last two decades, tourism industry was growing. More and more people like and they can afford to travel. Here is the positive correlation between these two factors, first, because of low-cost airlines and high-speed rails more and more people can travel, and not only once a year, they can do it often. At the same time, we can note that the economic situation in the world is better now, and people can afford more than for 20 years.

One more major factor that changes situation and price formalization in the airline industry and in the rail industry is technological advancement. Due to technological advancement, we have now high-speed rails, which change transportation duration, now it is much faster than it was for 20 years.

The political situation plays a very important role in both railway and airline industries. If the country is not secure, few people will travel. There are many countries that because of war or political unstable situation air and train travelers' percentage goes down. The best example is Egypt. For two years, the political situation in Egypt was very unstable, that's why many airlines canceled charter flights, demand went down, nobody wanted to have a vacation. Now situation is better than in the past two years and some part of travelers prefer a vacation there.

With the help of right marketing strategy, some countries have more tourist, which is perfect for the economic development of the country and for the transportation industry. Tourist look first what type of journey they can have in different places. It can be historical, site seeing, water sport, winter sport, devotion. After choosing the destination, people look at the reputation of that region, if there are many gentle and friendly inhabitants, what role religion plays in this country and how they can get there, which type of transportation they can use, how expensive will be the journey.

Countries need to understand do they need do they want to have many visitors or not. The government must have a right tactic, they need to have right infrastructure, strong transportation service, airports, high-speed rail station, bus station, railway station. It is important to have a good reputation all over the world, tourist orientated, make the country interesting for others. Each country due to his political, historical, economic situation chooses which type of tourist do they want to have. Tourism can change and make economic situation of the country better; different industrial sectors will prosper. It helps to develop and have a perfect transportation sector, gastronomy, roads, tourist invest money in countries.

In many Asian and African small countries transportation infrastructure is at a low level. They do not have high-speed rail infrastructure - only a few airports, sometimes they do not even have direct flights. Here are factors that change the whole situation and reasons that some countries have more tourists and other not at all.

The relation between airline, railway industries, and tourism are tangible. Due to this aspect, many countries invest finance in aviation and railway industry. They built new airports, roads, railways which give high visible impact in tourism. Well, integrated transportation industry will enter barriers lower in this industry creating a perfect market competition. Bilateral agreements will help movement local airlines and high-speed rails in the international market. Local airline companies will develop and produce more effective production and service.

Technological advancement makes a big movement in aircraft and high-speed rails industry. Due to technological advancement would produce more airplanes of a new generation and moreover, technological advancement imputes in our internment new transportation engine, which is the high-speed rail. This change made transportation industry more compatible. Private low-cost airline companies had a chance to order new aircraft, which will be not so expensive.

Production process are now more cost efficient. Technological advancement made it possible to order such aircraft that they are cost efficient. Companies can order from airplane producers what they wanted to have in an airplane. Low-Cost Carriers cut their costs reducing luxury equipment on the board: they do not order high tech televisions for passengers, do not use modern computer systems on the board. Concerning technical parameters and quality of the engine, cheap version of aircraft and luxury aircraft are the same.

Airplane industrial companies have started to produce more middle and small airplanes, which will have up to 250 seat places. These airplanes are special for low-cost companies which fly mostly on short or middle distance.

Model of ticket price formalization of high-speed rail and low-cost carriers

For analyzing ticket price formalization changes in the high-speed rail industry and in low-cost carriers' segment, it is very important to know which factors can change them and how the companies manage them. Regression between these two industries will be difficult to make because they both have different price formalization tactics and methods. All over they have some common points that affect price formalization of these two industries.

First of all, the airline industry buys AV-Gas for transportation. Most airline companies have fix contracts with airports, but some of them have only short-term contracts. The price of Av-Gas is not stable, it changes all the time. Companies trade Av-Gas only in American dollar. Exchange rate of USD to Euro fluctuates daily, that's why the price for the AV-Gas barrel changes every day and it can be more or less one of the main factors that change the price structure of airline tickets.

In the airline industry, every company uses yield management. Ticket price changes because of the ticket price of competitors. In this route, there are 3 airline companies and one high-speed company, all these companies compete with each other. All these companies have different prices for the same service.

Tickets' prices depend on the time of flights and how many companies offer the same service at the same time. During the expedition revealed that Air Europa has flights from Barcelona to Madrid only 2 times a day. The ticket price for Air Europa was always higher than for all other airline companies and sometimes higher than for the high-speed rail.

High-speed rail uses price formalization model for railway tickets different from that of air companies, but they have some common points of yield management. Full-cost carriers and low-cost carriers are big competitors for high-speed rail. One of the main drivers of ticket price formalization in these two industries can also be flights' and trains' frequency. Summarizing the above, most important factors that can influence and change ticket price formalization of airline and train industry are the following:

Flights - some airline companies are flying more than 20 times per day. Of course, it depends on the weekday. Mondays and Friday some airline companies are flying two times more than on Saturday and Wednesday.

Currency- It changes the price of AV-Gas. Some companies have short-term Av-Gas contracts with the airports. Every time when they get a new contract the price of Av-Gas will be not the same. That's why one of the main ticket price influence factors can be currency. If the exchange rate between US-dollar and Euro change the price of Av-Gas will change with it.

The main point is that if US-dollar exchange rate will go down compared with Euro, then Av-Gas price will go down. But, if US-dollar exchange rate will go up compared with euro than Av-Gas price will go up. All gas and oil companies in the world are trading only in US-dollar currency. That's why, all European companies who are trading or using these products, have to control and keep under control exchange rate.

Airline and rail companies are always checking the price of the same product as the competitors. There are many companies in transportation business, and they offer the same price for the same product or service. This is one of the main reasons why all companies need to compare prices of all companies.

Taking into consideration the described interdependencies, we suggest the following model, including all the above factors, for the ticket price formalization of Vueling:

$$(Q_{ng})P_{vul} = \alpha_0 + \alpha_1 P_{iber} + \alpha_2 P_{Air} + \alpha_3 P_{zug} - \alpha_4 F + \alpha_5 C \quad (1)$$

This model contains the following variables:

P_{vul} denominates the ticket price of Vueling Airline company.

P_{iber} - ticket price of Iberia Airline

P_{zug} - ticket price of RENFE company

P_{air} - ticket price of Air Europa Airline

F - the frequency of trains and flights per day

C - the US-Dollar to Euro exchange rate.

The variables were studied during the last 3 months, and for the ticket price formalization in Vueling company, we have received the results, which we are discussing farther in this part.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	5	3918,22	783,64	10,94	0
iber	1	2841,77	2841,77	39,66	0
erop	1	170,43	170,43	2,38	0,132
zug	1	889,16	889,16	12,41	0,001
flights	1	3,6	3,6	0,05	0,824
currency	1	1,11	1,11	0,02	0,901

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
8,46433	59,65%	54,19%	37,45%

Regression Equation

$$\text{vul} = 8,5 + 0,3966 \text{ iber} + 0,1165 \text{ erop} + 0,1975 \text{ zug} - 0,050 \text{ flights} - 2,2 \text{ currency}$$

Results show that p-value for Vueling (price of the Vueling airline ticket) is lower than 0.1. Hence, Null-hypothesis is rejected.

Next, correlation of flights and currency exchange rate is negative, they have a negative sign, meaning that if the exchange rate of the dollar to euro goes down, then Av-Gas price will be cheaper. That is why currency in this regression has a negative sign.

The coefficient of flights also has a negative sign. Explanation of this fact is obvious. If companies have more flights then demanded on the market, then the price for a flight would be cheaper. Because They would not have so many passengers on the board, and due to cheap ticket prices, they can get more price-sensitive passengers.

VIF value is low, which shows that there is multicollinearity, but it is not so high. Which is normal for the airline industry.

P-value for Iberia, Zug and Vueling are very low, almost zero, but for Air Europa, flights and currency near and over one. Due to this factor, it is explainable that ticket price for Vueling does not deplane price composition of Air Europa. The conclusion we make is that Vueling by creating his own ticket prices does not view Air Europa as a competitor.

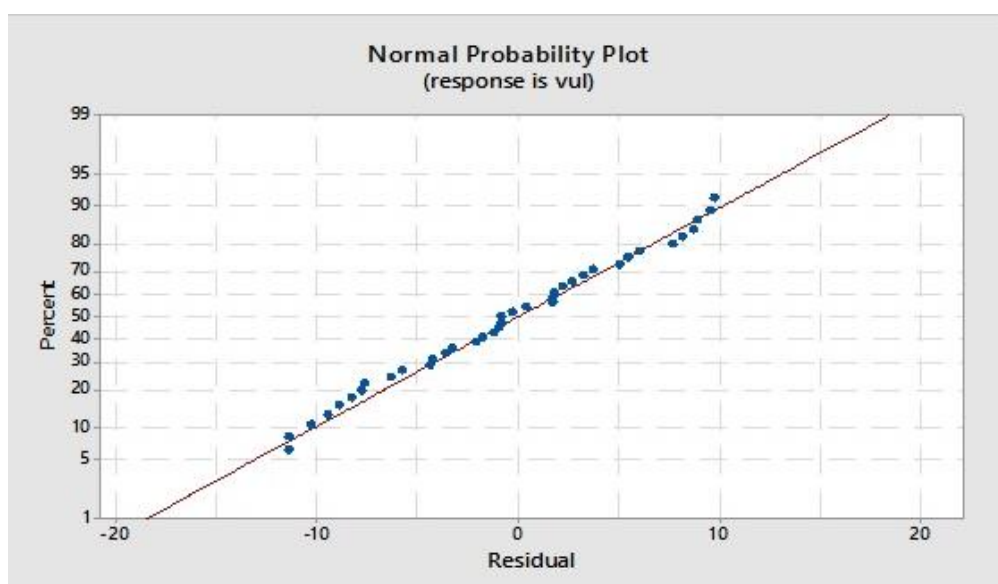
Currency does not influence price formalization, because Vueling has to fix a long-run Av-Gas contract with Airport in Barcelona and Vueling' head office in Airport of Barcelona.

Due to research, it became more obvious that Vueling company has more or less fix flights structure. Per day during whole summer 2018 they have form 15-20 flights per day. Consequently, the frequency of flights does not change the ticket price formalization of Vueling.

For Iberia and Renfe P-Value was significant, it was closer to zero. That shows that ticket prices of Renfe high-speed rail and ticket prices for Low-cost carrier Iberia influence price formalization of ticket prices of Vueling.

In this route, the three companies have more value and they are big competitors. During researches was visible that companies have the more flights and they ticket prices for this companies was approximately same for the same fling times.

This regression shows that null-hypothesis is rejected. These two companies are statistically important for the price formalization of Vueling Company. R-sq is more than 59 which is high and means that this model can be used for further research. R-sq(adj) is more than 50 %. This factor shows that this model is significant and on the following graph, it is demonstrated that all of these components have a significant influence on price formalization of Vueling.



Statistical Model of price formalization in Iberia

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	10646,1	2661,52	11,35	0,000
vul	1	9188,6	9188,64	39,17	0,000
zug	1	2055,4	2055,42	8,76	0,005
flights	1	120,7	120,74	0,51	0,477
currency	1	3,0	2,99	0,01	0,911

This model shows which factors influence tickets price formalization of the Iberia. Iberia is a flag carrier airline company in Spain. Iberia like Vueling is the main airline company in the Barcelona-Madrid route. There are many factors that influence of the price formalization of Iberia and some of this factor are included in this statistical model.

Like Vueling, Iberia is one of the biggest airline companies in Spain and they have long run contracts with Spanish airports. Because of this reason exchange rate dollar to euro change in AV-Gas contract between companies and Airport nothing, that's why P-value of currency is almost one, which shows that this component does not change price formalization of Iberia. The second important factor is that low-cost airline companies are working with the help of another concept. For the ticket price formalization, they did not calculate how much effort did they do, for airline companies is more important highs income due to involvement more passengers.

The frequency of flights is also higher than zero, which shows that this factor does not affect price formalization model of Iberia.

P-value of Vueling and Renfe are close to zero which shows that price formalization of Iberia directly depends on ticket prices of the two companies. They are significant.

Vueling and Iberia are the main competitors in this route. Only these two companies have more than 10 flights per day, to compare to Air Europa which has only 2 times per day.

Statistical model which include ticket prices of Air Europa make worse this whole model, because of this factor ticket prices of Air Europa does not include on this model.

To sum up, the model has proven through R-sq, which is higher than 50 percent and meaning that this model is significant and could be used for reliable conclusions. R-sq(adj) shows that there are many other factors that can influence ticket price formalization of Iberia.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
15,3158	54,43%	49,63%	38,78%

Regression Equation

$$\text{iber} = 32,2 + 1,266 \text{ vul} - 0,311 \text{ zug} - 0,286 \text{ flights} - 3,5 \text{ currency}$$

From the regression equation, it is clear that ticket price of Vueling goes up ticket price of Iberia goes up either. If the ticket price of the train, the frequency of flights and the changing rate of currency goes down the ticket price of Iberia will go up.

Statistical Model of price formalization in Air Europa

This Airline company is in this market for many years. Nowadays they did only two flights per day. All this information about flights was created due to information of official webpages of this airline companies during 3 months.

Air Europa has different price formalization structure then all these companies.in this statistical model is clear that none of these factors does not influence of price formalization of Air Europa. P-value of all these factors is much higher than zero. This means that there are no connections between these factors and price formalization structure.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	5	1413,9	282,779	0,89	0,500
vul	1	759,0	758,960	2,38	0,132
iber	1	262,3	262,323	0,82	0,370
zug	1	134,6	134,627	0,42	0,520
flights	1	141,8	141,833	0,44	0,509
currency	1	374,3	374,286	1,17	0,286

The model summary shows that other variables are influencing price formalization of Air Europa. These variables were not included in this statistical model.

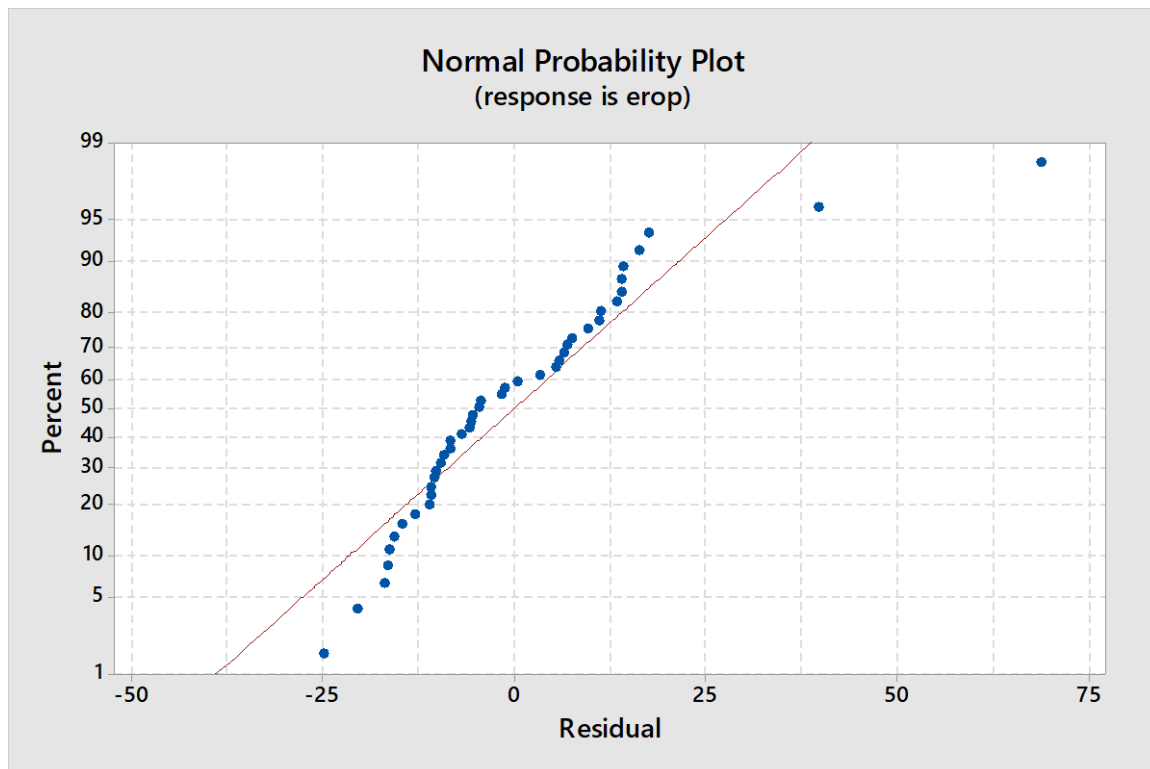
Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
17,8621	10,70%	0,00%	0,00%

Regression Equation

$$\text{erop} = 100,1 + 0,519 \text{ vul} - 0,172 \text{ iber} - 0,088 \text{ zug} - 0,312 \text{ flights} - 38,9 \text{ currency}$$

The results are better illustrated by the following graphic:



During researches was clear that the price of Air Europa does not have any connection which price formalization of other companies. Air Europa has only two times per day flights from Barcelona to Madrid. These flights were mostly in the evening. This factor stays stable during researching. Next factor is that the ticket price of Air Europa was much higher than the prices of all other companies.

Due to this statistical model is also clear that Air Europa does not use yield management on this route, because there is no connection between price formalization of competitors. From this we conclude, that other maintenance costs of air Europa like all other companies has a long-run contract only with these two airports.

Another factor like currency does not influence price formalization. This company has long run contracts with both airports, and all other maintenance costs are regulated according to these contracts. To conclude with, this statistical model could not describe the methods of price formalization in Air Europa.

Train ticket price formalization

Train price formalization depends on many factors. Mostly, train companies have different price formalization structure than airline companies. Till 90s train companies choose the train ticket price due to maintaining cost. They did not use revenue management; the number of passengers did not matter. One of the main factors of choosing this price formalization method is that till 90 almost all train companies were 100 percent under government protection. After 90s many European countries started liberalization of this market segment. Till now this program is not finished.

In many European countries train companies trying to use the same price formalization system like airline companies. German train company in the early 1990s tried to used yield management, but it did not work, because there are some more factors like infrastructure that changes ticket price formalization structure. Nowadays they change price formalization model, mostly they use some part of yield management but not all.

Regression Analysis: Train versus vul; iber; flights; currency

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	6882,4	1720,59	3,79	0,011
vul	1	5540,5	5540,51	12,19	0,001
iber	1	3981,1	3981,13	8,76	0,005
flights	1	12,9	12,94	0,03	0,867
currency	1	577,8	577,81	1,27	0,267

This regression shows that ticket price of Vueling and Iberia influence price formalization of the train ticket. The frequency of flights does not influence of price formalization of RENFE. Before, in other regression was also clear that flights frequency does not change price formalization. This variable does not influence ticket price formalization of any of the three companies. Further Currency does not change the price formalization structure, because high-speed rails do not use Av-Gas or some other types of oil. There is an ecological safety

transportation vehicle, and they use only electricity. Train frequency has also high P-value, which explains that train price formalization does not connect with the frequency of the train.

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
21,3154	28,50%	20,98%	15,08%

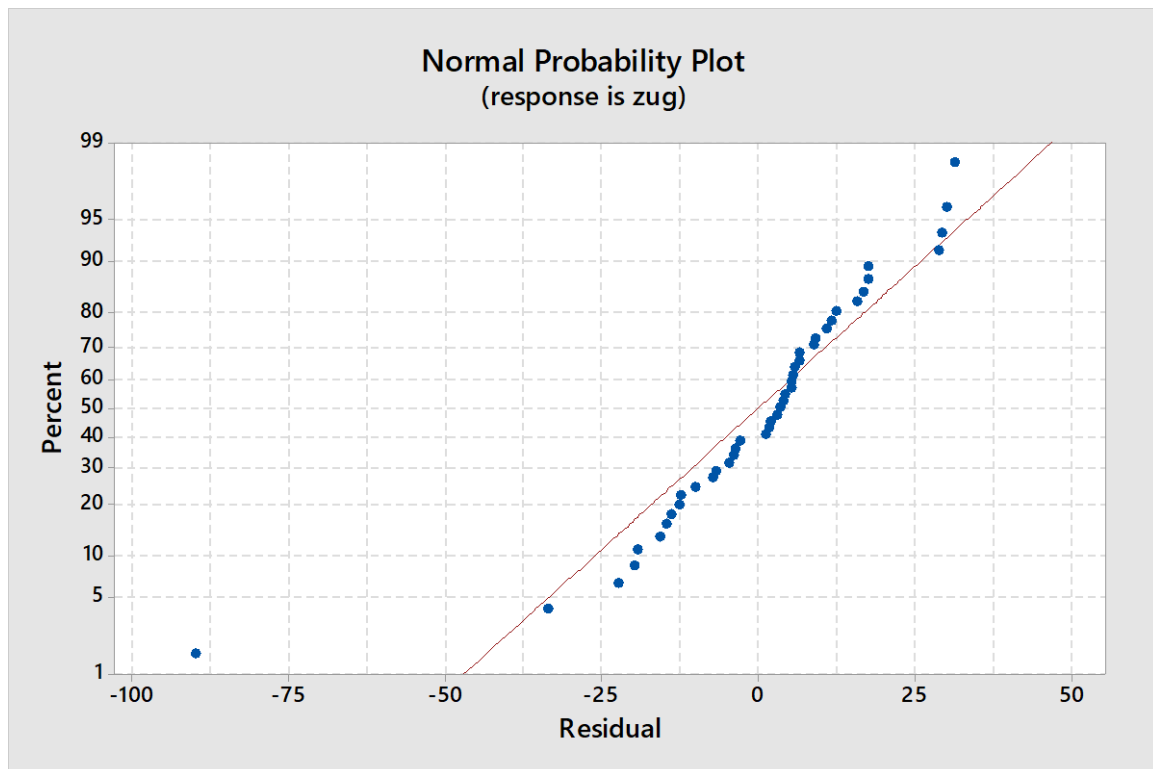
In Model summer is clear that there are much more factors, more than 70 %, that change, and influence train ticket price formalization. At the same time, these variables which were included in this statistical model have strictly influence ticket price formalization of the Renfe.

$$\text{RENFE} = 6,9 + 1,219 \text{ vul} - 0,602 \text{ iber} - 0,094 \text{ flights} + 47,5 \text{ currency}$$

In this model is clearly visible that ticket price of Renfe will increase if the ticket price of Vueling increases. If the ticket price for Iberia will decrease then ticket price for the train will do the same.

Another factor is that railway companies are under government protection, and they do not need to care about income to the same extent as private airlines, because the owner of the train company is not a private person but the government.

Nowadays they try to open the train market for privet persons, but till now it was possible for short-run direction, but not for long run routes. With the time, if the privet sector will have a part in the long run routes, then maybe train companies will change the price formalization structure.



The graph makes it more visible, and shows that this all factors influence of price formalization of RENFE, but there are more factors that that change the structure of train ticket price formalization.

Conclusion

Transportation segment is the cornerstone of industrial sector of every country economy. In many European countries, this segment has been successfully liberalized or to avoid exaggeration, certain steps in this direction with a substantial effect were taken.

This thesis has discussed the economical differences, and competition among the railway transportation companies, low-cost carriers, and full-cost airlines. Next, environmental point of view shows that traveling by train is much less damaging the environment than traveling by airplane. Using only trains people will reduce CO₂ emissions and consequently, environmental pollution. The governments of European countries are trying to reduce, and restructure the railway industry so that more travelers prefer to travel by train not by airplane or by bus.

In the current moment, the travelers prefer airplane to the train. The main reason for this choice is that after liberalization airline industry private companies got a chance to enter this business. Consequently, because of a big number of competitors' airplane ticket prices went down, and many companies got new ticket pricing and implemented new business models.

First, when low-cost carriers entered the airline business in the 1990s, they have introduced a new business model, which gave them an opportunity to save money and have lower costs. The main airports' fees are very high that's why they choose to offer their services not only in main airports but also in secondary airports, where fees still are not so high as in the main airports.

Low-cost carriers cut many costs: they cut personal costs on the board and at the airport. Low-cost carriers started to use online check-in, due to this reform, they saved a lot of money. Mostly, low-cost airlines do not have catering service on the board, flying with the low-cost airlines mostly is not comfortable. But due to all these reforms ticket prices for airplane went down, and much more travelers got the chance to travel cheaply.

This change has also negative impacts. Air traffic grows, with it grows also the environmental pollution, because of CO₂ emission of the airplane is very high. Airline companies use yield management for ticket price formalization because all big companies have also fixed long-run

contract with all distributors and Airports. With the help of these contracts, they can keep maintenance costs under control during the long period of time.

Airline companies are using revenue management. The main goal for every company is to get airplane full, that's why for each company is very important to get information about the prices of competitors and about services that they offer.

In the long-term perspective, airplane companies did not have competitors till 1990s. the railway was not a competitor for airline companies in the long distance because of different factors. With the technological progress, the situation of airline industry has changed as well. As a new competitor, they got high-speed rails. Which were faster than conventional trains.

High-speed rails are much better than airplanes in many aspects. They do not produce CO2 emission. It is environmental safety transportation product. Due to technological changes, high-speed rails are very fast, and traveling by the high-speed rail is very comfortable. Punctuality of high-speed rail is very high, which is very important for business passengers. Another important factor for high-speed rails is that most railway stations are at the city centers. Passengers do not need to take the extra vehicle to achieve the city center.

As we have discussed above, on the Barcelona-Madrid route passengers need not more than 3 hours by train. For the government of Spain, nowadays the most important question is how to reduce air transportation level. During the last twenty years because of liberalization of air transportation system the air traffic is much higher than it used to be.

Barcelona-Madrid route is one of the most popular routes in the EU. Due to great competition between different companies nowadays people can travel very cheap. In this route are three low-cost air companies, which are very popular in Spain, and in all Europe at the same time Spain has the best railway infrastructure. Renfe is the biggest high-speed rail company in Spain. It makes possible passengers have a comfortable journey. Ticket price for RENFE high-speed rail is mostly expensive than low-cost airlines ticket. But at the same time traveling by train gives passengers more comfortable trip, and possibility to reach city center much faster than traveling by plain.

The model that each company use for formalization ticket prices is very different. Airline companies use different management for tickets price formalization from that of railway companies. Airline companies use yield management. With the help of this method managers of airline companies look when the person books his ticket is it for tomorrow or for next

week. Airline ticket price depends on the time of booking, is it workday or weekend. Statistically, airline tickets are very expensive on Monday, Wednesday and Friday. If a person will reserve his or her ticket for at that they or the day after, it means that the person is time sensitive, and is ready to pay much more money than this ticket actually costs. Otherwise, if person two or even more months are looking for a ticket, then this person is price sensitive, and for her or for him is better to get a cheaper ticket. That's why if person book tickets earlier the same flight ticket will be cheaper than if the person will book the ticket only one day before the flight.

With the help of this management companies can manipulate tickets prices and make it completely different. At the same time, airline companies trying to be competitive with other airlines and high-speed rails. They are keeping all airline, and high-speed tickets prices under control because without it they can be compatible with the transportation market.

Due to this information, the statistical model took some variables which can manipulate high-speed rails and airlines ticket prices formalization. For this model 3 low-cost airlines were taken: Vueling, Iberia, and Air Europa and one high-speed rail company RENFE.

Variables were frequency of flights and rails, currency (payments for AV-Gas have always been made in dollar, and all European countries have to change euro to dollar, only then they can procure), ticket price for different companies during three months and 3 times a day, how it changes, when it cheaper or expensive, etc.)

These 4 companies are main competitors at the Barcelona-Madrid route. Due to model was clear that variables like currency and flights and rails frequency do not play a big role at the ticket price formalization of each company. Variables like ticket price of other transportation companies were more important and they influence ticket price formalization of Vueling and Iberia. Of course, there were much more other variables that change price formalization of the plane ticket like time and day when the person books the ticket, or for what period of time they book it, is a person price sensitive or time-sensitive, etc., but main variables of that influence ticket price formalization of Vueling is the ticket price of RENFE and Iberia. The ticket price of Air Europa does not influence ticket price formalization of the other companies. Iberia has the same structure as Vueling, but Air Europa does not compete with other transportation companies. None of these variables influence price formalization of Air Europa and at the same time, ticket prices of air Europa do not influence price formalization of other companies.

RENFE high-speed rail company uses some methods of yield management for ticket price formalization. The statistical model shows that ticket prices of Vueling, and Iberia have the influence to ticket price formalization of RENFE, moreover Air Europa ticket prices, currency and train frequency do not change price formalization structure of RENFE. This company is under government protection, that's why there are much more variables that change all situation. Difference between train, and airline companies' management is that airline companies are using revenue management, the main goal is to have no free sites at the airplane. They want to get all types of passengers that's why they change ticket prices. RENFE is under government protection, and they do not use revenue management like airline companies. Railway companies calculate all costs, and due to these calculations, they have an approximate price for a place.

Our results, developed on the basis of previous research, and supported by statistical model, using the latest data on ticket price formalization, provided valuable insight, and has proven the hypothetical interdependencies, we have assumed in the European transportation market.

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