

ABSTRACT

Railways and Spanish Economic Growth

in the late 19th century.

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The object of this thesis is to examine the contribution of Spanish railways to accelerated economic growth in the period 1855-1913. Although it has not been estimated, there is reason to believe that there was some growth in the period before the 20th century but, from all accounts, it was constrained by an inefficient, highly seasonal and costly road transportation system.

The contribution of railways will be assessed in three ways. First, by estimating the cost of the non-construction of the railway network through an estimate of the social savings. This estimate suggested that the contribution of railways accounted for 12 per cent of Spain's national income in 1878 and 23 per cent in 1912. When the full employment assumption embodied in these calculations is released, social savings diminished to the 'plausible' level of 7.5 per cent in 1878.

Second, as consumers of iron and steel, railways had little linkage effects on the iron industry because they imported the bulk of the iron required to lay down the network. The implications of an alternative policy which protected the local iron industry from the beginning of railway expansion are treated at length. Railways had, on the other hand, important feedback effects upon the domestic coal production and one fifth of the coal mined in Spain was consumed by railways.

Thirdly, connections between railways and the spread of the market reveal that they were a fundamental factor in the integration of the home market. Railways carried increasing volumes of grain, flour, wine and coal consumed in Spain.

ABSTRACT.

1. The Background:

Spanish economic backwardness in the 19th century can be explained in terms of several factors: low population density, inefficient public finances, low yields in agriculture and inadequate transport. Transport was an obstacle to economic development in 19th century Spain because improvements in communications were restrained by an irregular topography and a harsh climate. The supply of transport was highly seasonal because the bulk of transport services were offered by peasants during the off-peak agricultural season. In addition, professional carters supplied specialized services all the year round except when roads were impassable during the winter. The state subsidized professional carriers and demanded a large share of their services, mainly for provisioning of Madrid.

A rapid increase in population led to the re-allocation of land from animal feedstuffs to grain. It also increased demand for transport. And by the mid 19th century, the traditional transport system came under intense pressure and failed to supply the continuous flow of cheap transportation services required by a modern industrialising economy.

To the liberal governments of mid 19th century, the path to the modernisation of the economy lay in the construction of a railway network. Encouraged by active state support, vast sums of foreign and domestic capital were invested in railways after 1855.

Economic historians have argued, however, that state actions diverted scarce capital funds from alternative industrial investments; that the state failed to stimulate industrial development by protecting Spanish producers of railway equipment and finally that the liberal policies pursued by the state operated to serve foreign interests in the Spanish mineral sector rather than the endogenous requirements of the Spanish economy.

In my thesis, I make an alternative case and I argue that: if the domestic iron industry had been actively encouraged by the state to supply the needs of railways, the rate of railway construction would have been seriously delayed because investment in social overhead capital was required before industry, agriculture and towns could develop. Finally, I maintain that railways serviced internal far more than the external markets supplied by local producers.

2. The Thesis:

Chapter two examines the direct benefits of railways as resource savers through a social saving calculation. Social savings measure the loss to an economy if railways were shutdown for one year. In a counterfactual scenario, freight traffic would be taken over by a combination of waggon, pack animals and coastal shipping. I found that the social savings on freight transportation amounted to 12 per cent of Spain's national income for 1878.

However, if animals and men used in traditional modes of transportation were underemployed during the off-peak season, the opportunity costs for part-time carriers engaging in transportation were low and consisted of lost leisure time. In that case, market prices utilized in the social saving calculation will fail to reflect the true opportunity costs and as a result my first estimate will be

overstated.

Social saving case studies for other countries have made this point of an economy which is less than fully employed. But none of these studies actually discussed the problem. Spain in the 19th century provides an excellent framework to test the validity of the social savings model for an economy characterised by seasonal underemployment. Historical evidence certainly supports the view that peasants were underemployed for at least four months of each year.

If the economy had reacted to the railway shutdown by moving all goods during those four months, social savings would drop to an insignificant percentage. But this hypothetical solution to the transport bottleneck presupposed the building of huge stocks to sustain the domestic consumption of raw materials and final products during the remaining eight months of the year.

A more plausible alternative to a non-rail solution for the bottleneck was to assume that freight could be hauled by professional carriers for eight months and by peasants during the other four months. This exercise would bring down social savings to 7.5 per cent of national income.

Part Two examined the backward linkage effects of railways on the coal and iron industries. Chapter three reconstructs the derived demand for permanent-way iron over the period 1855-1913. Railways enjoyed an exemption from customs duties on imported railroad iron. My estimates show that railway derived demand for iron amounted to nearly half a million tons over the period 1855-72. Had local iron industry supplied Spanish railways, aggregate output would have increased by 120 per cent. But protection of the iron industry would have affected railways adversely in two ways: first, it would have raised construction costs; second, it would have delayed construction

because the local iron industry would, in all probability, not have been able to fulfill orders for railway material. Furthermore, given the further but limited linkage effects of the iron industry itself on the rest of the economy, dependence on railroad construction would have entailed a high degree of excess capacity between two construction booms.

When the import substitution process was finally initiated in the 1890's with increased tariff protection, 9.5 per cent of Spain's output of steel was delivered to rail manufacturers at that time.

In contrast to feedbacks to the iron industry, Chapter four shows that the derived demand for coal was basically directed towards the domestic producers. I estimated that about one third of the coal consumed by railways was imported from abroad. In aggregate, railways consumed around one fifth of the coal mined in Spain over the period 1865-1913. The chapter then proceeds to examine the implications of the protection for the coal industry.

Part three deals with the expansion of the market generated by railways. Chapter five examines the impact of railways upon the flour and grain trades. Railways did not alter existing trade patterns. When, after 1880, the Spanish periphery was invaded by cheap American wheat, railways did not play a prominent role because grain grown in the core was produced at uncompetitive prices. But, with protection after 1892, railways made possible the haulage of large volumes of grain to supply the deficit regions of the periphery.

Chapter six is focused on the wine trade. At two moments of the 19th century, Spain's wine industry benefited from the spread of vine disease in French vineyards. By comparing the response to active external demand, it has been shown that railways contributed little to the expansion of exports. The main vineyards were located near the ports and the cost reduction effects from cheaper transport afforded

by railways were fairly limited. After 1900, when the vine disease ravaged Spanish vineyards, railway serviced internal demand to a much higher degree than external demand.

Chapter seven examined connections between railways and the trade in minerals. The major railway companies hauled small volumes of mineral ores and the direction of the flows suggest that railways were servicing internal rather than external demand. Besides, non-coal minerals were not transport intensive on account of their location close to the ports, and were in fact mined before railways were laid down. I reject the view that railways were built to export cheap iron ores.

In the haulage of coal, railways opened up new coalfields in Central Spain and created trade by substituting domestic for imported coal in urban markets and mining districts. Furthermore, railways did not carry imported coal which was consumed on the spot near the ports. When protection was instituted in the 1890's, railways helped Asturian coal to penetrate areas formerly supplied by foreign coal.

3. Sources:

The accounts of contemporaries on the bad condition of roads and their negative effect on internal trade are proverbial but provide qualitative evidence which is generally difficult to quantify. The analysis of the main aspects of traditional transportation was made possible by using an unpublished questionnaire on the wine trade in the 1880's: the Informacion Vinicola. It provides an excellent source of freight rates charged by hauliers using carts and pack horses.

The bulk of this thesis is based on records collected in the archives of Spanish railways. At the time of my research, some of

these archives were unclassified. I used in particular, the collection of statistical material on freight flows of one of Spain's leading railway companies in the 19th century: the Norte railway company. The proceedings of the meetings of the board of directors were a most valuable source of information to apprehend the operation of railway companies in relation to permanent-way iron contracts, coal supplies and pricing policies.

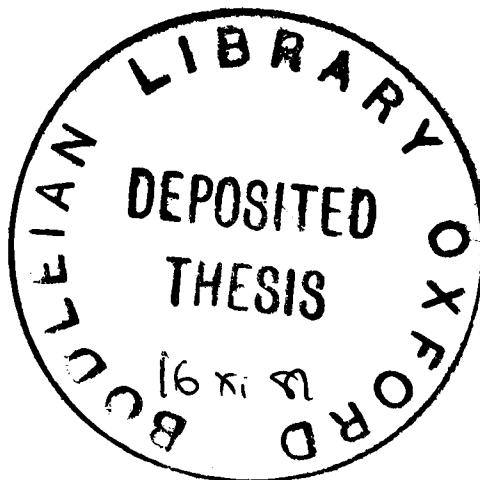
RAILWAYS AND SPANISH ECONOMIC GROWTH

IN THE LATE 19TH. CENTURY.

by

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To my parents

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List of Abbreviations.

A	: Compañía de los Ferrocarriles Andaluces.
AVT	: Compañía de los Ferrocarriles de Almansa a Valencia y Tarragona.
Bol. Fom.	: Boletín de Fomento.
Econ. Hist. Rev.	: Economic History Review.
JEH	: Journal of Economic History.
JISI	: Journal of the Iron and Steel Institute.
LRT	: Compañía de los Ferrocarriles de Lérida a Reus y Tarragona.
MZA	: Compañía de los Caminos de Hierro de Madrid a Zaragoza y Alicante.
Norte	: Compañía de los Caminos de Hierro del Norte de España.
Renfe	: Red Nacional de los Ferrocarriles Españoles
Rev. Min.	: Revista Minera.
ROP	: Revista de Obras Públicas.
TBF	: Compañía de los Ferrocarriles de Tarragona a Barcelona y Francia.
ZPB	: Compañía de los Ferrocarriles de Zaragoza a Pamplona y Barcelona.

CHAPTER ONE.

Transport in Spanish Economic History.

A). Introduction:

In studying the economic backwardness of 19th century Spain, economic historians have pointed to several causes. Political instability, civil disturbances and wars clearly deterred economic development and internal trade. The collapse of the Empire restricted foreign trade and terminated the large flows of earnings from Spanish emigrants.¹ At the same time, the decline in customs revenue coincided with increased government expenditure which called for new sources of public income. But the expenditure was financed basically by an astounding rise in national debt which plunged Spain's public finances into growing disarray. The state of public finances lay behind the agricultural policies pursued from 1798 onwards, and, as land reform became an instrument of fiscal policy, it operated to hinder the development of a prosperous class of farmers, even though large tracts of land formerly held in entail and mortmain were released. As population increased, the cultivated area expanded into marginal land and evidence suggests that yields declined over the first half of the 19th century. Agriculture failed to support economic changes in other sectors by releasing labour. The slow growth of population has also been identified as an indicator of retardation. At the beginning of the 19th century, Spain, which was the same size in area as France, had a third of France's population. Low population density and a slow rate

1. J. Fontana, "Colapso y Transformación del Comercio Exterior Español entre 1792 y 1827. Un aspecto de la crisis del Antiguo Régimen en España", Moneda y Crédito, CXV (1970), 3-23.

of population increase restrained the growth of internal demand over the 19th century. Finally, economic historians have laid considerable stress on Spain's failure to create an effective transport system to respond to the demand for services from a growing economy and population.¹ As they perceived it, high transportation costs hindered the expansion of the market, prevented regional specialisation, hampered competition and led to lower levels of output.

My introduction will outline the main features of transportation in pre-rail Spain and show how traditional transport acted as a bottleneck to Spain's economic progress. The second section of this chapter reviews the historiography on railway development in Spain and focuses on the role of the state, foreign capital and derived demand from the operation of railways. The final section discusses the historiography in the light of my own research.

B). The Transportation Bottleneck in Spain:

- In 1795, the great Spanish author Jovellanos wrote:

'Ordinary means of transport are not sufficient to stimulate agriculture; it is necessary to contemplate those means which, by their cheapness and swiftness, link all territories together and bring them closer to the farthest consumption points. These modern means, by promoting farming in the most remote areas of the kingdom, by granting everyone the support required to prosper, by spreading abundance everywhere, will distribute at the same time population and wealth more evenly than it is today being rigidly confined in the centre and the extremities.'²

Jovellanos referred of course to canals. But his statement is easily extended to the benefits which were to be derived from the operation of railways.

1. D.R. Ringrose, Transportation and Economic Stagnation in Spain, 1750-1850 (Durham, 1970).
2. G.M.de Jovellanos, Informe de la Sociedad Económica de Madrid al Real y Supremo Consejo de Castilla en el Expediente de la Ley Agraria in Biblioteca de Autores Españoles, (Madrid, 1918) I, P. 129, (hereafter, Biblioteca).

In the late 18th century, roads were few in number and badly built. The state, faced with an adverse topography and difficult climate, did little to improve the network. The irregular topography of the Iberian Peninsula raised construction costs and called for additional technical skills. Its heartland or Meseta was completely surrounded by a ring of high mountains which obstructed communications by roads radiating from Madrid. The location of these mountains is such that the natural outlets for Castillian goods are along the rivers flowing westwards through Portugal to the Ocean. And a further hindrance to internal trade was 'a neighbour as backward and poor as Portugal who impedes the extraction of surplus goods, depriving Spain of the advantages springing from the proximity of the sea and from the rivers which end in Portugal.'¹

The building of modern roads started late in Spain and proceeded at an exceedingly slow pace. In the first half of the 18th century, the country possessed bridleways rather than roads. The construction of the Reinosa-Santander highway and of a mountain pass across the Guadarrama range in 1749 marked a change.² The object was to provide an outlet for Castilian grain, northwards by facilitating access to the sea and southwards by connecting the 'granary of Spain' to the capital. The northern highway was to be complemented by a canal. Although vast sums of capital were absorbed in the construction, technical, financial and political difficulties prolonged construction well into the 19th century.³ Other road projects did not get under way because the state lacked revenue. The finance for public works was raised through indirect taxation, in particular from a tax levied on the salt trade. Construction

1. A. Moreau de Jonnes, Estadística de España (Madrid, 1835) p. 20.

2. See V. Palacio Atard, El Comercio de Castilla y el Puerto de Santander en el Siglo XVIII (Madrid, 1960).

3. See Memoria de la Comisión de Caminos y Canales sobre las Comunicaciones generales de España (Madrid, 1820) reprinted in Dirección General de Obras Públicas, Memoria de las Obras Públicas en España, (Madrid, 1856) pp. 191-3.

was also impeded by extraordinarily complex administration and the lack of technical knowledge displayed by road engineers. Jovellanos called repeatedly for more roads and recommended the construction of a road link between Asturias and Leon, as he predicted 'no incentive from the state will be necessary; once a highway is built, prosperity will find its way and provide for everything else'.¹ He was optimistic about the benefits because grain would be carried to Asturias where its price was four times higher than in Leon.² And the wool trade of Castile would also expand because:

'...once the road is built, sheep will be shorn and wool washed at the foot of these mountains; the effects of a road will be not only to save the haulage of the wool but to avoid sheep being exposed to a risky stay in the Guadarrama and a risky crossing of mountains after the shear in an unpredictable weather.'³

By the close of the 18th century, only 1,900 kilometres of highways had been opened to traffic - a mere 37 kilometres per year.⁴ But, during the first decade of the 19th century, road construction was spurred by the simplification of the administration and the creation of a college of civil engineers.⁵ The rate of construction increased seven-fold and in 14 years more additions were made to the network than in the previous 50 years.⁶ During the Napoleonic wars, construction was halted and maintenance deteriorated substantially. Indirect taxation contributed heavily and the remaining funds were raised through the creation of turnpike tolls.

The main highways radiating from Madrid were in full operation by 1820. However, in wet weather, communications were disrupted between

1. G.M. de Jovellanos, Carta (II) a D. Antonio Ponz in Biblioteca, p. 283.
2. G.M. de Jovellanos, Dos Informes al Superintendente General de Caminos in Biblioteca, p. 456.
3. Ibidem.
4. See Table 1, row 1.
5. See Dirección de Obras Públicas, op. cit., p. 48.
6. See Table 1, row 1.

the capital and the Mancha district.' Although the highway between Valencia and the French border was reported to be in excellent condition and one of the best in Spain, 'eight rainy days were sufficient to turn it into a dangerous and difficult road, especially between Tarragona and Barcelona'.²

The improvement in road communications is reflected in the accounts of travellers such as Bourgoing, who, in 1808 wrote:

' ... in the last few years, everything has been deeply transformed ... in the days of Monsieur Floridablanca, there could not be found in Spain more than ten leagues of road passable in all seasons'.³

Still the general condition of the roads remained horrid:

' ... few muleteers and few carters would dare to start their journeys without whispering some prayer or making the sign of the cross'.⁴

TABLE 1

Additions to the Highway System, 1750-1850.

	(1)	(2)	(3)
1749-1799	1,900	3.85	0.36
1800-1814	2,070	8.05	0.68
1815-1834	830	9.74	0.72
1835-1856	4,770	19.41	1.26

- 0 -

Notes and Sources:

Column 1: Length in kilometres opened to traffic during each period, see Dirección General de Obras Públicas, Memoria de Obras Públicas (Madrid, 1856), pp. 48-9.

Column 2: Road density at the end of each period in kilometres per thousand of square of kilometres.

Column 3: Road density at the end of each period in metres per thousand square kilometres and inhabitants. Population was estimated assuming a constant rate of increase of 0.63 per cent annually between 1797 and 1860 as given in Nadal, Fracaso, p. 17.

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1. See 'Memoria de la Comisión ...', loc.cit., p. 48.

2. J.Fr. de Bourgoing, Tableau de l'Espagne Moderne (Paris, 1808) iii, p.315.

3. Ibidem, i, pp. 3-4.

4. Ibidem, i, p. 30.

Between 1815-34, the construction rate slumped in the aftermath of the war years. But after 1835, road construction went ahead in spite of technical and budgetary constraints. Construction and maintenance costs were raised from turnpike revenue though financing through private loans was growing.

By 1856, Spain possessed little more than 9,500 kilometres of highways. Compared to France, the road network was totally inadequate.¹ France enjoyed over three times more roads per thousand square kilometres and inhabitants.² But, for two countries of similar size, the inferiority of the Spanish road network was partially offset by her smaller population. However, the imbalance between the two countries becomes enormous when it is considered that France used 4,500 kilometres of canals and over 7,000 kilometres of navigable rivers.³

By comparison with France, rivers in Spain were 'a sundering obstacle, never a line of communication'.⁴ Extreme climatic conditions and abrupt topography rendered rivers torrential in the rainy season and shallow in the drought. Rivers were navigable only along short sections.⁵

Spaniards tried to emulate European countries in the building of canals. Projects contemplated the provision of an extensive canal network to link the Ocean to the Mediterranean, and the prolongation of feeders to the southeast.⁶ Construction proved difficult due to geographical constraints and by 1850 only approximately 300 kilometres of canals were opened to traffic, although the Imperial de Aragon (80 kilometres in length) was built too distant from Zaragoza and meant

1. The French network was eight times longer, see J.C. Toutain, "Les Transports en France de 1830 a 1965", Economies et Sociétés Cahiers de l'ISEA Serie AF-9, Table 1, p. 11.
2. Ibidem.
3. Ibidem, pp. 74-5.
4. Parl. Papers 1908, CXVI, 479.
5. See "Memoria de la Comisión...", loc. cit., pp. 83-4.
6. Ibidem, p. 212.

transshipping goods which raised costs.

Overland and sea communications complemented each other in Spain because of the compact shape of the Peninsula. The low cost route consisted of hauling goods to a seaport and shipping them coastwise. However, Bougoing had noted that 'coastal trade remains very backward. Excepting Catalan and Biscayan vessels, coastal trade is almost entirely in the hands of French, English and Dutch seamen'.¹ Harbours were improved in the 1850's to dock larger ships.

Transportation along the roads was organised by carriers. First, there were a group of carriers who traded small volumes of luxury and manufactured goods for direct consumption. Secondly, there was a large class of professional carriers who specialised in servicing the government. Thirdly, a vast number of non-specialised, part-time carriers were engaged in transportation during the slack season.²

Madrid's growing dependence on imported grain after a series of harvest failures revealed the serious deficiencies of the traditional transportation system.³ Imported grain supplied to Madrid was more transport intensive than domestic grain because of the distances from the seaports to Madrid. Ringrose estimated that Madrid alone absorbed nearly 70 per cent of the capacity of professional carriers.⁴ And a French traveller reported that:

'... it is still recalled that thirty years ago, the supply required by Madrid daily was 3,700 bushels of wheat with the employment of not less than 30,000 draught animals.'⁵

Given that the traditional transportation system relied heavily upon the release of labour and capital from agriculture, its supply could not expand at the same rate as demand and transportation costs

1. J. Fr. de Bourgoing, op. cit., ii, p. 172.
2. D.R. Ringrose, op. cit., pp. 120-1.
3. Ibidem, pp. 38-41.
4. Ibidem, p. 90.
5. J. Fr. de Bourgoing, op. cit., ii., pp. 162-3.

started to rise more rapidly than prices over the second half of the 18th century. Indeed, rates charged by part-time carriers increased slightly faster than prices while the cost of specialised services grew much more rapidly.¹ The development of the professional carting industry was hindered by the restriction of privileges traditionally granted by the government to carriers, such as the access to grass lands in the winter. Pressure from a growing population led to a reallocation of pasture land to arable and livestock rearing.

However, harvest failures did not, as Ringrose suggests, compound the weakness of the system because it seems more reasonable to suppose that, when their crops were deficient, peasants would be more eager to engage in transportation. Furthermore, the high price of grain diminished the purchasing power of the population and depressed demand for manufactures and luxury goods, releasing at the same time some transport capacity.

Ringrose's important study brings out the seasonal nature of the transport supplies. Specialised services provided by professional carriers were interrupted in the rainy season for three to four months when roads were impassable to carts. And peasants were free to engage in transportation for a few months only at the end of the agricultural cycle. Because part of their costs were shared with agriculture, peasants could charge relatively low rates for their transport services which secured the haulage of bulky goods of low value. But in general, traditional transportation was costly. Jovellanos held transportation as the factor explaining the high regional variation in grain prices at the periphery and in the interior. According to Ringrose, transport mark-ups explained more than half of the regional variance.²

1. D.R. Ringrose, op. cit., p. 84.
2. Ibidem, pp. 84-5.

Transport services from the traditional system were highly seasonal and costly. The system, however, served to some extent the demand for transport from the subsistence economy since internal trade was likely to have progressed over the first half of the 19th century. Population had increased by over five million at a rate of 0.63 per cent annually between 1797 and 1860.¹ Under the aegis of a prolonged protectionist policy which started in the 1820's, the supply of grain for the periphery was secured from the surpluses of the interior. Furthermore, the distribution of population continued to be concentrated heavily in the maritime, non-grain producing areas of the periphery, resulting in an increased demand for transport.² The rent from turnpike tolls more than doubled in the period 1845-54, which suggests that internal trade intensified.³

The traditional system was likely to become less elastic when harvest was good. Peasants would probably be less willing to engage in transportation given the more favourable conditions prevailing in agriculture. Furthermore, the seasonality of transport supply and the lack of improvement in the road network did not serve the transport requirements of a modern economy because stocks of raw materials and consumption goods had to be built during the months when transport was interrupted. An industrial economy required a flow of cheap and continuous transportation services. For example, as a consequence of bad transportation, the ironworks of Mieres had to stop production because of a want for iron ore:

1. J. Nadal, El Fracaso de la Revolución Industrial en España, (Barcelona, 1975), Table 1, p. 17, (hereafter, Fracaso).
2. Nearly half of the Spanish population occupied the maritime provinces, data as given in Dirección General del Instituto Geográfico y Estadístico, Censo de la Población de España, 1860.
3. Dirección General de Obras Públicas, op. cit., Appendix 31, pp. 306-7.

' ... these works relied upon carts for the supply of raw materials and the haulage of its produce... in these conditions, requiring 200 carts daily, it is not possible to stimulate production... ' .¹

As Spain lacked internal waterways, traditional transportation was evolving into a bottleneck supply which opposed the development of economic activity.

C). Railways in Spanish Economic History:

Over the second half of the 19th century, 10,800 kilometres of railway lines were laid down in Spain. Table 2 indicates that after a dramatic start in the 1840's and early 1850's, the railway network was basically constructed between 1855 and 1866 and between 1873 and 1896.

TABLE 2.

Railway Construction in Spain, 1844-1913 (in Kms.).

	(1)	(2)
1848-55	55	440
1856-65	431	4,750
1866-75	108	5,840
1876-85	256	8,400
1886-95	212	10,525
1896-05	80	11,300

- 0 -

Notes and Sources:

Column 1: Average length of broad gauge track opened to traffic based upon R. Cordero and F. Menendez, "El Sistema Ferroviario Español", in M. Artola (ed.) Los Ferrocarriles en España, 1844/1943 (Madrid, 1978), 1, Appendix II-2, pp. 324-5.

Column 2: Total length of the network (broad gauge) at the end of each period.

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1. "Informe sobre la provincia de Oviedo" in Estadística Minera for 1871, p. 62.

During the first period, the length of the track expanded at an average rate of 430 kilometres annually. After 1873, the rate of construction slowed down to 230 kilometres, although intensive construction resumed again in the first half of the 1890's. Thus, in 1866, the network stood at 5,100 kilometres - approximately half of the length opened to traffic in 1900. Compared to Italy, also a late comer to the railway age, the building of railways in Spain was intensive during the initial phase. Spain in 1855 lagged far behind Italy. By 1866, however, the Italian network exceeded the Spanish network by a mere hundred kilometres. But construction slumped in Spain to around 60 kilometres annually after the crisis of 1866. By 1900, the Italian network opened to traffic was 16,000 kilometres or 60 per cent longer than the Spanish network.¹

During the first period, railway construction expanded in Spain along the main trunk lines which connected Madrid to the French border and to the sea. These lines formed the backbone of the two leading companies, the Compañía de los Caminos de Hierro del Norte (hereafter, Norte) and the Compañía de los Caminos de Hierro de Madrid a Zaragoza y Alicante (hereafter, MZA).² The Bilbao-Tudela and ZPB company linked Barcelona to Bilbao and provided a rail alternative to the long sea borne route. After 1873, feeders to these trunk lines were gradually built which linked all provincial towns to the main network.

Over the period 1830 to 1854, not less than 54 railway concessions were granted by the state to private individuals to construct a network

1. B.R. Mitchell, European Historical Statistics, 1750-1970, (1978).
2. See P. Tedde, "Las Compañías Ferroviarias en España (1855-1935)" in M. Artola (ed.), Los Ferrocarriles en España, 1844-1943, (Madrid, 1978) ii, pp. 47-93.

longer than the one actually built by 1900.¹ Tracks were laid along four of these lines amounting to three per cent of the total concessions. The Mataró-Barcelona and Aranjuez-Madrid lines were built for passenger rather than freight traffic. The Langreo line was to serve the Asturian coalfields and provide an easy outlet to the sea. The role of the state in this initial phase was limited to granting concessions. Speculation rather than construction occurred

After 1855, rapid construction was stimulated by the economic policy of liberal governments. The General Railway Law of that year granted subsidies and other privileges to private entrepreneurs, favouring the influx of domestic and foreign capital into railways. Government active support was of fundamental importance to the expansion from 1855-1866.

To some historians, the government's favourable attitude to railway development had adverse effects on the rest of the economy.² Tortella considers the state helped to deflect scarce capital funds away from alternative investments, particularly from industry. He estimated that by 1866 paid-up capital in railways was eight times larger than capital invested in manufactures.³ As a result of this discriminatory policy, investment funds made available to railways (paid-up capital, bonds and state subsidies) were 15 times higher than funds made available to industry. But Tortella's estimates under-rate investment in the manufacturing sector because he compared railway capital with investment in joint stock companies, in industry and at that time industrial concerns were family businesses rather than joint

1. See Dirección General de Obras Públicas, op. cit., Appendix 45, pp. 368-9.

2. The relationship between the state and railways is extensively analysed in M. Artola (ed.) op. cit., i.

3. See G. Tortella, Los Orígenes del Capitalismo en España, Banca, Industria y Ferrocarriles (Madrid, 1973), pp. 170-1, (hereafter, Orígenes).

stock companies.¹ Moreover, Tortella also assumes that railways and industrial investments were substitutive for each other and investors expected similar rates of return from railways and industry.² Nadal rejected Tortella's argument because he argued foreign capital provided the funds required to build Spanish railways. Had railways not been actively supported by the state, industry would not have benefited from the influx of Belgian, English and French capital.

Foreign capital certainly came to Spain stimulated by the favourable terms granted by the state to railway investments including subsidies for construction and guaranteed interest. State subsidies amounted to 612 million pesetas by 1890 or one fourth of the paid-up capital of the railways.³ While Tedde's estimates show that for 1867 foreign investment amounted to 64 per cent of paid-up capital of Spanish railways. Some share of the assets sold on foreign stock markets were probably in the hands of Spaniards.⁴

The contribution of domestic capital was by no means insignificant, and that gives more substance to Tortella's views on the opportunity costs of the liberal policies of 1855. Nevertheless, his hypothesis implies that in the middle decades of the 19th century there was a substantial amount of domestic capital available either for railways or industry. But bondholders in railway companies were not the kind of investors who normally risk their capital in venture business. The only other safe investment which attracted domestic capital was land.

1. J. Nadal, Fracaso, p. 38.

2. Ibidem.

3. Railway subsidies exclude the exemption from customs duties, see M. Artola, "La Acción del Estado", in M. Artola (ed.) op. cit., i, Table III-2, p. 353. For paid-up capital, see P. Tedde, op. cit., pp. 42-3.

4. See P. Tedde, "La Compañía de los Ferrocarriles Andaluces (1878-1920): una empresa de transporte en la España de la Restauración", Investigaciones Económicas XII (1980), pp. 32-3.

Nadal has argued that privileges granted to railway companies (such as the exemption from customs duties for all railway material imported) can be explained in terms of the pressures exercised by foreign capitalists on the Spanish government.¹ According to this line of argument, the building of the Spanish network was a profitable enterprise for French capitalists because the supply of railway material provided an outlet for French manufactures. But it is not obvious that French banks were interested in Spanish railways because they wished to promote the sales of railway inputs. Railway companies were profit maximising firms and they passed their orders to low cost producers independently of their nationality. Although France supplied large amounts of rolling stock, some was also supplied by Belgian and English works. While English rails constituted 60 per cent of the rails laid down on Spanish railways this was only because English rolling mills were, in the middle decades of the 19th century, the lowest cost producers in Europe. Undoubtedly, the exemption from customs duties favoured foreign iron industries, but it is difficult to see how Spanish economic policy was moulded by pressure of foreign capital.

Freight receipts started to decline at the end of the first construction boom in 1865.² This fact prompted Tortella to suggest that railways were built ahead of demand and that Spain did not need railways.³ The lack of industrial development deprived railways of an important consumer of railway services.

This line of argument can be objected to on several grounds. First, Tortella over-estimates the rate at which an industry could have developed under state protection from 1855 onwards. Secondly,

1. See Nadal, Fracaso, p. 162.

2. See Tortella, Orígenes, p. 186.

3. Ibidem, p. 189 and also Nadal, Fracaso, p. 47.

Spain was still a primary producer, so there is no reason to expect industry to emerge rapidly as a leading consumer of railway services. Thirdly, not only in Spain but elsewhere in Europe it took time to create a demand for railways. The time span between the start of railway construction in 1855 and the financial and economic crisis of the late 1860's is too short for transport users to switch from traditional means of transport to railways; or for railways to start generating forward linkages with the rest of the economy. Finally, swings in the volume of freight carried by rail suggest that the decline in traffic in the late 1860's must be attributed to the general economic crisis of those years, rather than to any long term deficiency in demand for railways.¹

Nadal has also rejected the railway versus industry strategy posed by Tortella, but he has offered an alternative hypothesis for the supposed failure of railways to stimulate rapid growth in 19th century Spain.² According to Nadal, the radial network laid down failed to respond to actual demands of the economy. He views railways as an instrument of exploitation rather than an instrument of development.³ But Nadal's hypothesis refers exclusively to connections between railways and Spanish minerals. The development of the mineral industry was hindered by high transportation costs for the haulage of mineral ores and for the haulage of coal demanded by the stationary engines at the pitheads.⁴

Nadal's hypothesis can be objected to on several grounds. First, minerals entered for a small share of railway traffic. For example, non-coal minerals accounted for four per cent of Norte's tonnage in 1880-1886, compared to eighteen per cent for wine.⁵ Secondly ,

1. See Tedde, "Las Compañías Ferroviarias", pp. 124-9.

2. See Nadal, Fracaso, pp. 46-8.

3. Ibidem, p. 50.

4. Ibidem, p. 49.

5. For the composition of railway traffic, see Norte, Memorias, 1880-6.

mineral flows did not follow a core-periphery direction, but matched internal demand. Third, and above all, minerals were not transport intensive because the richest mines were located in the periphery, so close to the sea ports that transport costs did not hamper the working of mines.

Economic historians have also agreed that the building of the Spanish network had limited effects upon the domestic metallurgy, simply because railway material was mostly imported from abroad. Indeed, the railway law of 1855 granted an exemption from customs duties for ten years on all railway equipment required for the construction of the track.

Tortella drew attention to the limited feedback effects from railways on the Spanish economy and Nadal blames government policy for the stagnation of the iron industry during the second half of the 19th century.¹ In his words, railways became, in the early years, 'the great lost opportunity' to develop a modern iron industry. Railways could have generated an active demand for iron manufactures which was absent for most of the century.² In his view, the General Railway Law of 1855 saw to it that orders were placed with foreign rolling stock and rail makers.

Nadal also observed that the general backwardness of the economy depressed demand for iron. The size of its agricultural market was small because of the lack of mechanisation which perpetuated old techniques of production. High production costs in pig iron manufactures were perpetuated by the use of charcoal. Coal mining had developed

1. See Tortella, Orígenes, p. 170. Also in N. Sanchez Albornoz, España hace un siglo: una economía dual (Madrid, 1977), p. 21. And J. Harrison, An Economic History of Modern Spain, (Manchester, 1978), p. 52.
2. See Nadal, Fracaso, pp. 158-65.

but on a limited scale and hindered by costly transportation. The capital required to finance a metallurgical sector was dear and the creation of joint-stock companies was prohibited before 1869.¹

Nadal suggests that the development of the iron industry in late 19th century confirms his argument. At the close of the 19th century, metallurgy underwent rapid changes: capacity was expanded, new production techniques were incorporated and the size of the market grew. Central to these developments were the profits which stemmed from the buoyant external trade in iron ores.² The Bessemer system, requiring non-phosphoric ores, had spurred intensive mining in the northern district of Bilbao after 1870. Foreign capital, mostly British, flooded into Spain; though the contribution of domestic capital must not be ignored. On average, 90 per cent of the ores were exported to England, Germany, France and Italy. But iron ore exports provided the profits which were reinvested to develop the local iron and steel industry.³ The first steel ingot was made in 1885. Soon afterwards, the new works started to manufacture rails and other railroad iron.

Spanish pig iron output doubled in the 1890's as a consequence of a growing import substitution and the expansion of the domestic market. But the significant factor behind this rapid transformation was the active role played by the state. Indeed, protection was granted in the course of the 1890's to the infant industry by levying high import duties upon iron manufactures and in particular railroad iron. Protection was, moreover, greatly reinforced by falling rates

1. Ibidem, p. 158.

2. Ibidem, pp. 165-6.

3. M. Gonzalez Portilla, "El Desarrollo Industrial de Vizcaya la acumulación de capital en el último tercio del siglo XIX", Anales de Economía XXIV (1974), pp. 43-83.

of exchange. Finally, production was directly stimulated by the state through orders for the supply of large quantities of steel plates to shipping yards.

Nadal estimated that between 1904 and 1913, rails totalled 600,000 tons, or over 20 per cent, of Spain's steel output in the period.¹ For Nadal, the railway industry became a leading sector which 'confirmed a fortiori the hypothesis of the great lost opportunity thirty years before'.²

At the time railway construction started, the Spanish iron industry was extremely backward. It did not possess the capacity necessary to supply railroad iron in the huge volumes required by the laying down of the track. Over the first ten years, Spanish railways consumed 416,000 tons of iron rails or an annual consumption of 56,000 tons of pig-iron. If railways were built with domestic rails, pig iron output would have had to increase by 166 per cent. Had capacity additions been insufficient, the building of the railway network would have been substantially delayed. Nadal's 'great lost opportunity' relies on the optimistic assumption that this expansion of the iron industry could have taken place. But, the decision to liberalise the import of railway material can be viewed as the understanding that the supply of railroad iron by local iron-works would have delayed construction.

D). The Contribution of Railways to Economic Growth, 1855-1913:

'The distances are far too great and the traffic far too small to call yet for the rail...'.³

wrote Richard Ford in 1846. This view, which stresses that in the

1. Nadal, Fracaso, p. 183.

2. Ibidem.

3. R. Ford, Gatherings from Spain, 1st edition, 1846. (1970), p. 59.

mid 19th century internal trade was sluggish, has been taken up by a number of economic historians. For Fontana, for example, contemporaries had failed to differentiate roads from the traffic conveyed onto them.¹ He argued that the causes to explain the depression of internal trade were not to be found in the bad condition of roads, but rather in the general backwardness of the economy. On basically the same grounds, Nadal disapproved of the government's decision to encourage the building of railways.²

Were Spanish railways built ahead of demand? It seems difficult to disentangle cause from effect: was internal trade depressed because of costly transportation or was it the other way round, was economic stagnation the main explanation for limited trade and for the poor condition of the road network?

Looking at the evolution of the economy over the first half of the 19th century, the first alternative seems more plausible. Although road construction proceeded at an accelerated pace, Spain remained poorly endowed with communications by 1850. Furthermore, Spain lacked the right kind of transport required for an industrial revolution. Both her shape and topography prevented the creation of waterways as an alternative to road transport. Thus 'in other countries, roads, canals and traffic usher in the rail which in Spain is to precede and introduce them'.³ Transport in the traditional economy was costly, highly seasonal and unresponsive to cyclical and to growing changes in demand. With the construction of canals barred by hostile natural conditions, the only serious alternative to roads was railways.

1. J. Fontana, Cambio Económico y actitudes políticas en la España del siglo XIX (Barcelona, 1973), pp. 29-31.
2. Nadal, Fracaso, p. 47.
3. R. Ford, op. cit., p. 58.

The lack of research on the traditional transportation sector makes it difficult to perceive and to analyse the full effects of the railways. Because our knowledge of the period before the 1850's is so limited, it is difficult to gauge the extent to which railways freed the economy from the bottlenecks imposed by the traditional transport by road and sea.

In the present state of knowledge, the best approach to the problem is from the perspective of the railways. By focusing on economic development which occurred with the railways, their benefits for the Spanish economy should become more apparent. But the point is not to describe the effects of railways but to quantify their contribution to economic growth. For example, the analysis of the services provided by railways from the 1860's onwards reveals that the new system catered for the growing demand for transport. But this fact tells us little about the actual benefits derived from railways. Railways, by cutting transportation costs, helped to expand the size of the market. They also released scarce production factors (becoming scarcer under population pressure) such as animal power and land allocated for the cultivation of animal feedstuffs. Furthermore, railways demanded large volumes of two inputs central to any industrial revolution: iron and coal.

Economic analysis provides some of the tools required to assess the impact of railways on Spain's economic development in the 19th century and enables us to confront and to analyse the major hypothesis about the impact of railways on Spanish economic history. For example, social savings (a concept developed by Fogel and Fishlow) attempts to estimate the contribution of railways to economic growth by posing a counterfactual scenario where railways are closed down for one year. By comparing the costs of transport by rail with the costs by alternative means of transport, social savings become an indicator of the gains in national income arising from the operation of the railways.

Or, alternatively, an indicator of the loss imposed upon the economy when the most efficient means of transport is closed down. Part I of my thesis deals with calculation problems posed by social savings. It discusses the economic implications of such estimates in the light of Spain's economic development. In particular, the reduction in transport costs and the effects of railways in releasing the economy from the seasonality inherent in subsistence transport will be closely analysed.

Social savings from railways had been calculated for the USA, England, Tsarist Russia and Mexico.¹ The distinctive feature of Mexico and Spain is that these two countries lack an extensive network of waterways which reduced transportation costs in the USA, England or Russia long before the advent of railways. Economic historians have concluded that railways were not 'indispensable' to American, English or Russian economic growth because the cost reduction which they promoted was not very large. However, in Spain or Mexico, where there was no cheap water alternative, railways induced huge transport cost savings.

An assumption, central to social savings, is that factors of production are fully employed. When the closure of railways reallocates them toward the alternative mode of transportation, the full employment assumption entails a loss in national product. However, in Spain peasants and their draught animals were idle during part of the year and supplied transportation services. Then, agricultural under-employment might distort the results of the calculations.

I have already argued that there are no obvious grounds for supposing the domestic industries could have supplied the materials required by railways. None of the studies which raise these issues

1. See P.K. O'Brien, The New Economic History of the Railways (1977), pp. 22-30.

went beyond assertion. Nadal found support for his views in subsequent developments of the iron industry. While it is obvious that protection in 1855 would have encouraged the production of domestic iron, it is less obvious whether such policy was practicable or efficient. Once the opportunity costs of the delayed construction of the railway network are estimated through a social saving calculation, it becomes easier to perceive the implications of such a protectionist policy implemented in 1855. What was the level of domestic pig iron and coal output necessary to supply railways? Was such a policy feasible in the light of the development of other national iron and coal industries? Part II takes up these issues when the thesis deals with the nature of feedback effects from railways by estimating demand for permanent way iron and coal.

The study of the interrelationship between market expansion and the building of railways has been neglected by Spanish economic historians. Unfortunately, our knowledge on commercial exchange before the advent of railways is restricted to contemporary accounts:

'Meanwhile the government invigorates the interior of Spain by building highways and canals, trade will be restricted to the exchange of oil and wine between provinces in hog's skins on the back of donkeys or mules; the exchange of grain supplied to neighbouring districts also by way of pack animals; and above all the exchange of wool hauled to the Northern seaports from the two Castiles...'¹

This account describes several features of pre-rail internal trade such as small shipments at short distances, precarious and expensive transportation.

The impact of the railways on market expansion is best visualised by comparing the structure of the market before and after railways. One method is to investigate prices to discover whether regional prices

1. J. Fr. de Bourgoing, op. cit., ii, p. 172.

tended to converge after railways were built. But the unavailability of price data for the period before the railways precludes this exercise.¹ Part III offers an alternative approach by selecting four basic commodities (grain, flour, wine and minerals) and analyses changes in their marketing over the second half of the 19th century.

By cutting transportation costs, railways widened markets and this brought greater efficiency and created new sources of economic activity. For example, Spain's inner coalfields were mined on a large scale after railways were laid down. Similarly, railways created a demand for the wine of the Central vineyards by linking them to seaports. Wine became over the second half of the 19th century, Spain's staple export. I will analyse whether the export of wine could have been possible on the same scale without railways. Thus, by focusing on the volume of wine, grain and minerals carried by rail, it should be possible to see whether railways expanded the size of the market and encouraged regional specialisation.

1. Wheat and barley prices have been compiled recently by Sanchez Albornoz for the period 1860-1890, see N. Sanchez Albornoz, Los Precios Agrícolas en la 2ª mitad del siglo XIX (Madrid, 1975).

PART ONE.

THE DIRECT BENEFITS OF RAILWAYS.

CHAPTER TWO.

SOCIAL SAVINGS.

A). Introduction:

The impact of the railways on the rest of the economy will be reflected at two different levels. First, there will be a saving of resources as less inputs will be required to perform the same volume of transportation services. Second, the reduction in transportation costs will affect the rest of the economy in two different ways: first, the market will expand in the sense that goods and passengers can travel further for the same price; and second, demand for transport intensive goods will increase through a price effect. The increased demand for transportation will be achieved through increased output from existing productive units and from the establishment of new productive enterprises (for instance, new mines or the expansion of the agricultural margin).

This chapter is concerned with the benefits derived from railways as resource savers. These benefits will be measured through a social saving calculation. Social savings will be defined as the extra cost that society will have to bear in order to provide transportation services if railways were closed for one year.¹

1. The bibliography on social savings has been greatly enlarged in recent years. A good record will be found in P.K. O'Brien, The New Economic History of Railways (1977). One should add R.W. Fogel, "Notes on the Social Saving Controversy", Journal of Economic History, XXXIX (1979), fn 1 pp. 1-2, and more recently J. Coatsworth, "Indispensable Railroads in the Mexican Economy", JEH XXXIX (1979), pp. 939-60. For the economic theory behind the social saving methodology as applied to history, see

(Footnote 1 continued on following page...)

In the event of the construction of a railway network, consumers of transport services can be expected to switch demand towards the new technology because of its relative cheapness and some other indirect advantages. Benefits derived from the reduction in transportation costs will be termed direct benefits, but even if the price of transport remained constant, consumers might still prefer railways to traditional means because of their higher speed, regularity, lower risks of loss and deterioration. These benefits which are derived from the special attributes of the railway vis a vis alternative means of transportation will be called indirect benefits.¹ Most of the chapter will deal with direct benefits (sections B,C and D) and indirect benefits will only be embodied in the last section (F). Sections B and C will be devoted to the calculations of the relevant variables which are required to estimate social savings, while section D contains an interim calculation. Social savings refer solely to goods traffic. Passengers services must be considered as a completely new commodity, journeys which, for the most part, would never have taken place without the advent of railways.² Receipts from freight traffic were far more important than passenger receipts. The available data for the two leading companies show that over the period 1868-1912, passenger output grew more slowly than commodity output. This was reflected in a decreasing share of passenger receipts in total receipts.

(Footnote 1 from preceding page continued...)

(1) E.J. Mishan, Cost-Benefit Analysis (1971), in particular Part II, A.J. Harrison, The Economics of Transportation Appraisal (1974), chapter 2, and D.R. Thomas, "Cost-Benefit Analysis of Railway Closures", Chartered Institute of Transport Journal, (1971), pp. 228-33.

1. The distinction between direct and indirect benefits was already set by C. Colson, Les Travaux Publics et les Transports (Paris, 1929), chapter III, sections 2 and 4.
2. See P.K. O'Brien, "Transport and Economic Development in Western Europe, 1789-1914, in P.K. O'Brien, ed., Railways and the Economic Development of Western Europe, 1830-1914 (forthcoming).

For instance, in 1912 passenger receipts accounted for 38 per cent of total freight receipts while in 1878 it was 49 per cent.¹ Finally, my calculation of social savings has been undertaken for only two years: 1878 and 1912. The first year was chosen because railway data were available, there is a contemporary estimate of national income for that year and the harvest was relatively good. Finally, a year in the early stages of railway operation seems particularly appropriate to assess the extra costs that the non construction of the railways would have entailed for the rest of the economy.² On the other hand, the calculation for 1912 can be viewed as an upper bound for the direct benefits from railways throughout the period.

The social saving calculation undertaken in this chapter falls within the ceteris paribus group, in the sense that the counterfactual economy is not allowed to adjust to the closure of its railways.³ In the Spanish case, the provision of an extended and improved internal waterways (or even highway) system seems to be highly hypothetical due to topographical and climatic constraints. Furthermore, railway lines were laid for the most part along existing highways and just a few lines served regions deprived of communications. Therefore, it will be assumed that no great savings could have been achieved through the improvement of the road surface and that its actual quality was good enough to bear the higher volume of road traffic due to a railway closure.

1. Freight receipts include here general merchandise, minerals and live-stock carried at 'grande' and 'petite vitesse'. Data from R. Anes, "Relación entre el Ferrocarril y la Economía Española (1865-1935)", in M. Artola, ed. Los Ferrocarriles en España, 1844-1943 (Madrid, 1978), II, Tables V-2 and Ap. V-3.
2. This counterfactual case could have happened if railway companies had been denied the exemption from customs duties which was granted by the 1855 General Railway Law. This point will be developed at length in Ch.3.
3. In Fogel's and Coatsworth's calculations, the economy was allowed to adjust to the closure of the railways by ways of the extension of the alternative transport system. In particular, see R.W. Fogel, Railroads and American Economic Growth: Essays in Econometric History, (Baltimore, 1964), Chapter 3,

When we move from a traditional situation without railways to a new one with railways, the gain for the user of transport services will be embodied in the increase in consumer's surplus (the area $P_a P_r FC$). It can be seen that SS overstates the increase in consumer's surplus by an area equal to the triangle FBC or $1/2 \Delta O . \Delta P$. If on the other hand we move from a situation with railways to an hypothetical situation where the railways have been closed down, we will move to another $D'D'$ in order to measure the potential expenditure in transport implied by the assumption of a constant volume of services. Measured in this way, SS reflects the cost for society of giving up its railway system for one year, taking for granted that the level of economic activity and demand for transportation will remain invariable. This comes down to assuming a zero price elasticity of demand for transportation.¹

On the basis of these assumptions, the saving in financial charges will in fact reflect the gain in national income because the factors of production released by railways will find their way to alternative uses within the economy. Alternatively, in the event of a railway closure, the factors required to supply the same volume of transport services will be withdrawn from other sectors of the economy with a net loss of output to society. The additional assumptions are that:

- i. prices in both sectors reflect marginal costs, and departures from true marginal costs will distort the social saving calculation and introduce biases which can, however, be assessed.
- ii. there must be full employment both in the 'actual' and 'counterfactual' economy.

1. This assumption has been the object of strong criticisms from opponents of the social saving model who are inclined to prefer a far larger elasticity in particular with respect to passenger traffic, see Fogel, loc. cit., pp. 22-3.

Both assumptions are common to cost-benefit appraisal. But it can be the case that the additional costs caused by the railway closure will fail to reflect true social costs because of departures from any of the above assumptions. Section E will assess the biases introduced in the calculations and will focus on the adjustments which must be introduced in the calculation in order to approximate the true opportunity costs of the resources allocated to transport.

B). The Railway Economy:

This section deals with the compilation of the railway variables which are needed for the social savings, that is the volume of freight carried by railways in each year 1878 and 1912 and the price of railway transportation.

B.1. The Output of Railways:

In this section, we will be concerned with the supply of transportation services by railways for the conveyance of freight. Freight includes all the goods traffic performed 'à petite vitesse' as opposed to the 'grande vitesse' for passenger traffic, and the carrying trade in perishable commodities. Livestock traffic has also been excluded from the calculations. Finally, it is necessary to exclude all goods that the railway companies moved for their own use.

Except for Norte and MZA, the limited scale of the operations performed by the 12 other companies (including Andaluces) in existence by the end of the century, deterred them from keeping costly statistical records of their performance. Elaborated statistics for the output (either for freight or passenger traffic) were seldom calculated because the marginal information which they provided did not compensate the small companies for their high cost. Only statistics which were

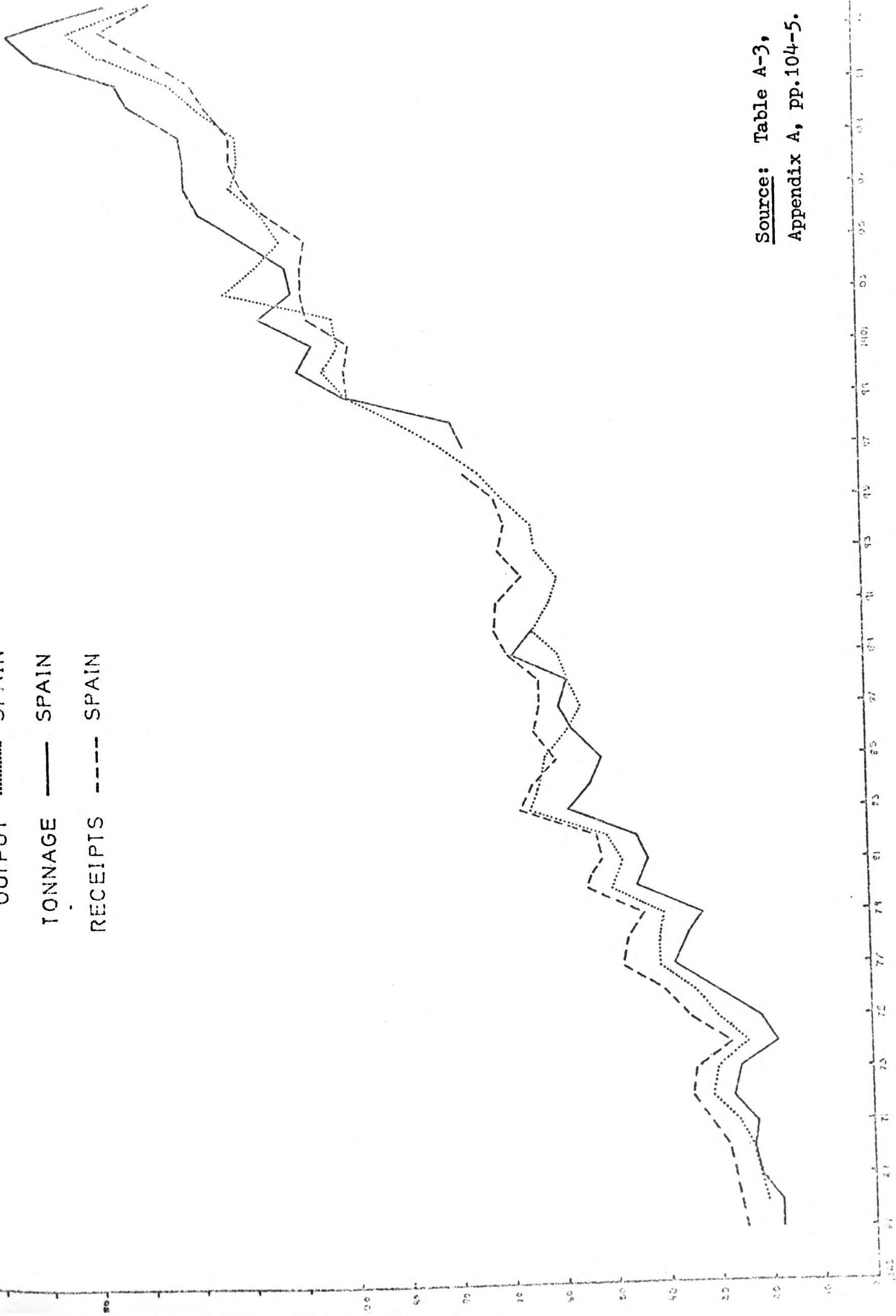
relatively easily compiled, such as tonnage moved, number of passengers carried and total receipts were recorded by the smaller companies. These data were usually published in the annual reports for the delight of small shareholders.

Not until 1897 did all the companies begin to send more complete information to the Ministry of Public Works.¹ Thus, the paucity of data on total railway output during the second half of the 19th century has obliged me to rely basically on the information provided by Norte and MZA companies.² An output estimate for 1878 was built relying upon available information on average hauls for the rest of the companies. In all other years, until 1897, the mean of the average rates per ton-km. both for Norte and MZA was applied to receipts in order to assess the output of the whole sector. A detailed account of the estimation of the global output is provided in Appendix A of this chapter.

Chart 2 shows total freight output for all broad gauge railways. The general trend is upwards with an annual rate of growth of 4.11 per cent between 1870 and 1914. Compared to a growth rate of 3.6 per cent on French railways, the performance of Spanish railways seems good.³ To some extent, the increase in railway output was obviously due to the fact that the network of lines expanded at high rates until 1900. After 1900, with a constant railway mileage, output grew at only 2.6 per cent. When the responsiveness of freight traffic increases to additions in the broad gauge network is measured, it is found that the supply of

1. This official publication included data on freight tonnage and receipts for all railway companies, Dirección de Obras Públicas, Memorias de Obras Públicas relativas a Ferrocarriles y Tranvías (Madrid), various years.
2. Norte and MZA were the only railway companies to keep a consistent record of their freight output, including data on average hauls and average rates per ton-km. of freight. For Norte, see Compañía de los Caminos de Hierro del Norte de España, Historia, Actuación, Concesiones Ingresos, Gastos y Balance, (Madrid, 1940) II, Tables 9 to 13 (hereafter Actuación). For MZA, see Compañía de los Caminos de Hierro de Madrid, Zaragoza y Alicante, Memorias del Consejo de Administración, (Madrid) 1868-1914, (hereafter, Memorias).
3. See J.C. Toutain, Les Transports en France de 1830 a 1965 (Paris, 1967), Table 10, pp. 157-8.

OUTPUT SPAIN
 TONNAGE ——— SPAIN
 RECEIPTS ---- SPAIN



Source: Table A-3,
 Appendix A, pp.104-5.

Chart 2: The Performance of Spanish Railways (1865-1913) (1899 = 100).

freight services was particularly elastic to the provision of new railway lines in the period 1880-84 and again from 1895 onwards. Indeed, in the first period the elasticity amounted to 3.93, and after 1895 it remained higher than 2.¹ On the other hand, during a ten year period starting in 1885, the supply of freight showed an almost complete lack of responsiveness to the expansion of the network, falling to 0.26 during 1885-9 and increasing slightly to 0.71 over the next five years.

However, traffic increases were also induced through price effects. The transportation demand was enlarged as the price of moving goods was reduced by the introduction of the railways. This is perhaps shown in Chart 3, where the density of freight traffic has been depicted. In spite of the cyclical fluctuations, the density of freight traffic per kilometre of railway line increased threefold over the period. Comparing the two charts, three cycles can be clearly distinguished:

(a) from 1867 to 1883:

In this period freight output increased rapidly at nearly 7.5 per cent annually. The responsiveness of freight demand to extensions of the network was especially intensive in the years 1880-4, when the elasticity of railway demand came to 3.93. The impact of the subsistence crisis of 1879 and 1882, and also the spread of the Carlist war throughout the Northern provinces which resulted in the temporary closure of some railway lines, emerges in all the curves.

(b) from 1884 to 1895:

In this period, railway output reflects the recession which affected

1. The elasticity of the supply of freight services to additions in the railway network has been defined in the following way:

$$\epsilon = \frac{\Delta O}{O} \cdot \frac{N}{\Delta N}, \text{ } O \text{ being the output of Spanish railways measured in}$$

ton-kms. and N the extension of the network in kilometres of railway line.

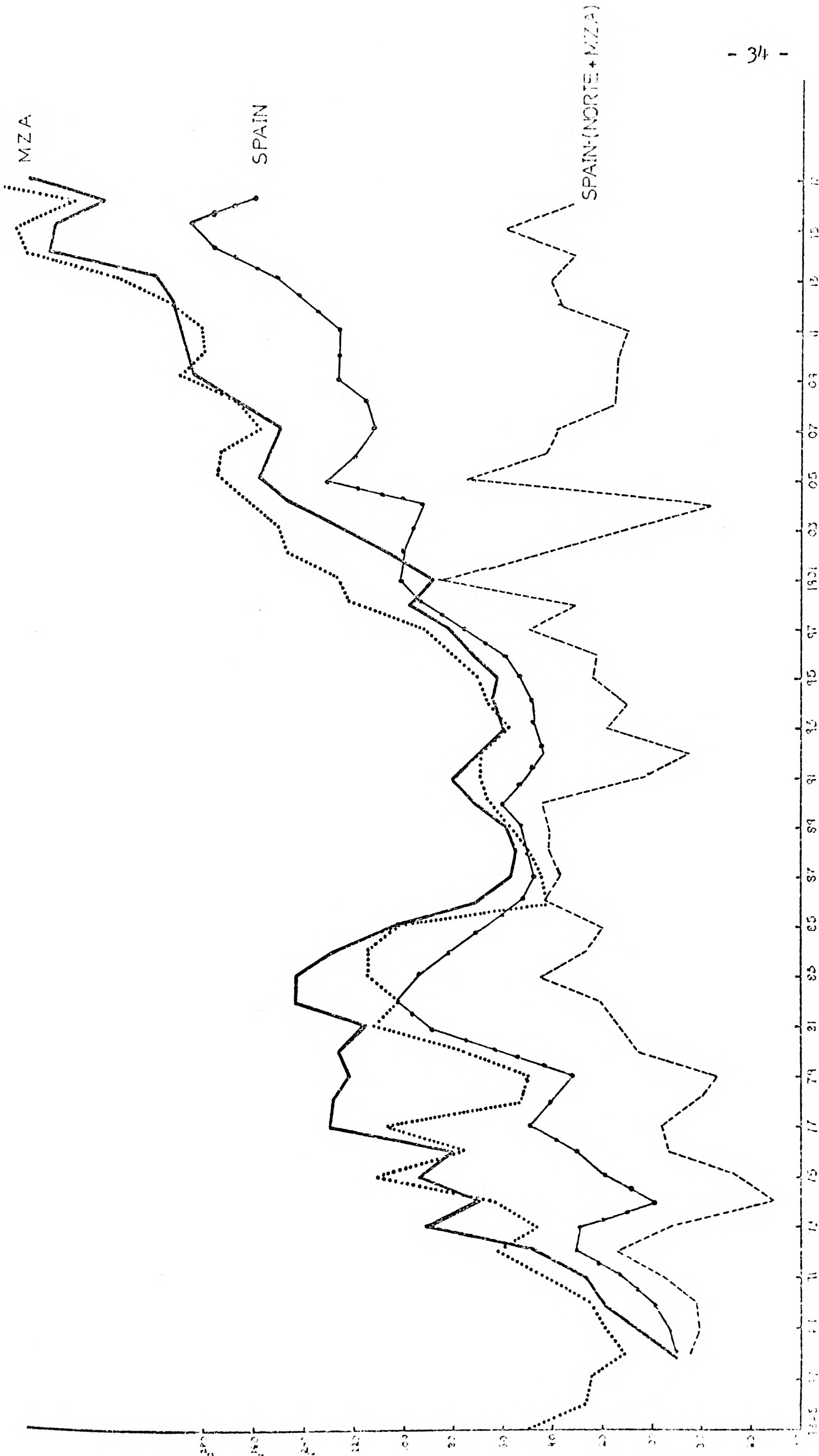


Chart 3: Density of Freight Traffic (Ton-kms./km. of track.)

Source : MZA and Norte, Memorias, 1865-1913. For Spain, Table A-3, Appendix A, pp. 104-5.

the economy between 1882 and 1896. The crisis which originated in the agricultural sector gradually diffused towards manufacturing and finally reached the financial institutions.¹ Chart 2 suggests that railway output reached a peak in 1883 and started to decline afterwards, showing signs of recovery after 1887. All this is reflected in railway output growing at less than 0.5 per cent per year. Stagnation was also accompanied by decreasing rates in traffic density (3.6 per cent annually over the first five years). However, the impact of the economic recession on the two leading companies did not fit into the general pattern. Norte's output started to fall in 1883 but had recovered already by 1887, although its traffic density slumped back again in 1893. On the other hand, the MZA freight output started to decrease only after 1885 both in absolute and density terms. MZA was slower to recover and initial recovery proved short lived and output went down again in 1891 (see Charts 2 and 3). This divergence between Norte and MZA implies that the economic recession first affected the Northern regions and spread later to the South where its overall impact was more serious.

(c) from 1896 onwards:

Freight output grew in this period at 4.1 per cent annually. The upward trend in output was held back at first by the loss of the American colonies after 1899 and later in 1904 by the effects of the agricultural crisis of 1904-5, but recovery followed almost immediately in 1906, although the 1906 output level was not superseded until 1910.

1. The cycles of the recession have been delineated by Tedde, see P. Tedde, "Las Compañías Ferroviarias en España, 1855-1935", in M. Artola, ed. Los Ferrocarriles en España, 1844-1943, (Madrid, 1978), II, pp. 146-52.

B.2. The Average Haul:

The average haul, or the average distance which one ton of freight is shipped, is one of the basic variables in the economics of transportation.¹ It helps to provide a better insight into the transportation framework and helps to some extent to obviate some of the deficiencies of aggregate output.

The average haul results from dividing total freight output by tonnage originated. It will be called 'H'. However, data on the tonnage moved by railway refers to tonnage carried, rather than to tonnage originated, in the sense that the former involves a double counting of the transit trade between railway companies.² Unfortunately, the volume of the transit trade is only known for Norte, and this information shows that trans-shipments among companies were far from negligible. For instance, transit trade between Norte and other companies sharing railway junctions amounted to 1.26 million tons of freight or over 18 per cent of the freight moved by Norte in 1907.³ Therefore, the average haul which is obtained when we divide freight output by tonnage carried will be a lower bound indicator for 'H', and I will refer to it as $\bar{H}$. $\bar{H}$ is in fact the mean of the average hauls for individual companies, rather than the average distance over which one ton of freight is shipped. $\bar{H}$ will, however, be used as a proxy for 'H' and it will understate 'H' because of the trans-shipment of goods among companies. This transit trade increased over time, and for later years, $\bar{H}$ will provide a less and less satisfactory proxy for 'H'.

1. See H. Barger, The Transportation Industries 1889-1946: Output, Employment and Productivity, (New York, 1951), pp. 75-92.
2. One ton of freight in transit from one company to another was considered by the latter as a completely new ton and thus counted twice when tonnage carried is aggregated. This is a major drawback in the analysis of R. Anes, see Anes, loc. cit. This double counting is avoided by using output data, see Barger, Transportation, p. 86.
3. Norte, Datos Estadísticos (1907).

Chart 4 shows the evolution of $\bar{H}$ over the period (except for 1891-8 when data on tonnage carried are not available) and the average hauls of Norte and MZA. The relative stability of $\bar{H}$ for Spain contrasts with the wide fluctuations of the average haul on MZA and should be emphasised. Between 1872 and 1912, $\bar{H}$ for Spain decreased from 162 to 127 kms., that is by 27 per cent, though part of this decrease might be due to the use of $\bar{H}$ instead of 'H'. Secondly, for the whole period, $\bar{H}$ remained lower than the average hauls on both Norte and MZA which reflects the short distance traffic on the rest of the railway sector. In 1901, none of the other companies hauled over distances longer than for Norte and MZA. For instance, the longest average haul was achieved by the MCP and amounted to 149 kms., while freight traffic travelling through the Andaluces network was hardly ever shipped more than 85 kms. Thirdly, the divergence between the trends of Norte and MZA is also interesting. Over the 1870's, MZA's average haul was on average 350 kms., 72 per cent higher than Norte's. To some extent, the average haul is proportional to the length of the railway lines. Thus, the longer hauls for MZA might have been due to the fact that its network was, on average, twice as long as Norte's. But the trend followed by the hauls of both companies is also different. Norte's freight travelled farther between 1868 and 1885, except for 1873 and 1876, when the effects of the civil war in the Northern provinces and the merger with the small Santander Railway Company might have disturbed the trade pattern. MZA's average haul showed large increases between 1868 and 1873, but with constant network.¹ The longer hauls were accompanied by decreasing rates per ton-km. which suggests that the company enlarged

1. The average haul increased from 224 kms. in 1868 to 352 kms. in 1873, or by 57 per cent, MZA, Memorias (1868-73).

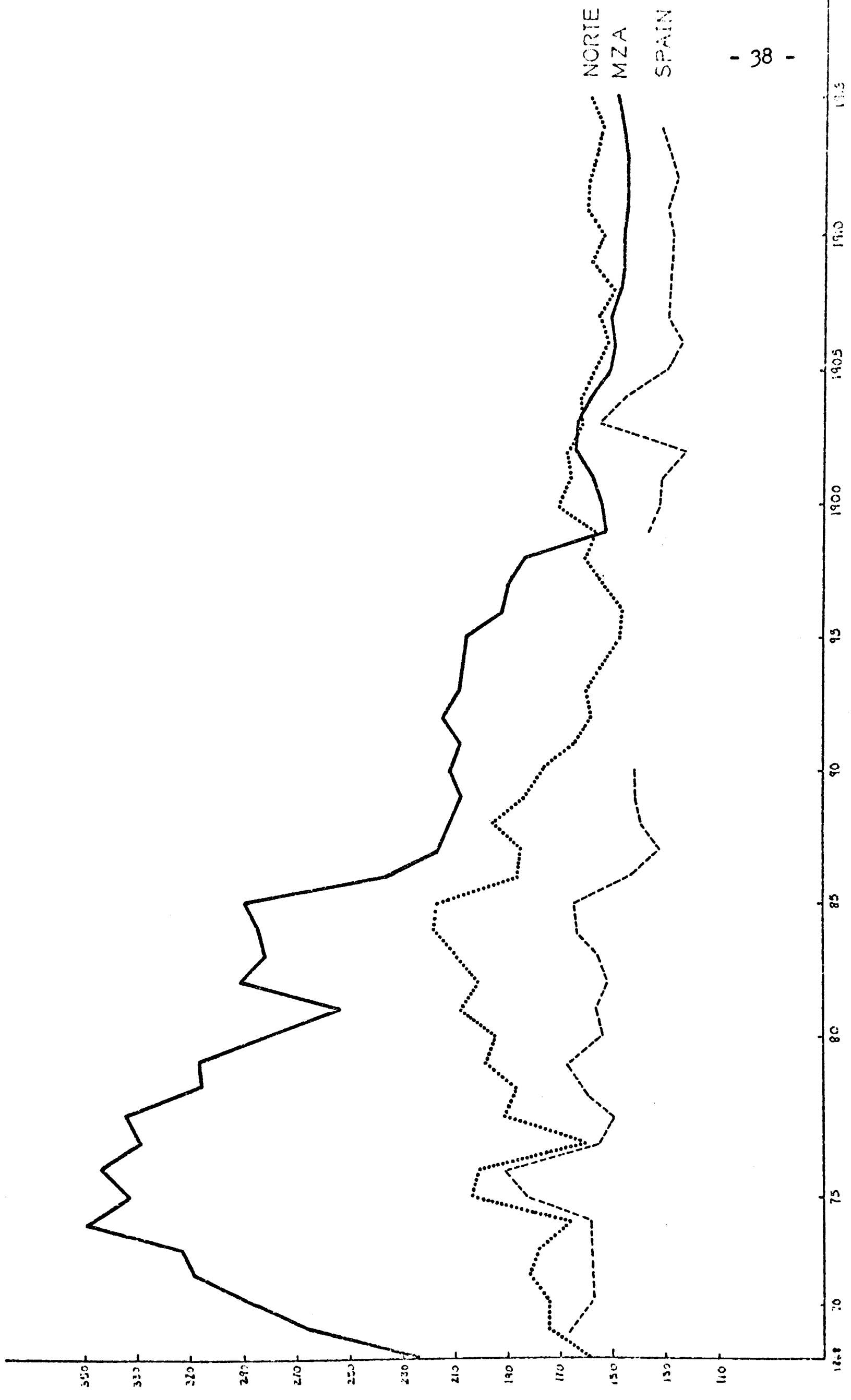


Chart 4: Average Haul (in kms.).

Source : For MZA and Norte, Memorias and Spain, Table A-3, Appendix A, pp. 104-5.

its market influence.¹ Thereafter, despite additions to the network, the average haul for MZA decreased steadily (except for 1882, when MZA merged with the Merida-Sevilla Company). This downward trend showed that MZA was incorporating local traffic and failed to grasp the potential opportunities of a wider market.

The long run stability of the average haul in Spain is matched by French railways. Between 1872 and 1913, the average haul in France fluctuated between narrow margins (± 10 kms), though the general trend was downwards.² In England, the picture is of increasing rather than decreasing hauls.³ How can we explain the downward trends in hauls in Spain?

During the second cycle of railway construction which started in 1875, more feeders to the trunk lines than trunk lines themselves were laid. An increasing share of short haul local traffic in the aggregate would have pushed downwards the aggregate average haul for Spain. Another relevant fact is that railway companies probably shipped increasing volumes of short haul commodities. For example, in 1885 Norte merged with the Noroeste Railway which served the Asturian coal-fields. By 1886, total coal shipments in tons had increased by 45 per cent. But receipts from this traffic went up by only 30 per cent showing that the increase in tonnage was to some extent offset by a fall in the average haul, since the bulk of coal was sent to the neighbouring Gijon. A final point is that railway gains in productivity were passed to users of railway services through lower rates and railways competed successfully with the carting industry over short distances.

1. See below, Section B.3.

2. Toutain, op. cit., Table 10, p. 158.

3. In England, Hawke assumed that the average haul increased linearly between 1847 and 1865, see G. Hawke, Railways and Economic Growth in England and Wales 1840-1870 (Oxford, 1970) p. 64, (hereafter, Railways).

Our findings on average hauls must now be related to the trend followed by aggregate output and tonnage carried by Spanish railways. A comparison of Charts 2 and 4 shows that output changes over time could be caused either by changes in tonnage or by changes in the average haul. In this sense, it is significant to stress that the recession in the economy from 1883 onwards which was reflected by falling output levels was made worse by falling average hauls, in spite of the clear signs of recovery in tonnage after 1885. In a similar way, a fall in the tonnage hauled in 1903 was offset by a sharp increase in the average haul. Over time, the fall in $\bar{H}$ for Spain was compensated by increasing tonnage levels.

B.3. Railway Charges:

The method used to obtain freight output estimates during the 19th century involved the use of an average rate per ton-km. based upon Norte and MZA's experience. From 1903, freight rates for the Andaluces company were also included. To what extent can this compound rate be safely applied to the whole railway economy?

The relative importance of these three companies guarantees that any bias introduced in the output estimates will certainly be a minor one. Furthermore, average freight rates for a number of other railway companies seem to validate the use of this compound rate. The evidence for this statement is contained in Chart 5. Over the period 1905-14, an increasing tendency for the gap in rates to narrow can be clearly observed. For example, in 1912 the average rate for the six companies depicted in Chart 5 was only 11 per cent higher than the compound rate of the three leading companies.¹ The chart also shows

1. The average rate for the three leading railway companies was 0.07358 pesetas per ton-km. of freight while the rate for the six companies was 0.08162 pesetas per ton-km.

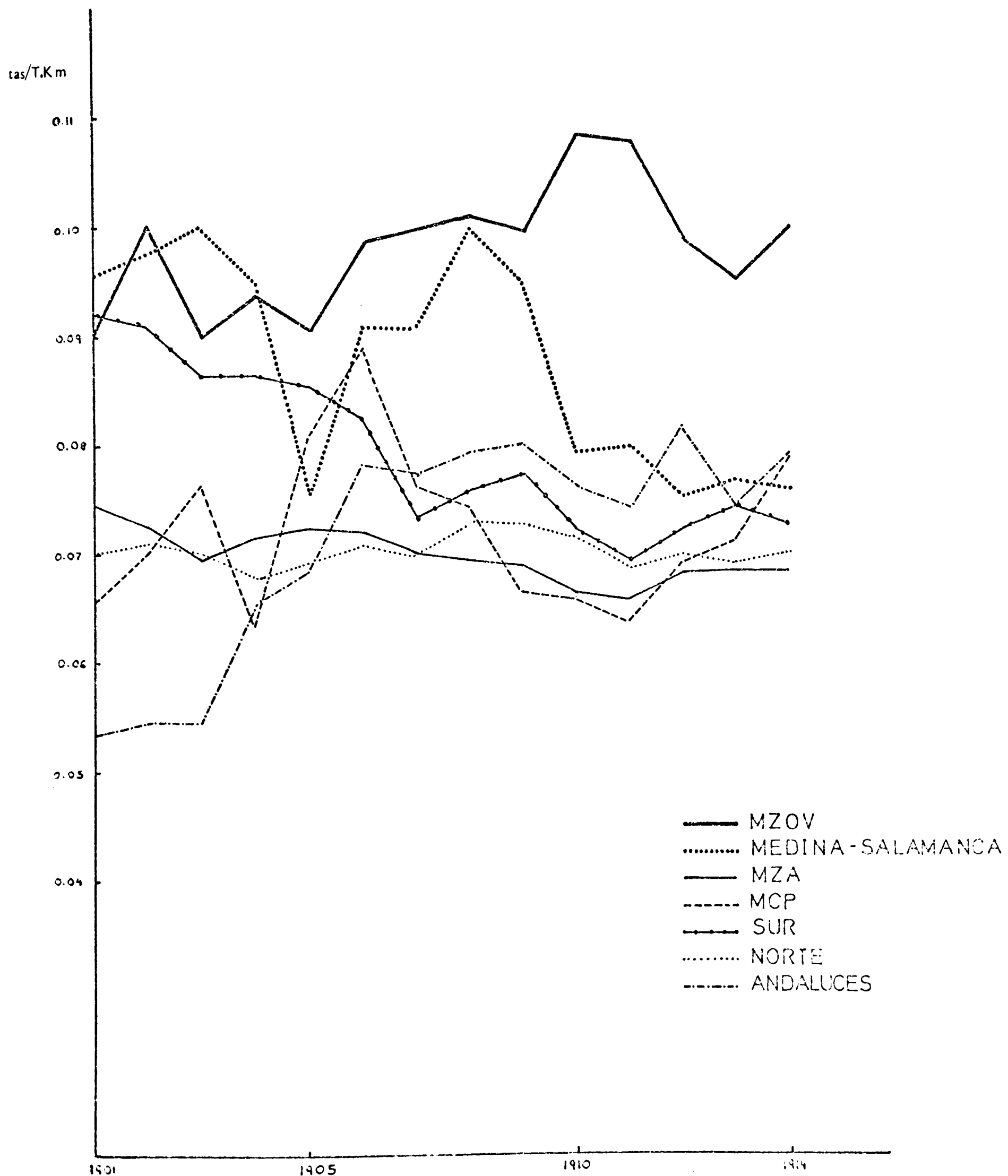


Chart 5: Freight Rates, 1901-13 (ptas/Tkm.).

Source : Memorias de Obras Publicas for the years 1901-1914 and Cambo, op. cit., II.

that larger companies such as MZOV or Medina-Salamanca tended to charge higher rates than the smaller companies.

Chart 6 shows the evolution of the average freight rate per ton-mile for Norte and MZA and that after 1898 both companies followed a similar pattern. But for earlier years, completely different trends can be observed. Over the second half of the 19th century (except for the years 1898-1900), the average rate for Norte remained well above the MZA rate. Two distinct phases can, nevertheless, be clearly distinguished:

(a) between 1867 and 1885:

The general trend of the Norte's rate is first upwards, whilst MZA's decreases. Over the 1870's, the average rate charged by Norte was over 50 per cent higher than the MZA's rate. After 1874, the two rates followed the same trend, although the gap between them widened and in 1885, the gap was at its maximum when the Norte's rate per ton-km. of freight exceeded MZA's by nearly 80 per cent.¹

(b) between 1886 and 1898:

Freight rates for MZA raised by one third in 1886, and by the end of 1887 they had already nearly doubled their 1885 value. As a result of this price increase, the gap between the rates of Norte and MZA became much thinner than it was previously. However, over these years, Norte's rate per ton-km. of freight still exceeded MZA's by 14 per cent on average.

There seems to be no clear explanation in existence for this broad divergence between the rates of the two companies. A comparison of Charts 4 and 6 seems to show that there was a stronger relationship between average hauls and average freight rates for MZA than for Norte. Indeed, in the case of MZA, the correlation coefficient between both

1. Norte, Actuación, II, Table 10, and MZA, Memorias, (1867-85).

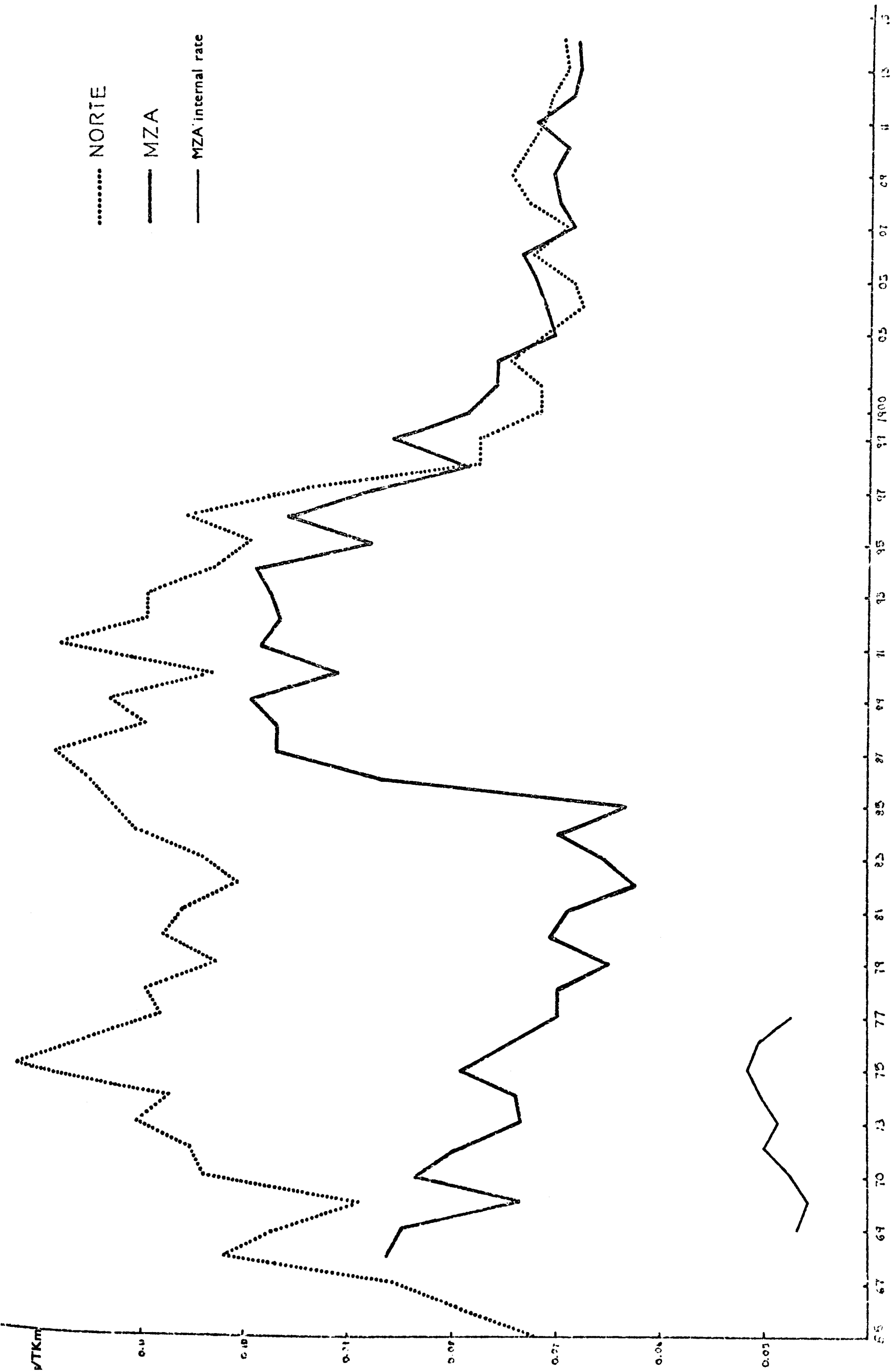


Chart 6: MZA's and Norte's Average Freight Rate (in 1913 pesetas).

Source : MZA, Memorias, 1868-1913; Norte, Actuacion, Table 10.

variables was -0.96 in the ten year period starting in 1868 with a constant network. The negative sign confirms that the cheaper the price, of transportation, the longer the distance to which the freight was shipped. Between 1878 and 1895, with an expanding network, the correlation coefficient was still -0.90.

This evidence on the relationship between rates and hauls suggests that the longer hauls for MZA helped the company to decrease its rates. Over long hauls, fixed costs of transportation spread out faster than over short hauls, where it is much more difficult to handle goods. But to some extent, Norte's average haul was also increasing between 1868 and 1885 and it was, however, accompanied by increasing rates.

A second possible explanation deals with the operating ratio (defined as the percentage of working expenditures to gross receipts) achieved by the two companies. However, it kept fairly close over time.¹ Average costs per unit of traffic (a compound of passenger and freight traffic) were in 1875 eleven per cent higher for Norte than for MZA.² But this small gap cannot explain that in this year Norte's rate per ton-km. of freight was 55 per cent higher than MZA's.

The explanation for the gap between the rates might be found in the pricing policies followed by each company. MZA's decreasing rates reflected an effort to hold up the progress of Norte in the Northern provinces. Indeed, for some years the Tudela-Bilbao Railway Company was at stake, and its alliance to MZA in the 1870's allowed the latter to compete successfully with Norte in channelling the Atlantic trade through its own lines. Norte succeeded in absorbing the Bilbao railway in 1878 and continued its advance eastwards. After 1896,

1. The operating ratio kept fairly stable, with under 50 per cent values, until the 1910's when it increased sharply due to the rising prices of coal.
2. Tedde has estimated average costs as a ratio of total costs (including financial charges) to a compound index of total traffic, see Tedde, loc. cit., Table IV-15 and IV-16. pp. 96-7.

attempts were made to put an end to the war rate between both companies and in 1906 a contract was signed between them in order to fight neighbouring railway companies.¹

Once the use of the mean rate per ton-km. of freight for Norte and MZA has been validated, the second problem which must be examined is to what extent these average prices of railway transportation can be safely used as a proxy for railway marginal costs. The identity between marginal costs and prices presumes a perfect competitive industry. However, the picture is more of monopoly as railway companies enjoyed strong monopolistic positions which were conferred on them by the radial shape of the Spanish network. Indeed, most of the routes were exclusively served by one company. In traffic flows between the centre and the periphery, the situation could be accounted as a duopoly, Norte and MZA competing to attract trade towards their sea shores.²

It seems justified to assume that railway rates were determined through monopolistic considerations rather than pure competition. Companies discriminated in favour of regions, consumers or even goods. But for the foregoing analysis, the important feature is that either pure monopoly or monopolistic discrimination will imply that average freight rates exceeded marginal costs. The use of a mean of freight rates will thus introduce a downward bias in the calculations.

1. A bondholders committee put the pressure on MZA's managers to force them to reach an agreement with Norte in 1895 when both companies were facing the financial difficulties caused by the fall in the exchange rate of the currency, see MZA, Procès Verbaux du Comité de Paris, 27 Dec. 1895, (hereafter, Procès). An agreement was finally reached to syndicate traffic between the two companies, MZA, Procès, 10 Jan. 1896.
2. For example, when the Madrid Caceres Portugal Railway Company passed a contract with the Portuguese railways in order to channel imported goods through Lisbon, MZA's reaction was of concern: '... le Comité partage l'opinion de défendre par tous les moyens possibles notre trafic ...le Comité est résolument d'avis de répondre a la déclaration de guerre du Caceres par la guerre...' (underlined in the original), MZA, Procès, 7 July 1882.

This departure from marginal costs can, however, be partially obviated by using what the companies called the 'internal rate'. These accounting rates were used by the companies to price the conveyance of the goods required to keep railways working, that is, coal, rails, and rolling stock. What the companies really meant by this concept is explained by the MZA's director to the Board:

'Le Comité a besoin d'être éclairé sur le coût réel des transports de service. Un membre fait observer que si le calcul est difficile à établir d'une manière générale pour des transports indéterminés, il ne saurait en être ainsi pour le transport des houilles, qui peut être fait par des trains spéciaux à des époques périodiquement déterminées. Le prix de traction comprenant l'usure du matériel et le personnel du train paraît suffire dans l'espèce. Le Secrétaire indique que le prix de 0.02 francs par tonne-km, lui paraîtrait suffisamment rémunérateur pour l'exploitation.' ¹

The internal rate for MZA between 1868 and 1877 is shown in Chart 5.

The fluctuations in the internal rate seem to keep pace with the average freight rate for MZA. The ratio between the two rates varied from one fourth in 1868 to one third in 1877, a peak being reached in 1875 when the internal rate was only 40 per cent of the average rate per ton-km. ² Nevertheless, the internal rate applied by Norte remained unchanged over a long period of time. ³ But in 1910, the internal rates of the two companies are the same - 0.015 pesetas per ton-km. of freight or one fifth of the average freight rate charged by MZA in that year. ⁴

1. MZA, Procès 2 July 1880.
2. Between 1868 and 1877, MZA published two different freight receipt figures, one including the freight carried for the company's own needs. Thus, the 'internal' freight rate was calculated as the difference between both rates. MZA, Memorias (1868-1877).
3. Over the period 1877-1904, the 'internal' rate was set by Norte at 0.01425 pesetas per ton-km. of freight. From 1907 onwards, it was raised to 0.015 pesetas and for 1905-1906, it was set at 0.03 pesetas per ton-km. These rates were deduced from Norte, Actuación, II, Tables 9 and 10.
4. MZA, Aprovisionamiento de Combustible para 1910, Comité de Dirección 16 June 1909.

In the calculations of the social saving, the internal and the average rate will be used. The average rate will produce an estimate of the financial charges saved by transport users and will reflect ultimately an income transfer from the owners of traditional means of transportation to the consumers. By comparison with alternate carting rates, the railway internal rate will produce an estimate of the saving in resources because of the introduction of railways. Both estimates will set the boundaries of the 'true' social saving of railways.

C). Traditional Transport:

This section is devoted to the analysis of the economic aspects of traditional transportation (canals, coastal trade and carting) before and after the construction of railways in Spain. All three forms of conveyance of goods will be examined in order to assess the cost of moving freight by each of them.

C.1. Inland Navigation:

The mountainous and irregular topography of the Peninsula prevented the diffusion of canals south of the Pyrennes during the second half of the 18th century. Inland navigation was, moreover, rare and precarious because the heat and drought rendered rivers shallow. As Richard Ford noticed in his Handbook, 'many of these river beds serve in remote districts, where highways and bridges are thought to be superfluous luxuries, for the double purpose of a river when there is water in them and a road when there is not'.¹ In spite of these geographical constraints, the Spanish government sought to provide cheap water transportation through projects for the improvement of rivers and the construction of a limited range of canals. The construct-

1. R. Ford, Handbook for Spain (1869) Part II, p. 179.

ion of the Canal of Castile actually started in 1751 and in the 1760's a concession was granted for the construction of the Imperial Canal of Aragon.¹ This ambitious project was designed to provide a commercial link between Northern and Eastern regions, avoiding the long journey by sea. While the Canal of Castile was intended to afford an outlet for Castilian grain up to Alar del Rey where it connected with a new highway to Santander, and from there corn was shipped to the American colonies.

After a hundred years of sporadic attempts at construction, (and having passed into private hands in 1831), the Canal of Castile was finally opened to traffic in 1852. For a few years, the Canal Company benefited from a monopoly in the grain and flour trade (flour was ground in mills along the canal). The composition of freight is shown in Table 1. It can be observed that the bulk of traffic took place upstream, that is from Valladolid in the interior towards Alar close to the Santander province. Grain and flour trade were dominant, and when the crop failed in 1868, flows were reversed and in that year 2.4 thousand tons of grain were shipped downstream. The sharp decrease in the tonnage shipped did not come about through competition with railways, but because Norte took over the canal.²

TABLE 1.

Canal of Castile. Composition of freight traffic (in thousand tons).

	1865	1868	1871	1874
Grain and Flour	79.0	6.4	7.1	37.1
Coal	1.2	.6	.1	-
Other	6.6	2.3	.3	.4
Total	86.8	9.4	2.5	37.5
Upstream	79.8	5.5	7.4	37.3
Downstream	7.0	3.9	.1	.2

Notes and Sources: See following page.

1. Compañía del Canal de Castilla, Fundación de una Sociedad por Acciones (Madrid, 1842) and also in P. de Alzola, Las Obras Públicas en España (Bilbao, 1899) p. 341.
2. Tedde suggests that the Canal's falling traffic was the effect of competition from Norte, See Tedde, loc. cit., p. 112.

Notes and Sources: (Table 1).

Compañía de los Caminos de Hierro del Norte de España, Datos Varios (Madrid, 1874), p. 28. The data contained in the original table published by Norte have been recalculated to reflect the right amounts in the totals.

Upstream refers to the traffic moved from the interior towards the periphery, that is from Valladolid to Alar del Rey.

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My next task is to establish if in the event of a railway shut-down, the Canal Company would have moved towards the rising end of its marginal curve because of a lack of capacity to cope with railway traffic. Although no information was found on the shipping capacity of the Canal, the 1865 freight tonnage may afford some insight into it. A conservative guesstimate of the average distance to which one ton of freight was shipped is half the total length of the canal. This will give us a lower bound estimate of the canal output capacity at 9.6 million ton-kms.¹ Railway freight data are equally scarce when it comes to estimate the volume of railway freight subject to be diverted to the canal, and it will be assumed that all the shipments between Valladolid and Alar would have been taken by the canal in the event of a railway closure and that shipments beyond these boundaries would have travelled first by road and then by water in spite of the transshipment costs involved. This exercise was performed for grain, flour and coal, the three main staples carried by the local railway. It can be seen that in the counterfactual case of a railway closure, the Canal of Castile would have absorbed 1.5 million ton-kms. of grain, 2.2 million ton-kms. of flour and 4.1 million ton-kms. of coal, or a total of around 7.8 million

1. This is the result of multiplying the 1865 total tonnage by half the distance of the canal. The only reference to the shipping capacity of the canal indicates that the company owned 300 barges, see J. Gonzales Garrido, La Tierra de Campos quoted in M. de Teran, Santander, 'Puerto de Embarque para las Harinas de Castilla', Estudios Geográficos (1947) p. 751.

ton-kms.¹ This estimate is well below the previous estimate of the shipping capacity of the canal and it guarantees that the diverted railway traffic would have been absorbed without rising marginal costs.

The Canal of Castile charged a reduced rate when shipments were made downstream (that is towards Valladolid) and when goods were carried in private barges.² In the 1880's, rates were modified in the sense that the same rate was charged in both directions, but a 0.025 pesetas discount per ton-km. of freight was still granted to private shippers.³ The next question which must be asked is if in the absence of railways, canal rates would have included a monopolistic quasirent. In the 1860's, when a competing railway line was laid between Valladolid and Alar, the canal company was forced to cut its freight rates.⁴ However, the canal managed to compete with Norte by syndicating freight shipments between Valladolid and Santander with the Isabel II Railway Company, providing in this way a shorter route to the sea shore than Norte through the Basque country. Norte tried repeatedly to break the deal between the Isabel II Railway and the canal and eventually succeeded in passing a contract with the canal company.⁵

Thus, in the event of a railway shutdown, canal freight rates would have been higher than the actual. However, the use of actual canal freight rates will not affect the social saving estimate but will understate the saving in financial charges met by transport users.

1. These figures were estimated from the actual flow of flour, grain and coal between the railway stations along the canal. Norte, Datos Estadísticos (1878) and Part III on the Pattern of Internal Trade.
2. Compañía del Canal de Castilla, Reglamento y Otras Disposiciones, (Valladolid, 1860).
3. Compañía del Canal de Castilla, Bases y Condiciones de Aplicación para las Tarifas del Transporte por el mismo (Madrid, 1884).
4. "El Ferrocarril del Norte y el Canal de Castilla", Gaceta de los Caminos de Hierro, V, (1860), 607.
5. Norte, Procès Verbaux du Comité de Paris 16 Jan. 1872 and 18 Sept. 1874.

The other main inland navigation routes included the Canal Imperial of Aragon and the navigable section of the Guadalquivir river as far as Seville. However, the Seville-Huelva Railway was only laid by mid-1879 and obviously a shut down of railways in that region will not affect the social saving calculation.

Compared with the Canal of Castile, data on the Imperial of Aragon are scanty. The Imperial which connected Zaragoza to Tudela never succeeded in attracting much traffic from the roads because it only linked the outskirts of these two important towns and its use involved important trans-shipment costs. Some evidence shows that in the 1850's, receipts hardly covered maintenance costs.¹ But in spite of these disadvantages, rates charged for the shipment of grain along the canal had forced Norte to cut its own rates 'to unprofitable levels' in order to secure the grain trade in the Zaragoza region.² A similar policy in relation to the Canal of Castile was followed by Norte in relation to the Imperial. In 1908, Norte succeeded in obtaining a lease for the operation of the Canal and rates were artificially raised to 0.12 pesetas per ton-km. of freight in order to avoid any competition from the water route.³

In the counterfactual scenario, railway traffic diverted to the Imperial canal would have involved only the traffic in goods produced near the canal and the two main local staples were wine and grain. In 1878, Norte carried only 330 thousand ton-kms. of these two commodities between Tudela and Zaragoza.⁴

1. Traffic amounted to a few barges, see Dirección General de Obras Públicas, Memoria de las Obras Públicas en España (Madrid, 1856), p.90, also G. Perez Sarrion, El Canal Imperial y la Navegación hasta 1912 (Zaragoza, 1975) appendix 2.
2. Compañías de los Caminos de Hierro del Norte y MZA, Actas de las Reuniones de la Comisión Mixta, 2 July 1909, session no. 26, (hereafter, Actas).
3. idem.
4. Norte, Datos Estadísticos (1878) and below, Part III on Inter-trade. The volume of grain traded within the boundaries of the canal amounted to 309 thousand tons, and 18,700 tons of wine.

In summary, my estimates indicate that by 1878 some 8 million ton-kms. of railway freight could have been diverted to internal waterways, or one per cent of total railway output for that year. Unlike Britain, the United States or Russia, the diversion of freight from railways to internal waterways was not possible in Spain. Norte's policy in relation to the two canals shows that if Spain had been able to build an extended network of internal waterways, savings from railways would have been far less important than they actually were.

C.2. Coastal Trade:

As de Bona noticed in 1863:

'Just as carriers have increased in numbers under the powerful stimulus from railways... railways will exert a strong and prosperous influence upon coastal trade... coastal trade and railways are harmonious and inseparable means of transportation rather than antagonistic... '1

Indeed, in some regions, for example along the Northern sea shore where no railway link was laid between the sea ports, railways and sea transportation soon became complementary. But along the Mediterranean seaboard where railways were soon laid, both systems came into competition.² This section will examine the interrelationship between railways and coastal trade by focusing on three main aspects: inland traffic liable to be diverted to sea transportation, the shipping capacity of coastal trade and the evolution of freight rates.

1. J. de Bona, "Los Ferrocarriles y la Navegación de Cabotaje", Revista Ultramarina Peninsular de los Caminos de Hierro, VIII, 1863, 351.
2. However, after 1900 some narrow gauge railway lines were also laid along the Northern sea board, for example the Bilbao-Santander. Their impact on coastal trade was soon felt. The British Consul at Bilbao reported in 1901 that 'coastal trade has greatly diminished since railway communication with Bilbao and Santander has been established', (Parl. Papers, 1901, LXXXIV), 634.

In the counterfactual economy without railways, both the freight traffic moved along the sea board by railway and the inter-regional trade between the distant Northern and Eastern provinces could have been shipped by sea. Few broad gauge lines were built in direct competition with coastal trade and only the freight carried by the Tarragona-Barcelona-Francia (TBF) and Almansa-Valencia-Tarragona (AVT) Railway Companies could have been diverted onto coastal ships in the event of a railway closure. In 1878, the TBF railway carried 39 million ton-kms. and the AVT 42.4 million ton-kms. of freight, in all, around 81 million ton-kms. or nine per cent of the aggregate output of Spanish railways for that year.¹ By 1912, the TBF moved 273 million ton-kms. and AVT some 207 million ton-kms. of freight and if we include the narrow gauge railway line between Santander and Bilbao, the total volume of freight would have come to 512 million ton-kms. of freight or 12.6 per cent of aggregate output for that year.²

The question of how much trade could have been shipped if the railways had shut down implies that the actual inter-regional long distance flows between Northern and Eastern sea boards must be taken into account. Competition between railways and coastal trade did exist because railway rates were cut in some specific routes to attract seaborne freight. And competition implies that in the absence of railways, some freight could have been shipped by sea. For example, Norte sharply reduced its rates in order to secure the traffic of goods between Northern seaports. Thus, shipments of zinc ore from

1. Dirección General de Obras Públicas, Memoria de las Obras Públicas relativa a Ferrocarriles, 1873-80 (Madrid, 1882) and Appendix A to this chapter.
2. Dirección General de Obras Públicas, Estadística de las Obras Públicas en España 1912-16: Ferrocarriles y Tranvías (Madrid, 1917) Table 9, pp. 236-41, and appendix A to this chapter.

Barruelo were attracted away from the sea route through a scheme of discount rates.¹ In long distance traffic, Norte formed a syndicate with the Bilbao Railway Company and MZA to obtain the traffic in goods between Bilbao and Alicante via Madrid.² In a similar way, MZA was forced to cut its rates in order to retain the traffic in wool shipments from Extremadoure to the Catalan textile mills which might otherwise have travelled by sea via Lisbon.³

However, actual data on long distance flows of goods between Northern and Eastern provinces served by Norte suggest that the volume of trans-shipped goods was quite limited.⁴ Coastal trade statistics tend to confirm this statement. For example, the volume of freight trans-shipped from the Atlantic to the Mediterranean sea board in 1860, prior to the construction of railways, accounted for 5.1 per cent of the aggregate tonnage shipped and from the Mediterranean to the Atlantic 13 per cent or in total 137 thousand tons of freight. In 1878, the respective percentages were 7.3 per cent, and 8.1 per cent or 155 thousand tons of freight.⁵ Thus, evidence suggests that, for both years, interseas coastal trade shipments played a minor role which was surely due to the lack of integration in the domestic market. A limited scale of exchanges by sea also confirm that inland exchanges by rail were surely small. Therefore, in my calculations I will assume that only railway borne freight in direct competition with the sea route could have been shipped by sea, or, as it has been stated, nine per cent and 12.6 per cent of the aggregate output of Spanish railways in 1878 and 1912 respectively.

1. Norte, Procès 23 May 1866.

2. Norte, Procès 2 Aug. 1865.

3. MZA, Procès 5 June 1872. Again in 1909, MZA cut its rates in the same route, this time to attract the cork trade, see Norte and MZA, Actas 1909, session no. 21.

4. See Chapter 5 on the Pattern of Internal Trade.

5. Estadística del Comercio de Cabotaje (Madrid, 1860 and 1878).

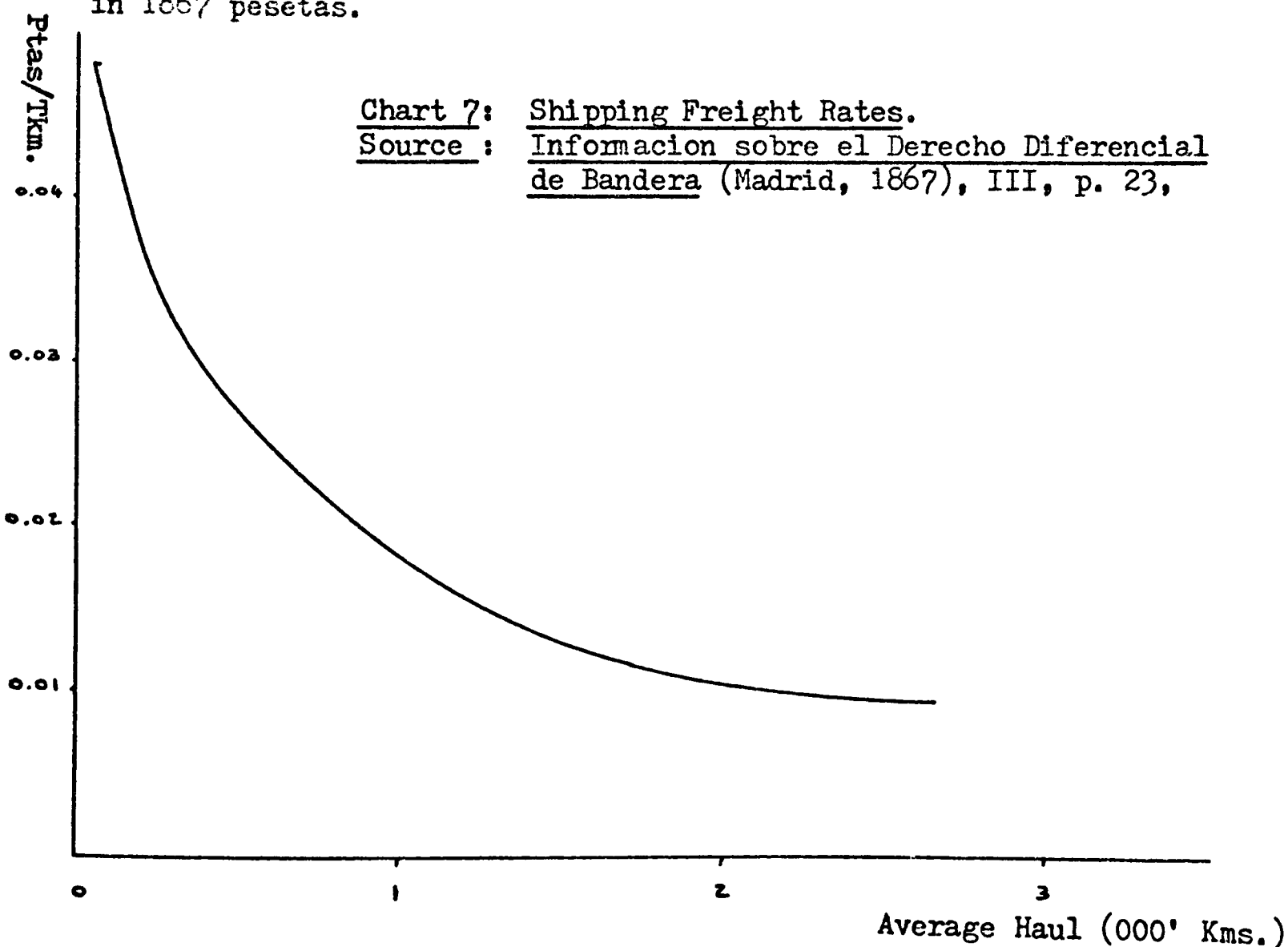
The next step in the analysis deals with the problem of capacity within the shipping industry. Official coastal trade statistics include only tonnage shipped and do not mention average hauls. According to my estimates, freight diverted to sea transportation in 1878 would have amounted to 794,000 tons and to 4.3 million tons in 1912. The estimates imply an additional demand for shipping which comes above 82 per cent of the capacity available in the first year and 138 per cent for 1912. But demand expressed in tons conceals the true capacity of the shipping industry which should be measured in ton-kms. In 1878, the tonnage of goods landed at Cádiz, Oviedo and Santander amounted to 38 per cent of the coastal trade traffic.¹ A conservative 'guesstimate' of the average haul along the Atlantic sea board would be the distance between Gijon and Bilbao, given that over half of the traffic was landed between these ports. The average haul along the Mediterranean sea board can be assumed to equal the distance between Cádiz and Alicante (which holds a central position in that board) and finally Alicante to Gijon for the intersea trade. For 1878, these assumptions would imply a shipping capacity of 554 million ton-kms. with an average haul of 556 kilometres.² Assuming that railway distances along the Mediterranean sea ports are similar to the distances by sea, the closure of railways in 1878 would have required the provision of an extra 15 per cent capacity for that year. Furthermore, some evidence suggests that there was probably a significant amount of idle capacity in the shipping industry. The slow process towards market integration made the provision of return cargoes difficult. J. Costa acknowledged that: '...only one quarter of Spanish ships were able to find cargoes, the rest in ballast (with gravel or stones)... ' and saw

1. Estadística del Comercio de Cabotaje (Madrid, 1878).

2. See Appendix B to this Chapter.

this is a prime cause in the stagnation of the shipping trade.¹ The margin which is added when empty returns are taken into account puts my shipping capacity estimate well above the counterfactual shipping demand. It is therefore possible to conclude that the shipping industry would have been able to cope with railway freight without increasing marginal costs.

Freight rates for 1867 and for the shipment of Asturian coal from Cijon are shown in Chart 7. The scattered observations show that there was a negative linear relationship between freight rates and distance which is supported by a high coefficient of correlation ($r = -0.95$). It is, however, necessary to infer the corresponding rate for the actual distance to which railway freight was moved. In 1878, the average haul of the AVT and TBF companies was 102 kms.² Once an exponential adjustment is made to the freight observations and this distance is entered into the equation, it is found that the resulting freight rate amounts to 0.03735 pesetas per ton-km. of freight in 1867 pesetas.



1. J. Costa, "dictamen sobre el Estado de la Marina Española" in Congreso de Geografía Marcantil y Colonial (Madrid, 1883), session 6, p. 301.
2. See Appendix A to this chapter, Table A-1.

However, when these freight rates were compiled in 1867, most of the shipping was still performed by sailing ships. Technological innovations in shipping through the introduction of iron in the construction of ships and the substitution of steam for sailing ships helped to decrease waterborne freight rates. In 1860, over 96 per cent of the shipping tonnage was still provided by sailing ships. In 1885, this ratio had fallen to 37 per cent.¹ At the same time, improvements to harbours such as the Ría of Bilbao, Gijon and Barcelona enabled ships of higher tonnage to dock, which decreased further the fixed shipping costs. Therefore, it is necessary to adjust the estimated 1867 freight rate to incorporate these later developments in the shipping industries. Indeed, the falling trend of freight rates over the second half of the 19th century was significant. For example, by 1900, freight rates for the shipment of coal from Gijon to Barcelona had decreased by 80 per cent.² North's ocean freight index is a good proxy to adjust my estimate.³

To summarise this section, it should be emphasised that coastal trade had succeeded in adapting to the railway challenge by providing a cheaper transport alternative. In the early 20th century, the pricing policy of the two leading railway companies was still designed to offset competition from seaborne traffic. Norte's and MZA's pricing policies in the Mediterranean coastal regions indicates that coastwise trade was depriving them of profits.

C.3. Overland Transportation:

On the eve of railway construction, the traditional transportation system was probably very similar to the picture drawn by Ringrose

1. E. Frax, El Comercio de Cabotaje en la Epoca de la Restauración (Madrid, 1978) mimeographed, p. 74.
2. (Parl. Papers, 1900, XCIV), 142.
3. See Table 3, row (7) and notes on the Table, pp. 32-3.

for the second half of the 18th century.¹ The persistence of subsistence agriculture throughout the 19th century, the lack of technological advances in road transportation (either in the form of better animals, new carts or improved highways) implies that descriptions for the 18th century are valid right up to the introduction of railways. In this section, I will first examine the mechanisms of the traditional carrying system and second I will focus on the actual price of road transportation.

A significant share of transport services was provided by part-time carriers, mostly farmers, who hauled local crops to nearby markets during the slack season.² They were engaged mainly in agriculture and transport provided only a secondary source of income. They operated in short hauls and offered a network of intra-regional transportation services. As opposed to part-time carriers, professional carriers supplied transportation over the whole year, except for two or three winter months when roads were muddy and often impassable. Many contemporary writers, travellers and official publications referred to the bad state of the highways and country roads during the rainy season.³ Draught and pack animals would rest during these months to be fit for the coming working time.⁴

Nineteenth century Spain faced a transport bottleneck because of the inelasticity of supply to meet the requirements of its developing economy. Nevertheless, the transport system as it evolved over time provided non-specialised services at low cost, particularly for the

1. D.R. Ringrose, Transportation and Economic Stagnation in Spain 1750-1850 (Durham, 1970), (hereafter, Transportation).
2. Ringrose, Transportation, Chapter 3, pp. 48-54.
3. The answers to the Información Vinícola which has been extensively used for estimating the price of overland transportation is a good source to appreciate the extent of this problem.
4. Thaer stressed that the maximum number of working days for farm animals could not exceed 300 days, see A.D. Thaer, The Principles of Agriculture (1844) p. 74. Therefore, we can assume that this resting period would have coincided with the rainy season.

haulage of bulky commodities of little value. Peasant carriers were competitive with professional carters because their fixed costs were shared with their primary activity, that is agriculture. Moreover, the part-time carrying trade was certainly perfectly competitive in the sense that there were no barriers to entry. Professional carriers, on the other hand, were also moving in the same direction. In the second half of the 18th century, they belonged to guilds which aimed to protect their trade from outside interference, defended their prerogatives (for example, they were exempted from turnpike tolls) and guaranteed the use of grasslands where draught animals could graze.¹ The position of the guilds started to weaken in the 19th century when demographic pressure transformed pasture into arable. The decline of guilds gradually undermined the monopoly of professional carriers and in the middle decades of the century, the trade had become much more competitive. There are instances, however, of highly specialised arrieros, for example, the Maragatos in the province of Leon who continued to charge monopolistic rents and benefited from the renowned reliability of their services.² For these reasons, I will assume that when railways started to be laid the professional carrying trade was much more competitive and therefore that actual prices of transportation reflected marginal costs.

In spite of the overwhelming importance of overland transport within the subsistence economy, contemporary writers paid surprisingly little attention to the specific problems of road transportation. As a result, most of the data which have been used in my calculations had to be gleaned from a variety of sources. The main source on prices of road transportation was an official enquiry on the wine trade in the

1. Ringrose, Transportation, Chapter 7, pp. 103-16.

2. G. Borrow, The Bible in Spain (1889), p. 162.

1880's.¹ From these price quotations, rates per ton-km. of wine were derived and are presented in Appendix D to this chapter. Rates differentiated between waggon and pack animals, and in my calculations, I have obtained average rates for different distance intervals. The results are shown in Chart 8, parts A and B. Two features ought to be stressed: first, both waggon and pack animal rates relate negatively to the distance travelled, and once average fixed costs had spread out, the decreasing tendency smooths and beyond a certain distance, the actual price of road transportation remains constant. Second, waggon rates remain lower than pack animal rates, and the gap increases as distance lengthens.

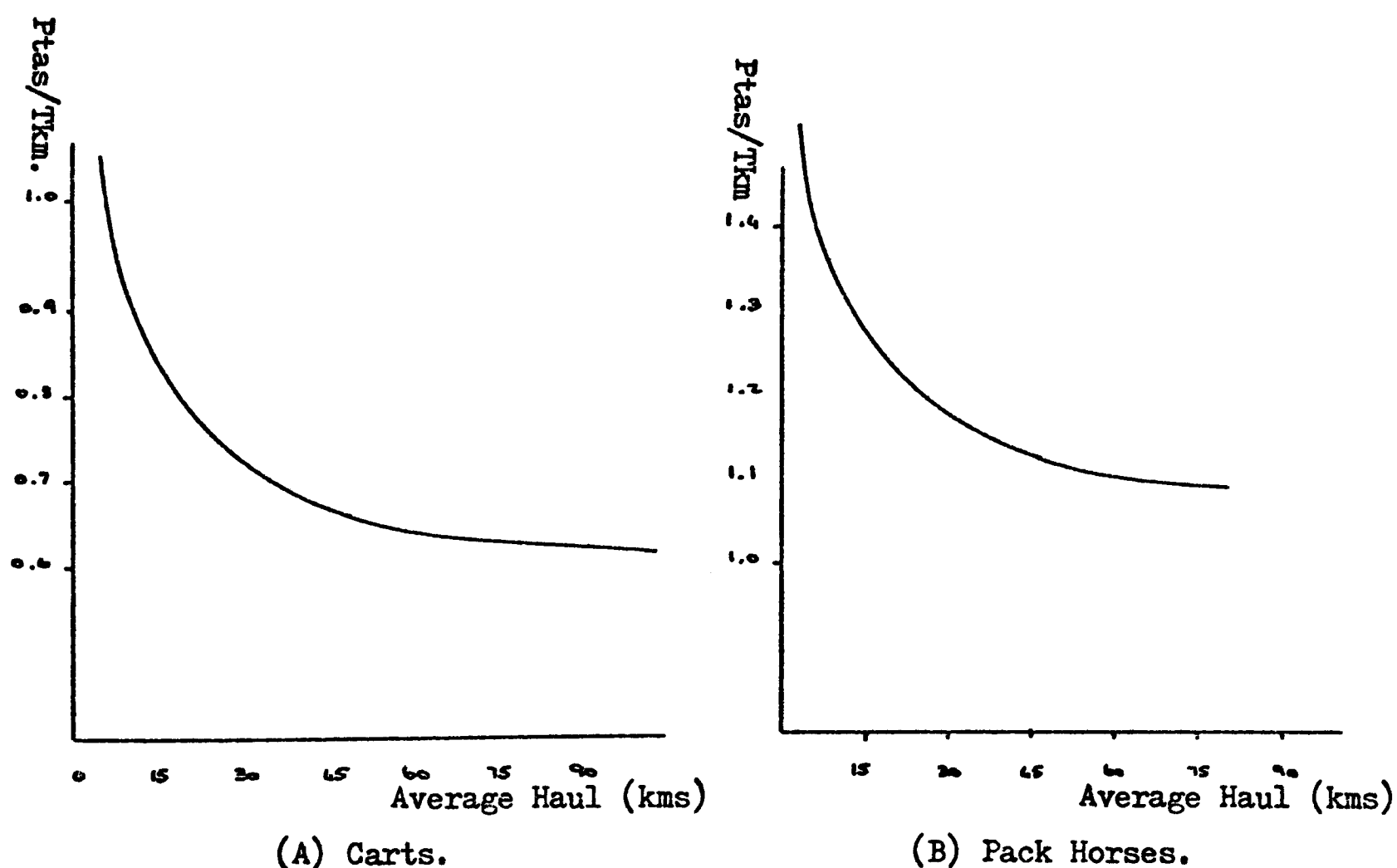


Chart 8: Carrying Rates of Traditional Transportation.

Source : See Table D-1 in Appendix D to this Chapter.

1. In particular in Part II question 2 referred to the means used to provide an outlet to local wine surplus and the price of transport to the nearest railway station and from there to the French border, see Información Vitícola de 1886 (Archivo del Ministerio de Agricultura leg.79). For further details, see Appendix D to this chapter.

My next task is to examine to what extent these rates for the haulage of wine can be safely used in my social savings calculations. In this sense, we will have to answer questions relating to the representativeness of these rates, their evolution over time and, finally, they will have to be weighted according to the respective capacities of the carting and pack animals' trades.

First, to what extent can the price for wine transportation be extended to all commodities? My estimates on the average rate for the main staples moved by Norte in 1878 show that the rate for wine had a central position within the rate spectrum and was actually very close to the average rate per ton-km. of freight for that year.¹ I will, therefore, assume that also in the overland carrying trade, wine was an average commodity group.

Table 2 shows the evolution of some quotations over the second half of the 19th century. Comparisons are, however, difficult to draw because these rates do not relate to specific distances or commodities. Nevertheless, all rates show a relative stability except for the 1873 rate which coincided with the civil war and the 1882 one. In general, the quotations in the Table are lower than the prices in Chart 8, owing to the fact that the former refer to bulkier commodities.

Finally, the rate to be used in the social saving calculation should be properly weighted to reflect the carrying capacity of the carting industry and its beasts of burden or arriería. Although the carting industry expanded over the first half of the 19th century with

1. Norte's average rate per ton-km. of freight was in 1878 0.102 pesetas, see Table A-1, appendix A. From Norte's Datos Estadísticos of 1878, the output in ton-kms. for the main staples carried by Norte in that year were estimated, see chapter on the Pattern of Internal Trade. Given the total receipts per commodity class, I could deduce the average rates. The average rate per ton-km. of wine was in 1878 0.0934 pesetas, or 9 per cent lower than the overall average rate. Other rates ranged from 0.1762 pesetas per ton-km. of textiles, to 0.0585 pesetas per ton-km. of coal. The other main staple shipped by Norte, grain, was charged 0.09437 pesetas per ton-km. and flour, 0.11293.

the construction and improvement of highways, most contemporary writers referred to the extension of the carrying trade by way of pack animals after the 1850's. According to a leading contemporary economist, the perdurability of this situation was explained by:

' ...the attachment (to pack animals) of peasant families who were brought up in this trade, the attempt to defraud turnpike tolls by using side bridle paths, high railway rates and the risks involved in trans-shipments'.¹

Moreover, the extensive use of the mule, preferred to the horse or oxen, was explained because:

' ...agriculture needs a swift-footed animal, capable of travelling to the plots in little time, for moving goods to the market... ; a motive power for superficial ploughing which may give good yields if not perfect; an animal dry fed and not requiring fodder, and just as good for drawing a cart or plough as serving as pack animal'.²

The popularity of the mule reflected in a high mule to horse ratio.

In the second half of the 19th century, the ratio had peaked at 1.57, while in the late 18th century, it was only 1.37.³

The numbers of carts and pack animals are, however, difficult to count. There seems to have been an overwhelming majority of pack animals. For example, in the Eastern region between Casas Ibanez and

1. F. Caballero, Resena Geográfico Estadística de España (Madrid, 1868) p. 99.
2. Dirección General de Agricultura, Industria y Comercio, La Ganadería en España: Avance sobre la Riqueza Pecuria en 1891 (Madrid, 1892) Avila p. 62 (hereafter, Ganadería). Richard Ford explained that the use of the mule was in such demand because: '...(the mule) has something in his morale which is congenial to the character of his master: he has the same resignation under burdens, the same self willed obstinacy, the same capability of endurance of labour, fatigue and privation', Ford, Handbook, pp. 163-4. Most contemporary writers debated on the uses or misuses of the mule in agriculture, see in particular N. Casas, Diccionario Manual de Agricultura y Ganadería Espanolas, (Madrid, 1857), p. 297. On the advantages of the mule over horse labour, see R.L. Allen, Domestic Animals (New York, 1848), pp. 168-9. On the disadvantages of the mule, see J. Tellez "Del Ganado de Labor Preferible", Conferencias Agrícolas de la Provincia de Madrid (Madrid, 1876-7), pp. 309-22.
3. M. Prieto, "Cria Caballar", Gaceta Agrícola, XX (1881), p. 146.

Utiel, 11,500 pack animals could be counted and only 1,448 carts.¹

The problem is, however, obviously easier to solve with respect to the professional carrying trade than to the part-time peasants. In the first group, the Contribución Industrial y de Comercio reported that in 1879 the number of arrieros and trajineros (muleteers) amounted to 16,741 and that some 17,450 taxpayers were engaged in carting.²

In the aggregate, some 34,200 individuals full time engaged in transportation. But this figure falls short by half of the number enumerated in the 1877 Population Census.³ Two reasons may explain the difference.

First, the fiscal origin of the Contribución led to an understatement of the number of 'potential' taxpayers. Secondly, the fact that individuals engaged in transportation who were not owners of carts would be included in the Census data but not in the Contribución. Given that the Contribución offers more reliable statistics of the larger scale professional carrying trade, pack animals in that trade outnumbered carts by only 25 per cent.⁴ If carts and animals are expressed in capacity equivalent figures, the 'potential' predominance of pack animals over carts in the professional sector will vanish away. Indeed, beasts of burden amount to only twenty per cent of the total capacity in the professional sector.⁵

1. Proyecto de Ferrocarril de Villagordo a Utiel (1888) Archivo de Renfe. In 1858, Madrid had 492 pack horses and 572 mules and horses providing full time transportation services, and in the aggregate 207 carriages distributed in the following way: waggons (40); carts (152); galeras (1); tartanas (14), Riqueza Pecuaria y Transportes terrestres y fluviales, Archivo Municipal de Madrid, Sección de Estadística, leg. 6-60-20.
2. Dirección General de Contribuciones, Contribución Industrial y de Comercio (Madrid, 1879), Tables 26 to 32, (hereafter, Contribución).
3. Dirección General de Estadística, Censo de Población de España (Madrid, 1877), provincial totals under 'Arrieros y Carreteros'.
4. The total number of waggons came to 18,443 while pack animals (excluding draught animals) amounted to 22,889. Source Contribución, Tables 26 and 32.
5. See Appendix C to this chapter.

TABLE 2.

Evolution of Carting Rates 1848-1900

(in current pesetas and 1878 constant pesetas).

Year	Rate ₁	Rate ₂	Observations
1848	2.98	3.1298	Wine Class (1)
	2.03	2.132	Grain Class (1)
1855	0.5278	0.5278	Class (2)
1862	0.625	0.5727	Class (2)
1873	0.905	0.9479	Class (2)
1880	0.4	0.4151	Class (2)
1881	0.55	0.5670	Class (2) Coal
1882	0.9542	0.9491	Class (2) Iron Ore
1889	0.59	0.6914	Class (1) Ores
1890	0.6667	0.7430	Class (2) Manure
1900	0.60	0.5795	Class (2) Iron Ore

- 0 -

Notes and Sources:

Column 1: Rate₁ refers to carting rates expressed in current pesetas.

Column 2: Rate₂ refers to carting rates expressed in pesetas of 1878

(1) : refers to pack animals and

(2) : refers to waggon transportation.

The rates were deflated according to Sarda's price index.

1848 : "Informe de la Comision nombrada para que informe del camino que ha de conducir de los pueblos de Chinchon y Morata a esta Corte", Caminos Vecinales. El Agronomo (1848), 5.

1855 : Evrard, Les Moyens de Transport (Paris, 1874), pp. 122-3.

1862 : D. Manes, "Noticia sobre las minas de Somorrostro", Revista Minera (1873), 21.

1873 : Compañía del Norte, Proces Verbaux des Reunions du Comite de Paris, 26 April 1873.

1880 : L. Gorostiza, Apuntes sobre la Rebaja de Tarifas (Madrid, 1881) p. 26.

1881 : Projet de M. Legrand d'un chemin de fer de Penarroya a Lerena (Renfe Box 13).

1882 : W. Gill, "The Iron Ore District of Bilbao", JISI (1882), 63.

1889 : F. Gisbert, "Exportación de Minerales de la Sierra de Cartagena", Revista Minera (1889), 23.

1890 : Provincia de Tarragona in Avance Estadístico sobre el Cultivo de Cereal y de Leguminosas Asociadas en España (Madrid, 1890) III.

1900 : P.M. Clemencín, Siderurgia y Transportes Mineros (Madrid, 1900), p. 2.

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In the part-time sector, relative capacities are even more difficult to assess. A contemporary estimate reckoned that in this sector, pack animals contributed to 25 per cent of the total capacity.¹ This same source states that the number of carts engaged in transportation amounted to nearly 450 thousand and beasts of burden numbered 613 thousand. Therefore, the former estimates for both the professional and part-time sectors show that when relative capacities are taken into account, the traditional view of an overwhelming arriería must be qualified. Furthermore, because railways were built along existing highways, railway traffic could have been taken over by waggon in a counterfactual situation without railways, assuming that the pattern of distribution of railway traffic remained unchanged. Thus, the lack of material constraints on the use of carts, their relative cheapness and their higher carrying capacity imply that in the counterfactual world the economy will react to the closure of its railways by moving goods preferably by cart, at a rate similar to the cart to pack animal ratio. The price of transport will be a weighted average rate derived from the data contained in Chart 8, and adjusted to the average haul of railway traffic. This compound carting rate comes to 0.7937 pesetas per ton-km. of freight.²

Hence, the essential feature of this traditional system is that the supply of transport services depended upon agricultural labour and animals and was highly seasonal. At harvest and sowing times, the supply was restricted to professional carriers, as farmers

1. According to this estimate, the capacity output of the carting industry was 2,677 million ton-kms. in 1865, while pack animals could move an additional 867 million ton-kms. or about one third, see F. Caballero, op. cit., p. 96. This table and calculations were published in an anonymous article "Estadística de Transportes Terrestres", Gaceta de los Caminos de Hierro XIII (1868), pp. 161-3.
2. See below notes on Row (9) of Table 3, p. 69.

and their workers were fully engaged on the land. Moreover, both the professional and part-time sectors in the carrying trade were perfectly competitive in the sense that there were no barriers to entry. In this sense, actual price of road transportation reflected true opportunity costs of the resources engaged in transportation. Finally, although the relative capacities of the professional and part-time sectors have not been quantified, evidence suggests that at least 80 per cent of the transport demand would have been satisfied by carts.

D). An Interim Calculation:

The results of the two previous sections will now be combined in the social saving calculation. These sorts of estimates for Spanish railways are, however, not new. As early as 1866, the railway companies estimated that the saving accruing to transport users after railways had started to be laid was not less than 75 million pesetas annually.¹ In the 1880's, the director of MZA replied to critics on the dearness of railway transport by claiming that if:

'...freight receipts of the Spanish railway network are one hundred million pesetas every year, agriculture and trade are benefiting from an annual saving of two hundred million pesetas' (underlined in the original).²

And he alleged furthermore that his estimate should be viewed as a lower bound.

1. "Exposición de las Compañías de Ferrocarriles", Gaceta de los Caminos de Hierro, XI (1866), 113-5.
2. The estimate was presented as a lower bound by stressing that the haulage of goods by road could not be performed for less than 0.22 pesetas per ton-km. of freight, see MZA, "Datos Estadísticos facilitados por la Compañía de MZA", in La Crisis Agrícola y Pecuaria: Información Escrita (Madrid, 1887) vol. VI, p. 122, (hereafter, Crisis).

Tables 3 and 4 present two estimates of the social saving of Spanish railways in 1878 and 1912. My 1878 estimate suggests that the contribution of railways was much larger than was anticipated by MZA's director. Moreover, the results also show that the elimination of monopoly pricing by railway companies, that is the use of an internal rate instead of the average rate per ton-km. of freight, involves an extra saving of 57 million pesetas or a 12 per cent increase in total benefits.

Economic historians have tended to express social savings in terms of GNP estimates. Expressed in terms of Mulhall's national income estimate for 1878, my social saving estimate accounts for 11.8 per cent.¹ Therefore, the shutdown of railways for one year in 1878 would have entailed a loss of 12 percentage points in national income. Similarly, by 1912 the direct benefits from railroad operation accounted for 18.5 to 23 per cent of that year's national income.²

However, the unreliability of Mulhall's estimate urges us to find alternative ways to visualise the size of social savings. For comparative purposes, social savings exceeded in 1878 the value of Spanish exports by 26 per cent. An alternative way to assess these savings involves the calculation of the acreage of arable land necessary to feed the animal population required to sustain economic growth at its 1878 actual level in the absence of railways. In a period of rising population, the opportunity costs of bread grain land become highly substantial.

1. Mulhall's estimate for Spain's national income in 1879 is 175 million pounds or 4,375 million pesetas, see M. Mulhall, Progress of the World, (London, 1880), p. 437.
2. There are two national income estimates for 1912. The first was built by the Consejo de Economía Nacional and comes to 10,210 million pesetas, see B.R. Mitchell, European Historical Statistics, (London, 1978) Table J1, p. 415. A revised estimate has been produced lately by the Instituto de Estudios Fiscales which comes to 12,638 million pesetas, see Instituto de Estudios Fiscales, Datos Básicos para la Historia Financiera de España, 1850-1975, p. 1142.

My capacity estimates for carting and hauling goods entail that some 519,000 mules (or horses) would have been required to provide 669 million ton-kms. of freight services in 1878.¹ The feeding needs of this animal population for one year amounted to 10.15 million quintals of barley or 1.12 million hectares of land.²

The opportunity costs of this land involve the loss of wheat output as it becomes necessary to grow animal feedstuffs rather than bread grains. Expressed in terms of wheat acreage in 1891, the social savings from railways amounted to somewhere in between 32 and 43 per cent.³

1. This calculation is based on the assumption that carting would have provided 80 per cent of the transportation output, see text. Furthermore, it was assumed that carriers would engage in transportation all year round, or 248 days, that is, the calendar year deducting feast days and a two month rainy season allowance for the impassability of roads, see section E.1., pp. 78 and 79. Finally, effective transportation was held to be 75 per cent of the full capacity, see text. Therefore, the effective transportation capacity of a cart will be 3,350 ton-kms. per year and 670 ton-kms. for a mule. The final estimates involve the provision of 159,000 carting journeys or 319,000 mules and a further 200,000 mules for pack carriage.
2. These calculations are based on the information provided by Table 6. The feeding allowance per mule amounts to 30.9 Hls. of barley per year. It is the result of 6.3 litres per day as a maintenance allowance or 23 Hls. for 365 days, and a 3.2 litres allowance while at work during the remaining 248 days or 7.9 Hls. of barley were transformed into weights by use of a coefficient:- 1Hl. = 0.633 metric quintal. The yield of 9.06 Qm/Ha. is provided by the Junta Consultiva Agronómica in 1891, see Junta Consultiva Agronómica, Avance Estadístico del Cultivo Cereal y de Leguminosas Asociadas (Madrid, 1891) III, pp. 597-8. An alternative yield of 6.7 Q/Ha. for 1860, though very unreliable, was produced by S. Millet, see J. Vicens Vives, Historia Económica de España (Barcelona, 1969), p. 585. Using the latter yield, the equivalent land acreage becomes 1.51 million hectares.
3. There are two estimates of area of wheat for 1891, see Junta Consultiva Agronómica, op. cit., pp. 595-6, amounting to 3.5 million hectares under wheat, and E. de la Sotilla, "Producción y Riqueza agrícola de España en el ultimo decenio del siglo XIX y primero del XX", Boletín de Agricultura Técnica y Económica V, (1911), amounting to 2.6 million hectares.

TABLE 3.

The 1878 Social Saving Estimate.

(1)	Railway Output	876.1	10^6 Tkm.
(2)	Railway Charges	0.08537 ^P	/Tkm.
(3)	Railway Cost	0.02165 ^P	/Tkm.
(4)	Canal Output	8.0	10^6 Tkm.
(5)	Canal Cost	0.1403 ^P	/Tkm.
(6)	Coastal Trade Output	81.0	10^6 Tkm.
(7)	Freight Rate	0.04053 ^P	/Tkm.
(8)	Overland Output	669.0	10^6 Tkm.
(9)	Carting Rate	0.7937 ^P	/Tkm.
(10)	Saving of Charges	459.6	10^6 Ptas.
(11)	Social Savings	516.4	10^6 Ptas.

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Notes and Sources:

- Row (1) : Railway output in millions of ton-kms. from Table A-1 Appendix A, p. 99.
- Row (2) : Railway freight rate in pesetas per ton-km. from Table A-1 in Appendix A, p. 99.
- Row (3) : Railway Cost in pesetas per ton-km. from MZA's internal rate, see text, pp.46-7 and MZA, Memorias 1878.
- Row (4) : Canal Output in millions of ton-kms. is the railway freight which hypothetically would have been transferred to internal waterways during a railway shut-down, see text pp. 49-52. for calculations.
- Row (5) : Canal Cost in pesetas per ton-km. is the average rate for the haulage of grain and flour shipments along the Canal of Castille, see Compania del Canal de Castilla, Bases y Condiciones de Aplicación para las Tarifas de Transporte por el mismo (Madrid, 1884). The Sarda's price index was used as a deflator.
- Row (6) : Coastal Trade Output in million ton-kms. reflects railway output transferred to coastal shipping, see text, pp. 52-3.
- Row (7) : Freight Rate in Pesetas per ton-km. from Chart 7, p. 56. North's Ocean Freight Index was used to reflect the impact on freight rates of the increasing use of steam ships in coastwise trade, see D. North, "Ocean Freight Rates and Economic Development, 1750-1913", in Journal of Economic History XVIII (1958), 537. The new rate was then deflated according to Sarda's price index.

Notes and Sources contd. (Table 3).

- Row (8) : Overland Output in million ton-kms. measures the railway freight output reallocated to road transport as a difference of (1) - (4) - (6). Railway distances had to be qualified because of the 'roundaboutness' of railways with respect to road distances. This factor was calculated by comparing the distance from Madrid to all major provincial towns both by railway and by road. It showed that distances by railway were 15 per cent longer than by road.
- Row (9) : Carting Rate in pesetas per ton-km. This rate is a compound of carting and pack animals estimated in section C.3. under the assumption that carting would provide 80 per cent of the road transport supply. Chart 7 suggests that beyond 90 kms. (or 103 kms. in railway equivalent) carting and pack animal rates would have been constant at 0.6011 and 1.0585 pesetas per ton-km.
- Row (10) : Saving of charges (in million pesetas) or the direct benefits of railroad over alternative means of transportation when railway average rate quotations are used.
Saving of Charges = (4) x (5) + (6) x (7) - (1) x (2).
- Row (11) : Saving of Real Resources (in million pesetas) using real costs (3) instead of railway tariffs (2).

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TABLE 4.

The 1912 Social Saving Estimate.

(1)	Railway Output	3,780	10 ⁶ Tkm.
(2)	Railway Charges	0.07088 ^P	/Tkm.
(3)	Railway Cost	0.015 ^P	/Tkm.
(4)	Coastal Trade Output	475	10 ⁶ Tkm.
(5)	Freight Rate	0.04245 ^P	/Tkm.
(6)	Overland Output	2,809	10 ⁶ Tkm.
(7)	Carting Rate	0.8447 ^P	/Tkm.
(8)	Saving of Charges	2,125	10 ⁶ Ptas.
(9)	Social Savings	2,336	10 ⁶ Ptas.

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Notes and Sources:

- Row (1) : Railway Output in millions of ton-kms. from Table A-2 in Appendix A, pp. 102-103.
- Row (2) : Railway freight rate in pesetas per ton-km. from Table A-2, p. 102.
- Row (3) : Railway Cost in pesetas per ton-km. from MZA's internal rate, see MZA, Aprovisionamiento de Combustible en 1910.

Notes and Sources contd. (Table 4).

- Row (4) : Coastal Trade Output in millions of ton-kms. as the sum of the freight output of the TBF and Almansa-Tarragona railway lines. For the TBF quotation, see MZA, Memoria (1912), p.41. For the Almansa-Tarragona, see Dirección de Obras Públicas, Estadística de las Obras Públicas en España (Madrid, 1919), Table 9.
- Row (5) : Freight Rate in pesetas per ton-km. is the 1878 freight rate deflated according to Sarda's price index.
- Row (6) : Overland Output in millions of ton-kms. measures the railway freight reallocated to overland transportation as the difference between (1) and (4), and after being qualified to reflect the 'roundaboutness' of railways, for coefficient, see notes on row (8) in Table 3, p. 70.
- Row (7) : Carting Rate in pesetas per ton-km. is the 1878 carting rate deflated according to Sarda's price index, see row (9) of Table 3, p. 70.
- Row (8) : Saving of charges (in million pesetas) or the direct benefits of railroad over alternative means of transport as the difference: $(1) \times (2)$ and $(4) \times (5) + (6) \times (7)$.
- Row (9) : Saving of real resources using real costs (3) instead of railway rates (2).

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E). Biases:

This section will be devoted to discussing the various biases which have been introduced in the calculations by the assumptions of the model. These biases in upward and downward directions can be summarised in the following way:

		Upward	Downward
(a)	$\epsilon = 0$	+	
(b)	Perfect Competition		+
(c)	Railway Subsidies	+	
(d)	Highway subsidies		+
(e)	Full Employment	+	

The zero price elasticity assumption presumes that the counter-factual economy will demand a constant volume of transportation services in spite of the large price increase in transportation. Professor Fogel has recently shown that calculations based on the zero elasticity assumption are extremely sensitive to changes in ϵ^1 . However, these

1. See Fogel, loc. cit., Table 2, p. 12.

criticisms forget the restricted objectives of a social saving calculation. The release of this assumption leads to historical enquiries beyond the purposes of the model, which is simply a tool of static analysis and was not designed to take into account dynamic factors in economic growth. If the argument on the release of the zero price elasticity assumption is followed, it will then be necessary to ascertain the changes in the all-other-things sector and the level attained by the new gross national product. This is a major weakness of all these criticisms. Indeed, the new social saving estimates are still related to the old GNP achieved in the economy served by railways. If the railways shut-down affects the location of economic activity by curtailing production, it is obvious that the post-closure GNP will be lower than the actual and therefore the share of social savings in GNP higher than if related to the actual GNP.

For purposes of calculation, it was assumed that railways were perfectly competitive. Any differential between railway rates and actual marginal costs will understate the social saving estimate. However, the estimate was improved using an 'internal rate' for the railway companies which is a more accurate indicator of the real costs of railway operation.¹ As a result, the 1878 social savings will be increased by 12 per cent.

Biases (c) and (d) originate from the fact that railway companies paid for the maintenance costs of their track whereas road carriers enjoyed free right of way on most roads, after turnpikes were abolished in 1869.² Therefore, the charges quoted by carriers for overland transportation will fail to reflect full social marginal costs because highway maintenance costs were entirely met through state budget. The

1. See above section, B.3., p. 46.

2. Turnpikes were abolished in July 1869 but were temporarily reinstated in 1877 for ten years along some highways.

state was in effect subsidising the traditional carting industry and the social costs of carting are understated by its tariffs. However, as a compensatory factor, railway companies were also granted state subsidies on their construction by the Railway General Law of 1855. Had these sums not been advanced, railway rates would have been higher in order to cover higher construction costs. Thus, actual railway rates overstate social savings, whereas carting rates may understate them.

The full employment assumption is that all factors of production are fully employed in the actual and counterfactual economies. If the 19th century Spanish economy was less than fully employed, the cost to society of employing additional resources in the traditional transportation sector will be overstated by factor costs expressed at market prices. Social savings will be adjusted by means of a shadow price which reflects in a better way the true opportunity cost of resources.¹ This issue will be treated at length in section E.1.

E.1. The Release of the Full Employment Assumption:

Professor Toniolo has recently criticised the use of the social saving model in the context of backward European economies like Spain and Italy.² He argued: in countries with large subsistence sectors where the supply of labour at the prevailing subsistence wage was probably highly elastic, social savings may lose all their

1. For the methodological issues behind a departure from full employment, see in particular, I.M.D. Little & J.A. Mirrlees, Manual of Industrial Project Analysis in Developing Countries (Paris, 1969) Chapter XIII, A.J. Harrison, op. cit., Chapter III pp. 46-53; R.H. Haveman & J.V. Krutilla, Unemployment, Idle Capacity and the Evaluation of Public Expenditures (Baltimore, 1968) Chapters I, IV and V.
2. G. Toniolo, "Railways and Economic Growth in Southern Europe: Some Methodological Remarks", unpublished paper delivered at the conference on Railways and Western Economic Development (Madrid, 1979).

economic significance. The social saving model certainly assumes that all factors of production are fully employed so that the diversion of resources in order to provide the necessary transportation services will result in the loss of output in the rest of the economy. But if some of these resources, particularly labour, would have been otherwise under or unemployed, wages would then fail to reflect true opportunity costs and, as a result, social savings would be highly overstated.

None of the social saving calculations undertaken for other societies have examined the full employment assumption in any depth. Professor Fishlow admitted almost en passant that the move to a more efficient transportation system could result in increased leisure rather than in an output gain.¹ He conceded that in his calculations social savings were not affected by the less than full employment of the agricultural labour force by use of low carting rates designed to compensated for unemployment among the labour force. In his study of the impact of railways in Tsarist Russia, White also claimed that in backward economies, social savings might be well overstated.² He argued that in the traditional transportation sector, maintenance costs of the draught animals would have been met at all events and should accordingly be deducted from the final estimate.

Nineteenth century Spain provides a good case study to examine the view that estimates of social savings may be highly sensitive to the lack of a fully employed labour force or stock of draught animals. Spain's labour intensive agriculture absorbed high inputs of agricultural workers during determined seasons of the year. For the rest of

1. A. Fishlow, American Railroads and the Transformation of the Antebellum Economy, (Cambridge, 1965), pp. 29-30.
2. C.M. White, "The Concept of Social Saving in Theory and Practice", Economic History Review, 2nd. ser. XXIX (1976), pp. 92-3.

the year, labour was partially unemployed. This is the familiar situation where during a large part of the work year, the marginal productivity of agricultural labour may turn out to be close to zero. Because of those seasonal variations in the use of manpower, labour must be considered separately during the busy and slack seasons. During the busy season, the marginal productivity of labour is positive implying that any withdrawal from agriculture would result in the loss of agricultural output. Thus, the first aspect of the problem to be analysed deals with the maximum number of days that labour (and capital in the form of draught animals and carts) was utilized in agricultural operations. Ploughing and sowing were normally performed between October and November in most rural areas. Harvest was spread out between June and July, and August was devoted to threshing the grain. Animals were normally used in this latter operation due to the absence of modern threshing machines. Hoeing and a second ploughing of the land were performed during March and April. Obviously, not all the regions in Spain fit neatly into this time pattern, but local variations will not affect the argument.¹ Long distances between villages and plots, and between plots themselves, consumed labour time and so did the moving of manures and crops. In the province of Soria, the time devoted to each of these tasks distributed as follows:

'On average, a labourer works annually 150 days; fallowing requires twenty to thirty days, grain sowing between thirty and forty, legumes and other crops twenty to thirty, hoeing twelve to twenty, eight to fifteen in moving manures, and finally, thirty to forty at harvest...'²

While animals were used on the farm for at least five to six months every agricultural year. The work input was, however, subject to

1. For regional variations according to crops, see the answers to Dirección General de Agricultura, Industria y Comercio, Avance Estadístico sobre el Cultivo Cereal y de Leguminosas Asociadas en España, (Madrid, 1890), (hereafter, Avance).
2. Answer sent by V. Herrero, agricultural engineer of the province of Soria, Crisis II, p. 162.

yearly variations. When the crop was especially large, more work was obviously required than when it fell below average.

Given the lack of historical accounts on Spanish agriculture, it is necessary to use a proxy to support this qualitative evidence. This can be found in the maximum number of working days performed by agricultural labourers in various parts of the country. Some examples covering most regions have been set out in Table 5:

TABLE 5.

Agricultural Working Days for Men and Beasts.

	(A) Labourers	(B) Beasts	
Alava	180		
Albacete	200		
Avila		210	(2)
Burgos	215	260	(1)
Cadiz	260		
Castellon	300		
Ciudad Real	250		
Coruna	200		
Cordoba	260		
Gerona	100		
Huelva	200		
Huesca	210		
Leon	240	217	(1)
Logrona	120		
Murcia	160-280		
Navarra	100-150		
Palencia	285	220	(2)
Pontevedra	160-180		
Salamanca	200		
Segovia	260	260	(1)
Sevilla	250		
Toledo	200		
Valencia	200		
Valladolid	220	210	(1)
Vizcaya	190		
Zaragoza	200		

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Notes and Sources:

Column (A) : agricultural labourers.

Column (B) : animal teams.

(Notes and Sources contd. on following page...)

Notes and Sources contd. (Table 5).

The maximum number of working days for labourers was compiled from the answers to question 38 in Crisis Agrícola y Pecuaria Alava, V-116, Albacete, III-175, Burgos, IV-207, Cadiz, V-279, Castellon, III-531, Ciudad Real, III-654, Coruna, V-609, Cordoba, IV-661, Gerona, III-45, Huelva, III-331, and IV-151, Huesca, V-477, Leon, IV-579, Logrona, III-545, Murcia, IV-647, and V-615, Navarra, IV-414, 205, Palencia, III-202, Pontevedra, IV-356 and V-481, Salamanca, IV-89, Segovia, IV-496, Sevilla, V-808, Toledo, III-391, 454, Valencia, V-690, Valladolid, IV-31, Vizcaya, V-77, and Zaragoza, III-286.

The maximum number of working days for animal teams was compiled from Ganadería. (1) refers to mule teams and (2) to horse teams. Avila, p. 82, Burgos p.240, Leon, p. 111, Palencia, p. 151, Segovia, p. 493, and Valladolid, p. 563.

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Given a normal crop, the average maximum number of working days for the village labourer was around 210 days. Thus, if the working year is set at around 300 days, labourers were perhaps fully employed for 2/3 of the agricultural year, or slightly over half of the calendar year.¹ Although the data in Table 5 are consistent, the information is local and does not take internal migration into account. Furthermore, the figures do not consider the wide diversity of crops and land tenure. Where the size of the plots was small, the farmers seldom employed labourers.

A related problem consists of establishing to what extent the labour force was actually fully employed during the working part of the year.² Full employment at harvest would be accompanied by a

1. The working year was in some regions shorter than in others. But in general, around 90 days were lost every year, see Consejo Provincial de Agricultura, Industria y Comercio de Baleares, Crisis, V, p. 745. A british Consul in Spain reported that '...besides the usual 85 Sundays and Fetes days in the year, the Spanish Calendar adds 100 extra Saints days and 25 more are to be added for bull fighting and other public amusements. Thus, 14 per cent of the working time of the year is lost', (Parl. Papers 1866, LXXII), 441. Of course, during harvest time, Sundays and other feast-days could be devoted to work, so that it can be assumed that the average length of the working year was 300 days.
2. Recent studies on the underemployment of the labour force in developing countries have shown that the marginal productivity of labour during the busy season is positive, see for example S. Nath, "Estimating the Seasonal Marginal Products of Labour in Agriculture", Oxford Economic Papers, (1974).

scarcity of labour in other sectors and a relative dearness of agricultural labour. In general:

' ...the wage paid to the village labourer varied with the crop, but also with the seasons, or the population density, ...grain shortages or skills ...; but crop and season being particularly important. It can be stated that an agricultural labourer earns during the fall, winter and spring not less than 1.5 pesetas daily in wheat growing areas, and during the harvest, not less than 5 pesetas.'¹

The proportional increase in wages is significant for the argument, but the actual amount, even if not very accurate, will not affect it. In all regions, higher wages in the summer attracted men and draught animals away from their normal occupations in order to secure the crop. Furthermore, full employment in the fields was reflected by a relative scarcity of labour in industry.² Thus, the increase in agricultural wages during the summer guarantees the full employment of the agricultural labour force at harvest. During the rest of the working year, there is no evidence of full employment.

In section C.3., I argued that agronomists thought that farm animals required at least two months rest every year in order to be fit for hard and continuous agricultural work. It was also assumed that this rest would take place during the two winter months when roads were impassable. In addition to the 210 days of work in the fields, this leaves another three months during which men, carts and draught animals were unemployed and available to provide transportation services. However, this new estimate ought to be qualified by bringing in the size of the 1878 crop. In that year, the crop was not large but neither did it have the characteristics of scarcity and subsistence crisis. The national average price for wheat increased by

1. Crisis, II, p. 161.

2. Estadística Minera for 1903, p. 150.

eight per cent during the agricultural year 1877-8, and a further nine percentage points were added during the following agricultural year.¹ Lower than average yields implied less toil in the fields, especially if the harvest period was shorter than usual. Thus, a conservative estimate would add one more month for transport outside agriculture provided by peasants and their beasts.²

In summary, men and animals would have been otherwise unemployed for some three to four months in 1878. During that time, the withdrawal of labour and capital from the land could have left farm output unchanged. The implications of seasonal unemployment are obvious. The market prices quoted and utilized in the social saving calculations for road transport fail to reflect the true opportunity costs of the resources devoted to transportation. Therefore, my social savings estimates of Tables 3 and 4 are overstated.

The problem now is how to adjust for the upward bias in order to take proper account of the low or even zero opportunity costs of peasants and their capital during the off-peak season. Two extreme cases and an intermediate solution will be investigated. The first limiting case posits that any increase in the level of transportation demand will be entirely satisfied from the pool of unemployed peasant carriers. It will be called the inventory solution. It presumes that the Spanish economy could react in the most efficient way to a shutdown of its railway network by holding inventories until commodities

1. N. Sanchez Albornoz, Los Precios Agrícolas durante la 2^a mitad del S. XIX, (Madrid, 1975), Table 3-2, p. 180.
2. '...when the crop fails or when we are through a crisis like the present one, agricultural works fall by at least 30 to 50 per cent, for want of means to employ labourers ...', answer given by the City Council of Ecija in Crisis III, p. 627.

could be moved during the off-peak season at the lowest transportation costs. The second limiting case can be identified with the social saving estimate built up in section D. In that estimate, railway freight was reallocated to professional carriers, or a combination of professional and part-time carriers, the latter being treated as 'professional carriers' as far as the price of road transportation was concerned. An intermediate solution assumes that the additional demands generated by the closure of railways will be supplied both by employed and unemployed carriers. It differs from the second case in that professional and part-time carriers are treated separately. It is, I will argue, the most realistic of the three cases.

E. 1.1. The Inventory Solution:

In this case, stocks would have been built up during the agricultural busy season until the slack season had arrived, enabling the haulage of goods at low opportunity costs. The model requires that the flows of information on transport required reached the peasants, even if they were located far away from the usual transport networks. In other words, this case operates in terms of a perfect market.

Horses, mules, donkeys and oxen were all used by landholders as a source of motive power for ploughing, hoeing, threshing, at harvest, for the haulage of crops and as locomotion. In the farm economy, normal maintenance costs become fixed unless farmers decide to rent out the beats whenever they are needed. But for society as a whole, maintenance costs were certainly fixed. If during the slack season, the farmer had decided to stay on his land, maintenance costs had still to be met. Had the animals been fed on grain and hay, these costs would be equivalent to the revenue obtainable on the market for these fodder crops. Had they been grazed, maintenance costs would be equal to the costs of maintaining pasture land instead of turning it into arable.

On the other hand, if the farmer decided to market his labour and capacity for transportation services, he would incur extra costs in the form of the extra feeding of the animals when working, at higher depreciation rates from the higher risks of accidents, higher costs of shoeing, and finally a compensating cost for moving away from his land and home. Thus, the problem is to isolate these extra variable costs in order to measure the opportunity costs of off-peak transport from farmers. When estimated, this new 'shadow price' for peasant transportation will be used to modify our social saving calculation and will effectively relax the full employment assumption which underlies that calculation.

Evidence on the amount of extra feed required by horses at work suggests that up to 50 per cent more nutrients were needed to perform hard draught work than when idle. In most examples of animal diets, the extra feeding requirements when the animal is at work are concealed in the overall amount of feed consumed during the year. This is the main drawback of the series of tables on animal maintenance costs that will be found in Ganadería.¹ Morrison's nutrient requirements were used to solve this problem. He estimated that a 1,000 lbs. of live weight cart horse requires from 11.3 to 13.9 Therms when at work and from 5.6 to 7.2 Therms when idle (1 Therm = 1,000 calories).² A similar result can be obtained when we use data from earlier writers. Boussingault, for instance, stated that in England a stable horse required 5 kg. of hay and 5 kgs. of oats per day, while a cart horse needs 7.5 kgs. of hay and 7.75 kgs. of oats. Expressed in energy equivalent units, the ratio of both diets comes to exactly 1.50.³

1. Ganadería, for full reference see footnote 2, page 62.
2. F.B. Morrison, Feeds and Feeding. A Handbook for the Student and the Stockman (New York, 1936), Table III in the Appendix. (hereafter, Feeds).
3. J.B. Boussingault, Economie Rurale Considerée dans ses Rapports avec la Physique, la Chimie et la Météorologie (Paris, 1851), p. 554, and net energy values of feeding stuffs from Morrison, Feeds, Table II (Appendix).

A similar conclusion is reached by Grandeau and Leclerc in an interesting study on the feeds of the cart horses belonging to the Compagnie Générale de Voitures of Paris.¹ All the previous tests refer to horses but they could be extended to mules because the amount of feed required by a mule is very similar. Indeed, '... although the mule has a greater live weight than the horse, it is also less demanding than the horse'.² Finally, problems derived from a richer diet in the quoted European countries were easily solved in Spain where horses, mules and donkeys were fed on barley.³ Table 6 was compiled on the basis of this evidence. It shows the different costs involved in the maintenance of farm animals when idle over one year (rows B to F) and the extra feeding costs for work (row G).

Total maintenance costs represent the cost of keeping the animal alive during the year, that is the maintenance ration or amount of food which is required to support the animal. Whereas total work costs incorporate the extra feeding when the animals are fully employed during the working year, that is excluding the two months rest period. The table confirms that mules, and by extension horses, were far more expensive to rear than oxen. Moreover, mules had an advantage over horses in that:

'...the expense of shoeing a mule the year round does not exceed one third that of the horse, his hooves being harder, more horny and so slow in their growth that shoes require no removal and hold on till worn out.'⁴

Furthermore, by the end of their working life, oxen were put to fatten and sold for their fat, meat and hides whilst only hides could be of any use with horses and mules.⁵

1. L. Grandeau & A. Leclerc, Etudes Experimentales sur l'alimentation du Cheval de Trait (Paris, 1882), p. 84.
2. Palencia, Ganadería, II, p. 152.
3. N. Casas, op. cit., under 'caballo'.
4. R.L. Allen, op. cit., p.185, Palencia, Ganadería, II, p.151-2, and footnote no. 2 on page 62.
5. Moreover, an ox yields every year around ten tons of manure, while a mule yields only 4 tons, see Valladolid, Ganadería, p. 563 and Burgos, Ganadería, p. 241.

TABLE 6.

Maintenance Costs of Farm Animals (in 1878 ptas.).

	(1) Mule.	(2) Oxen. (team).	(3) Donkey.
A) Price (K)	600	600	110
B) Maintenance Costs:			
B.1. Barley	298	158	98
B.2. Straw	100	132	37
B.3. Fodder	-	54	-
C) Stable Costs:			
C.1. Veterinary	3		
C.2. Shoeing	17	24	14
C.3. Shearing	4	-	-
C.4. Stable	14	14	5
C.5. Harness	24	24	6
D) Total ₁	443	382	146
E) Financial Charges:			
E.1. Interest on K	30	30	6
E.2. Risks	18	18	3
E.3. Depreciation	50	86	12
F) Total ₂ (idle)	541	516	167
G) Extra Feed:			
G.1. Barley	124	86	39
H) TOTAL (at work)	682	626	220

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Notes and Sources:

A) Price: First column for mules is the average price of 15 provinces, Crisis Agrícola y Pecuaria (Madrid, 1887); Ternel (III-20), Leon (III-36), Palencia (III-211), Logrono (III-240), Zaragoza (III-297), Huelva (III-321), Toledo (III-392), Almería (III-475), Burgos (III-513), Sevilla (III-636), Alava (IV-121), Pontevedra (IV-483), Murcia (IV-628), Huesca (II-354), Zamora (II-425). This price was deflated according to Sarda's price index.

Oxen: same source.

Donkeys: same source.

B) Maintenance Costs:

B.1. : Column 1: 6.3 litres per day, or 23 Hl. per year. The daily allowance was estimated from Leon, Ganadería (Madrid, 1891), p. 111, on the assumption that 50 per cent more feed is required when animals are at work, see footnote 2, page 81. The 1878 price of barley (per Hl) is 12.95^D as the average price between the two agricultural years 1877-8 and 1878-9 from N. Sanchez Albornoz, Los Precios Agrícolas durante la 2^a mitad del S XIX (Madrid, 1975), Table 3.2, p.180.

Notes and Sources contd. (Table 6).

(B.1.): Column 2: a 2.4 litres daily allowance of carob beans or a 8.8 Hl. a year, estimated from Palencia, Ganadería p. 154 on the assumption that when idle, the maintenance ratio is 50 per cent less than when at work. Price for carob beans is 9.8p per q³, from Revista Comercial in Gaceta Agrícola (1880) and deflated according to Sarda's price index.
Column 3: a 2.08 litres of barley daily allowance estimated from Palencia, op. cit., p. 156 on the same assumption. Price for barley, see Column 1.

B.2. : Column 1: a 25 metric quintals per year, see Palencia, Segovia and Soria, Ganadería, pp. 152, 511, 492. The price for straw is the deflated 1880 quotation from Revista Comercial, op. cit.

Column 2: 3.3 tons a year as in Palencia, op. cit., p. 154, at 34p/q³.

Column 3: 9.2 q³ a year as in Palencia, op. cit., p. 156.

B.3. : Column 2: A daily allowance of 2.3 kg. of hay and 2.2 kg. of fodder estimated from Palencia, op. cit., p. 154, on the assumption that the requirements when idle are 50 per cent lower. The quotation for 1891 were deflated according to Sarda's price index.

C) Stable Costs:

C.1. : Valladolid, op. cit., p. 562, Palencia, p. 154 and p. 156.

C.2. : Column 1: it was assumed that shoeing expenditure was proportional to the number of working days, see Valladolid, op. cit., p. 562.

C.3. : Column 1: Three times a year at 1^p, Palencia, Avance Estadístico sobre el cultivo cereal y de leguminosa asociada en España (Madrid, 1890), II, p. 566.

C.4. : The same source as C.1. on the assumption that stable costs are the same for one or two animals.

C.5. : The same source as in C.1.

D) Total₁ : (B) + (C) - C.2.

E) Financial Charges:

E.1. : all three columns at five per cent.

E.2. : All three columns at three per cent, same source.

E.3. : Column 1: Life expectancy was estimated from the answers to question 121 of the Crisis to last 15 years. However, actual working life was 12 years given that mules were sold when they were 3 years old, see Crisis, answers to question 120.

Column 2: Life expectancy was set at 10 years for oxen and average working life at seven, same source as in column 1.

Column 3: Life expectancy was set at 12 years for donkeys and average working life at nine years, same source as column 1.

F) Total when idle as: (D) + (E).

G) Extra Feed:

G.1. : Column 1: an extra daily allowance of 3.2 litres of barley or 9.6 Hl. a year, Leon, op. cit., p. 111.

Column 2: an extra allowance of 1.2 litres of carob beans, 1.1 kg. of hay and 1.1 kg. of fodder, Palencia, op. cit., 154.

Column 3: an extra daily allowance of 1 litre of barley or 3 Hl. a year (300 working days, see text).

H) Total when at work as: (F) + (G) + C.2.

The extra feed required per working day was a heavier charge for both donkeys and mules than for ox carts. Indeed, variable costs account for 17.5 per cent of fixed costs for oxen and 25 per cent in the case of donkeys. Once the real costs of maintaining farm animals have been calculated, the 'shadow price' (or marginal costs) of part-time transportation can be estimated. This has been done in Table 7.

TABLE 7.

Shadow Price of Transportation per ton-km. (in 1878 ptas.).

	(1) Mule	(2) 2 Mules plus cart	(3) Ox cart	(4) Donkey
A) <u>Marginal Cost of Peasant Transportation:</u>				
A.1. Traction Costs	0.1305	0.0522	0.0244	0.0736
A.2. Depreciation of Cart	-	0.0168	0.0133	-
A.3. Total	0.1305	0.069	0.0377	0.0736
B) <u>Full Costs of Professional Transportation.</u>				
B.1. Traction Costs	0.6315	0.25	0.1391	0.3056
B.2. Depreciation of Cart	-	0.0185	0.0226	-
B.3. Labour Costs	0.5694	0.1139	0.1253	0.8541
B.4. Total	1.2009	0.3824	0.2870	1.1597

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Notes and Sources:

A) Marginal Cost of Peasant Transportation:

- A.1. : Column 1: (C.2. + G.1.) in Table 6/1080 Tkms. being the annual transport capacity of a mule, see text (section C.3) and footnote 5, page 63.
Column 2: ((C.2 + G.1) x 2) - C.4/5400 Tkms. Maintenance costs for 2 mules from Table 6. Stable costs (C.4.) were deduced on the assumption that they are the same for one or two animals. For transport capacity see text (section C.3.) and footnote no. 1, page 63.
Column 3: (C.2. + G.1.) /4500 Tkms. Maintenance costs for oxen from Table 6. Transport capacity on the assumption that the daily distance travelled by an ox cart was 25 kms., see A. de Foville, L'evolution des moyens de transport (Paris, 1880) p.4.
- A.2. : Column 2: The life of a cart was assumed to be one thousand days, see Palencia, Avance, p.585. Furthermore, a cart was fully employed in farming between 60 and 70 days every year, see Palencia, op. cit., p 585, Soria, Ganadería, p. 570.

Notes and Sources contd. (Table 7).

- (A.2.) : J. Hildago Tablada, Curso de Economía Rural Española (Madrid, 1864), p. 301. If part-time farmers used their carts for transportation during 120 days, it would mean that a cart wore out after 5.5 years. The annual depreciation rate will be 60 ptas., given that the price of a cart was 330 ptas. in 1878, Palencia, op. cit., p. 585, and Sarda's price index was used as a deflator. The depreciation rate was then divided by 3,240 Tkms., being the transport capacity of the cart during the 180 days.
Column 3: idem, A.2. and A.1.
- A.3. : A.1. + A.2.

B) Full Costs of Professional Transportation:

- B.1. : Column 1: (H) from Table 6/1080 Tkms., see Column 1.
Column 2: (H x 2 - C.4) / 5400 Tkms., see Column 2
Column 3: (H) from Table 6, Column 2 / 4500 Tkms., see A.1.
column 3.
Column 4: (H) from Table 6, Column 3 / 720 Tkms., see A.1.
column 4.
- B.2. : Column 2: Assuming that the working year of a cart is 300 days in the professional sector, a cart will wear out in 3.25 years. Hence, the yearly depreciation rate will be 101 pesetas or 0.3385 pesetas per day.
Column 3: idem.
- B.3. : The day's wage of a farmhand in charge of the farm animals is 1.5 pesetas, see Leon, Ganadería, p. 109, Palencia, op. cit., p. 151, Valladolid, op. cit., p 563 in 1890. However, the day's wage for an oxherd is slightly lower, 1.39 pesetas. It was assumed both for mules and oxen that only one labourer was required for two animals. Then, $(1.5^p \times 365)/300$ being the labour cost per work day.
- B.4. : B.1. + B.2. + B.3.

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Part A of Table 7 shows the different costs met by the peasant carrier when he decides to provide transportation services rather than stay idle on his land. In this sense, 'traction costs' include the variable costs of motive power (that is the extra feeding when at work, and shoeing) per day of actual work. For the professional carrier, traction costs involved total costs of providing transportation services over the whole year minus the two months of the rest period. Thus, the shadow prices in Part B of the Table are in fact average total costs, whilst peasants work with variable costs because their fixed costs are related to agriculture and transport is only a marginal activity. This

last statement explains also why labour costs should only be taken into account in the case of professional carriers alone. In the economy of the farm, labour costs (that is the opportunity cost of the labour time spent in rearing farm animals) become fixed because they must be met at all events. However, the shadow price of part-time transportation should be viewed as a lower bound, given that some costs, such as the compensation required for being away from the farm have not been included. Indeed, for the 19th century peasant, long journeys implied time away from home if they took on railway hauls of up to 300 kms. (as implied by the counterfactual in the social saving model). This in time involved an absence of 20 days¹. During these days, the peasant carrier would have to meet increased lodging costs, increased food costs, etc. that would not have been met had he stayed on his farm.

Finally, shadow prices in Table 7 both for professional and part-time carriers have been worked out on the assumption that capacity was at all times fully utilized. Just as railway carriage, pack animals and carts were liable to be underutilized because of the structure of traffic.² It will be assumed that the ratios of empty returns in the carrying trade were similar to the ones met by railway companies. Evidence on Norte and MZA suggests that in 1878, around 25 per cent of the carriages were sent back empty.³ This will raise the effective cost of moving goods in Table 7 by 25 per cent.

1. Assuming that a cart covered 30 kms. per day, a return journey to a distance of 300 kms. will take around 20 days, see Appendix C to this chapter.
2. In many instances, there was no balance between inflows and outflows of goods in railway stations. For example, Quintanilla, in the Barruelo coal district, shipped off 15 times more goods than were shipped in. Assuming a ten ton average cart-load, it meant that only one railway carriage out of ten was shipped in loaded, Norte, Datos Estadísticos (1878).
3. Norte, Actuación, II, Table 32, and MZA, Memorias, (1878).

When a new marginal cost of peasant transportation is substituted in Table 3 based on the assumption that pack animals would have satisfied 25 per cent of transport services and that donkeys and mules on one side, and ox and mule carts on the other, would have had the same opportunities of providing transport services, the new carting cost of moving railway freight will be 54.9 million pesetas.¹ This will bring down the final saving of resources to 40.3 million pesetas or 7.8 per cent of the previous estimate. To conclude, assuming that Spain's transport demands satisfied by railways could have been met entirely from the services provided by peasants, their draught animals and carts, the social saving from railways falls sharply. However, as a compensating factor, the capital costs involved in operating an economy based on a four months running transport system would have been huge. If goods moved by railway in 1878 could be accurately valued, opportunity costs on holding stocks during eight months ought to be added to the new social saving estimate. The limiting nature of the present case is clearly demonstrated because this solution is totally implausible and costly. After all, the transport system was not run in this way.

E.2. The Intermediate Calculation:

The Intermediate Calculation departs from the **normal** social saving calculation in the sense that it rejects the view that, in spite of the presence of unemployed resources, the incremental demands for transport would have been satisfied only from fully employed resources. From the opportunity cost argument, full and part-time carriers should

1. The new 'shadow price' of carting is 0.0655 pesetas per ton-km. and 0.082 pesetas per ton-km. is the effective shadow rate, once the 25 per cent empty capacity allowance has been taken into account. These new prices were then entered into the calculations in Table 3, Row (8).

be treated separately. But the degree to which underemployed resources can be expected to respond to demand for transport services will obviously depend on the rate of seasonal unemployment. Thus, when peasants were fully employed in agriculture, additional transport services would have been supplied only by professional carriers. But, on the other hand, when men and beasts were relatively idle in off-peak seasons, some of the demand for transportation would have been logically satisfied by part-time farmers. Assuming perfect geographical mobility of men and their animals (see section E.1.1.), part-time carriers would have been preferred to professional carriers, even if their services were much less specialized, because they could charge lower rates.

On the basis of the calculation undertaken in the previous section. it might be hypothesised that the economy might logically react to the closure of its railway network by moving freight during six months, or $3/5$ of the working year, by way of its professional carriers and assuming perfect substitutability could rely on part-time carriers during the other four months.¹ When this intermediate hypothesis is tested, resource saving due to the introduction of railways comes to 326 million pesetas or 63 per cent of the original social saving estimate. If the goods traffic is assumed to be evenly distributed along the 300 days of the work year, professional carriers will move 410 million ton-kms. or $3/5$ of the freight diverted to the road in 1878. The cost of moving these goods will amount to 318.6 million pesetas at the actual carting rate used in Table 3. During the other four months, part-time carriers will move 268 million ton-kms. of freight at the 'shadow' carting rate of 0.082 pesetas per ton-km., estimated in the previous section.

1. See above, section E.1.

It is possible that social savings overstate the contribution of railways to the economy because of the seasonal underemployment of the agricultural labour force and their draught animals. The full employment argument has led to contemplation of two possible alternatives to a railway shut-down. A peasant or inventory alternative will involve the haulage of all goods during a four months period when farm labour and capital could be idle. The original social saving was adjusted by way of a 'shadow price' of road transportation which reflected in a more satisfactory way the true opportunity costs of resources. The new estimate was only eight per cent of the original. However, it might be expected that capital costs involved in the building of stocks during the remaining eight months and gains derived from the switch of circulating into fixed capital would have been high enough to offset the modest resource gain. An intermediate hypothesis differentiated between professional and part-time carriers, and in this sense, provided a much more plausible alternative. Savings were set at 63 per cent of the original estimate. The next step of the argument will be to examine capital gains due to inventory adjustments.

F). Indirect Costs:

Railways were not only cheaper but also faster, more regular and more reliable as a means of transport over carriers by road. Some. indirect gains should be added to the already assessed direct benefits. Speed and regularity helped the economy to achieve a higher degree of efficiency through inventory adjustments. This process would have led to a transfer of circulating into fixed capital.

The greater speed of railways exerted a double impact on the economy. First, it was now possible to reduce stocks by cutting down

the normal delivery time of inputs and finished goods. Second, goods were less liable to deteriorate because journeys were much quicker. But the stock reduction effect was probably insignificant. In the counterfactual scenario of 1878, goods were moved at an average distance of 128 kms. by road.¹ Muleteers could have covered this distance in some five days whereas it would have taken approximately one day by train.² Therefore, a railway shut-down would have forced firms to build stocks to last for four additional days. But freight trains were only to run when companies could secure reverse shipments or a full train load. Delays in delivery were thus normal in the railway economy, and for that reason the saving in reduction of stocks on account of speed was quite unimportant.

Perishable products and in general most merchandise were liable to deteriorate if exposed for too long to extreme climatic conditions. Faster journeys by railway diminished the probability of suffering losses in freight shipments, although the poor service provided by railway companies was blamed too often by railway users.³

Most important of all, railway transportation freed the Spanish economy from the seasonal impassability of roads. In the course of calculations in the previous section, it was assumed that roads were impassable during at least two winter months every year. This was a

1. The 1878 average haul for railway freight was 150 kms., see Table A-1 in Appendix A to this chapter. Given that on average, railway distances were 15 per cent longer and more 'roundabout' than road distances, the corresponding distance by road will be 128 kms., see notes to row (8) in Table 3, p. 69.
2. See Appendix C to this chapter. For the speed of Spanish trains, see A. de Foville, L'évolution des Moyens de Transport (Paris, 1880) p. 14.
3. For example, Valladolid wine growers claimed that their wine arrived in France turned to vinegar due to the poor service provided by the Norte Company, see "Irregularidades Ferrocarrileras", in La Crónica Mercantil 14 Jan. 1881 and 21 Jan. 1881, and "El Transporte de vinos y la Compañía del Norte" in La Crónica Mercantil 18 March 1881.

lower bound estimate and assumed that in the event of a railway closure, freight would have been moved by using highways, less liable to be interrupted by bad weather. But on most local roads transportation was interrupted for longer periods as evidenced by numerous complaints from manufacturers.¹ For example, a witness from the iron works at Nuestra Sra de Baracaldo declared in 1867 that '...it is necessary to stock coal from year to year... in the summer we stock most of the coal and coke which will be consumed during the winter...'.² In Asturias, the works at Mieres had to cease production because of the scarcity of minerals.³ The Sociedad Palentina found that it was indispensable to stock 'ore and coke to last for at least eight months'.⁴ Hampered by bad communications, the Belmez coalfield was unable to develop the potentialities of its mines:

'...coal is carried on the river beds during the dry season... no carter would ever support his draught animals when roads are impassable in fear of not being able to attend his obligations...'.⁵

In the pre-rail era, Spanish firms were thus forced to stock large quantities of inputs and final goods. The data in Table 8 shows the extent of this problem. Among the iron works (rows 5 to 11), the works at Guriezo and Bolueta were the more affected with stocks of up to 90 per cent of their fixed capital. However, the stocks held by the engineering concern Maquinista Terrestre were much less important. But how could railways alter these ratios? By securing a regular

1. See above section C.3. p.57 and footnote no. 2 , page 58. Also, most of the answers to the Interrogatorio sobre el Derecho Diferencial de Bandera referred to the unavailability of roads during the rainy season.in particular, the answers to question 3 of the Crisis contained many useful references.
2. Nuestra Sra del Carmen de Baracaldo, contestación al Interrogatorio sobre el Derecho Diferencial de Bandera, (Madrid, 1867) II, p. 164, (hereafter, Interrogatorio).
3. Informe sobre la provincia de Oviedo, Estadística Minera (Madrid, 1871), p. 62.
4. Sociedad Palentino Leonesa, Interrogatorio, II, p. 89.
5. Sociedad Hullera y Metalurgica de Belmez, Interrogatorio, III, p. 73.

delivery of inputs and a regular outlet of final produce, railways could help firms to switch circulating capital into fixed capital, and the process would result in lower ratios in column (3) of the Table. For example, at the ruling rate of interest, the opportunity cost of the capital tied up in stocks in the Bolueta ironworks its fixed capital could have been increased by four per cent over one year by enabling a quicker turn-over.

TABLE 8.

Fixed Capital and Stocks (in 10^5 pesetas of 1867).

	(1) Fixed K	(2) Stocks	(3) (2)/(1)
(1) "Reverbero"	2.5	3.7	1.5
(2) Portilla Hos & White	26.6	6.0	0.24
(3) Maquinista Terrestre y Maritima	32.5	5.0	0.15
(4) Sdad de Navegacion e Industria	11.5	4.0	0.35
(5) Casa Heredia - La Concepción	5.0	2.5	0.50
- La Constancia	37.5	15.0	0.40
(6) Pedroso	46.2	12.0	0.26
(7) Bolueta	13.0	10.5	0.81
(8) Sdad Hullera y Metalurgica	45.0	3.5	0.08
(9) Bacaicoa	7.5	2.2	0.30
(10) Gurieza	2.2	2.0	0.89
(11) Alsasua	6.2	6.2	0.16

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Sources:

This table was built from the information provided by the answers to question 2 in Volume I and question 14 in Volume III of the Información sobre el Derecho Diferencial de Bandera (Madrid, 1867):

(1) vol. I, p. 25	(2) vol. I, p. 41	(3) vol. I, p. 57
(4) vol. I, p. 69	(5) vol. III, p. 28	(6) vol. III, p. 29
(7) vol. III, p. 90	(8) vol. III, p.111	(9) vol. III, p. 121
(10) vol. III, p.127	(11) vol. III, p.129	

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Thus, the assumption is that railways, because they could surmount adverse climatic conditions, were able to obviate bottlenecks in manufacturing production. Nevertheless, as the early trunk lines were built along the best highways, their contribution to a reduction

of stocks was weaker than it was when secondary lines were constructed. Indirect benefits can only be assessed by disaggregating the service of railways commodity by commodity. Unfortunately, this will not be possible with the data now available. But in order to illustrate the economic significance of holding larger stocks, an exercise was undertaken for Norte and MZA's coal shipments. In 1878, these two companies moved 218 thousand tons of coal or slightly over eight per cent of their total freight shipments. Assuming that coal was evenly distributed throughout the year, the construction of Norte and MZA's lines made it unnecessary for firms and urban retailers to stock coal during the two winter months when roads were impassable. Thus, it was possible for Norte and MZA's customers to cut stocks by 36 thousand tons. The money tied up in this quantity of coal would have amounted to 1.1 million pesetas and at the current rate of interest (4.6 per cent) a sum of this magnitude would have yielded 50,000 pesetas.¹ Compared to the social saving estimate, this sum becomes insignificant. Having reached this point, we must recall the Inventory Solution. It was assumed there that the haulage of goods would only take place during four months which cover the slack season on the farms. It would have been necessary therefore, to build stocks to cover consumption needs during the remaining 8 months. Capital tied up in coal stocks would have yielded 200,000 pesetas in alternative uses.² Compared to the social saving on coal transportation by Norte and MZA, it would have increased the adjusted social saving estimate by 7.7 per cent.³

1. Thirty pesetas per ton is the price paid by the Norte company for its coal in 1878, see Norte, Actuación, II, Tables 35 and 35. This price reflects more suitably the compound of domestic and imported coal which was moved by railway. Interest rate from G. Tortella, Los Orígenes del Capitalismo en España (Madrid, 1973), Table J-1 in the appendix.
2. idem.
3. See Appendix E to this chapter. pp. 113-4.

Had Spanish railways been shutdown for one year, the costs of providing transport services in order to sustain the level of economic development achieved by 1878 would have entailed a loss of 12 per cent of Spain's national income. In 1912, social savings were 18.5 to 23 per cent of Spain's national income. Demand for transportation services would have been matched by a combination of overland transport and waterways. Canals would have taken over just one per cent of the demand for transport services and a further nine per cent would have been shipped by sea.

Social savings reflect the loss to the economy of closing down its railway network only if all factors of production are fully employed. If some factors are unemployed, social savings may overstate the contribution of railways because market prices will fail to reflect true opportunity costs. The discussion on the release of the full employment assumption ended up in two social savings estimates.

An 'inventory' solution was feasible at the cost of moving goods for just four months in each year. It brings down my social saving estimate to 0.92 per cent of Spain's national income in 1878, though indirect costs of stocks can be expected to rise steeply. An 'intermediate' solution states that transport services will be supplied by professional carriers, while peasants were tied to their land during the busy season and that they would have been replaced by part-time carriers during the off season. Resource saving due to the introduction of railways comes to 326 million pesetas or 7.5 per cent of Spain's national income.

APPENDIX A.

New Output Estimates of Spanish Railways (1865-1913).

Most of the calculations for this chapter have relied heavily upon the overall freight moved by Spanish railways. The evolution of freight traffic over time was illustrated through changes in an index of railway output. However, none of the previous case studies on Spanish railways had made use of such an index. Indeed, Anes based his argument on the tonnage carried by the two leading railway companies without explicit references to the rest of the sector.¹ The only attempt to build such an estimate was undertaken by Casares.² The low reliability of this latter estimate justified the need to gather into a new index the actual evidence available on freight traffic.

The output index is the product of the tonnage carried by each individual railway company and the average distance along which each ton of freight was shipped. This unweighted index has the advantage of avoiding double counting for the transit trade among companies. A ton of freight transferred from one company into another was counted by the latter as a completely new ton. Thus, when tonnage is added for all companies, transit trade will be counted twice. There are two different ways to obviate this drawback of railway statistics. The first is to work with value estimates, that is total freight receipts. The second is to build a freight output estimate in ton-kms. The disadvantage of the former is that it incorporates changes which may originate in the pricing policy of railways.

1. Anes, loc. cit.,
2. A. Casares Alonso, Estudio histórico-económico de las construcciones ferroviarias españolas en el siglo XIX (Madrid, 1973), Table 34, pp. 258-9. Casares' output estimate is the product of the tonnage carried by train-km. by the total train mileage. His 1878 estimate is three times higher than my own.

Unfortunately, most railway companies only started to compile output data after 1897. For earlier years, most companies only kept a record of tonnage and freight receipts. To estimate output over the 19th century, two alternative ways were possible. First, historians could make use of value data. Second, they could estimate the average hauls for each company from available information for a later period. The first, or the 'receipts' method, presents, however, two major drawbacks.¹ On the one hand, average rates are known only for the leading companies. On the other, receipts data are quite unreliable because there is no clear specification of the traffic earnings which are included in the totals. Indeed, for some companies, freight receipts included livestock receipts and the 'internal' freight traffic. While post 1900 freight receipts can always be checked by confronting several sources, pre 1900 data are more scant. The second, or the 'average haul' method was followed to build the 1878 and 1912 estimates.² In the second of these years, the exercise comes down to a revision of published data. But for 1878, most average haul estimates had to be 'guesstimated' from published evidence. Although it is much more reliable than the 'receipts' method, its application to the whole second half of the 19th century was restricted by the fact that railway companies were continuously changing in size. Therefore, in spite of the quoted disadvantages, the 'receipts' method will be adopted except for 1878 and 1912.

1. Output is found as a result of dividing total freight receipts (R) by the average rate per ton-km. of freight (r) or:

$$O = \sum_j \frac{R_j}{r_j}, \text{ where } j \text{ is a subscript distinguishing companies.}$$

2. According to the 'average haul' method, output is found as the product of the tonnage carried by each individual company (T) and the average haul to which it is shipped (d) or:

$$O = \sum_j \sum_i T_i \cdot d_i, \text{ where } i \text{ is a subscript distinguishing commodities. However, average hauls for each commodity are unknown and as}$$

a result we will work with: $\sum_i T_i \cdot d_i = T_j \cdot d_j$

I). The 1878 Railway Output:

The 1878 output has been compiled in Table A-1 and details of the calculations are given in the notes to the Table. Total output was worked out company after company by collecting evidence on each company's average haul. It must be stressed that in the Totals, the figure in the average lead column is in fact the mean of the average leads of all railway companies. (that is, what we called $\bar{H}$) rather than the true average haul or 'H'.¹

(TABLE A-1... see following page.)

1. See discussion on the differences between $\bar{H}$ and 'H' in Section B.2., p. 36.

TABLE A-1.

The 1878 Railway Economy,

(Tonnage, Freight Receipts,

Average Hauls and Average Rates and Output).

Railway Co.		Tonnage (000'T)	O/T kms.	O (10 ⁶ Tkm)	Receipts (000'P)	R/O (p/Tkm)
(1)	MZA	1,161.5	307	356.9	23,754	0.065
(2)	Norte	1,450.5	187	271.4	28,131	0.102
(3)	Norceste	242.2	60	14.5	1,583	0.1089
(4)	AVT	400	106	42.4	3,695	0.0875
(5)	Creal	266.2	200	53.3	2,963	0.0556
(6 ₁)	Córdoba-Málaga	192.1	96	18.4	2,336	0.1266
(6 ₂)	Campillos-Granada	45.7	62	2.8	346	0.1222
(6 ₃)	Utrera-Moron	46.3	46	2.1	257	0.1204
(6 ₄)	Sevilla-Jerez	217.6	84	18.3	1,591	0.0870
(6 ₅)	Jerez-Bonanza	7.1	33	0.2	39	0.1664
(6 ₆)	Córdoba-Belmez	143.5	70	10.0	757	0.0754
(6 ₇)	Osuna-Roda	8.5	35	0.2	46	0.1563
(7)	Madrid-Plasencia	43.7	142	6.2	656	0.1057
(8)	TBF	394	99	39.0	2,943	
(9)	MZOV	50.2	72	3.6	364	0.1008
(10)	Lérida-Reus	94.1	62	5.7	94	0.0859
(11)	Granollers-San Juan	47.7	40	1.9	224	0.1175
(12)	Medina-Salamanca	29.8	64	1.9	221	0.1161
(13)	Santiago-Carril	8.3	41	0.3	42	0.1234
(14)	Triano	484.2	8	3.9	1,125	0.2905
	Total ₁	5,333	160	853.1	72,249	0.0847
(15)	Buitron	35	45	1.6	538	0.3362
(16)	Tharsis	226.8	42	9.5	868	0.0914
(17)	Langreo	257.2	42	10.8	1,065	0.0986
(18)	Silla-Cullera	3.7	26	0.1	14	0.14
	TOTAL	5,855.7	150	876.1	74,734	0.08537

Notes and Sources:

Dirección General de Obras Públicas, Memoria de Obras Públicas relativa a Ferrocarriles (Madrid, 1883).

(1) MZA: (See following page...)

Notes and Sources contd. (Table A-1).

- (1) MZA: The receipt figure in the Memoria of Obras Públicas includes livestock earnings. Receipts were accordingly revised by way of the data published by the company. Cia de MZA, Memoria of 1878.
- (2) Norte: Tonnage in the Memoria includes internal shipments. On the other hand, receipts include internal freight, live-stock and freight traffic. Data used here are the ones published by the company, Cia del Norte, op. cit., II.
- (3) Noroeste: In 1878, the Noroeste Company included the following lines:

	Kms.	%
Palencia-León	122	21
Leon-Astorga	52	4
Astorga-Brañuelas	27	
Leon-Robla		
Robla-Pola	33	6
Pola-Busdongo		
Pola de Lena-Gijon	63	60
Lugo-Coruna	115	9

Percentages in the second column refer to the share of freight (expressed in tons) for the year 1886 after the company was merged to Norte. The length of the lines was deduced from F. Wais, Historia de los Ferrocarriles Españolas (Madrid, 1974). Tonnage data for the different tracks were estimated from Norte, Datos Estadísticos (1886). However, in 1886 not only were these tracks part of Norte's network, but the link between Pola de Lena and Busdongo had been established enabling the shipment of coal southwards. When the main activity centres were located at the terminus stations, average haul was guesstimated to equal $3/4$ of the length of the line. On the other hand, when the track was relatively short and the main activity centre was located at one end, average haul was assumed to equal the length of the line. Finally, tonnage for each track was deduced assuming that the former percentages remained constant.

Palencia-Leon : $0 = (.21 \times 242.2)(122 \times .75) = 4.6 \times 10^6$ Tkms.
Leon-Brañuelas: $0 = (.04 \times 242.2)(79 \times .75) = .6 \times 10^6$ Tkms.
Leon-Busdongo : $0 = (.06 \times 242.2)(33 \times 1) = .5 \times 10^6$ Tkms.
Pola-Gijon : $0 = (.60 \times 242.2)(63 \times .75) = 6.8 \times 10^6$ Tkms.
Lugo-Coruna : $0 = (.09 \times 242.2)(115 \times .75) = 1.9 \times 10^6$ Tkms.
In the aggregate, $0 = 14.3 \times 10^6$ Tkms, $O/T = 60$ kms. and $R/O = 0.1103^P/Tkm$. The estimated R/O is perhaps a bit too high, given that the bulk of freight traffic was coal shipments. However, it might be due to the fact that R included livestock earnings, significant in the Galician area.

- (4) AVT: Almansa-Tarragona was merged to Norte in 1891. The first available year of the Datos Estadísticos series is, however, 1901. For that year, the average haul is 106 kms., or around one third of the length of the line. This line is characterised by transit traffic originating in La Mancha or Extremadoure, and shipped to Catalonia. Given that in 1878 the AVT Company possessed railway junctions both with MZA at la Encina and TBF at Tarragona, it will be assumed that the pattern of trade remained unchanged. The 1901 average haul can thus be applied to earlier dates. The

Notes and Sources contd. (Table A-1).

- (4) AVT: (contd.) estimated output is endorsed by an average rate which falls within the boundaries set by Norte and MZA.
- (5) Creal: The Ciudad Real-Badajoz was merged to MZA in 1880. The 1878 average haul is the mean of the 1880 and 1881 average hauls, or 200 kms. See Cia de MZA, Memorias 1880, 1881. The average rate ($0.0556^P/\text{Tkm.}$) for 1878 is only 15 per cent lower than the 1880.
- (6₁), (6₂): The average haul was chosen as half the length of the line.
- (6₃), (6₄): idem.
- (6₆) : Given that the bulk of the trade were coal shipments from Belmez to Cordoba where it could connect with MZA, the average haul was assumed to equal the length of the line.
- (7) Madrid-Plasencia: Given the lack of further information, it was assumed the $\bar{H} = .75$ of the length of the line.
- (8) TBF: The Tarragona-Barcelona-Francia was merged with MZA in 1898. $\bar{H}$ is the mean of the average hauls from 1899 on onwards, see Cia de MZA, Memorias 1899-1905.
- (9) MZOV: According to the 1878 Report of this company, 95 per cent of the freight traffic took place between Medina and Zamora, see Cia de MZOV, Memoria 1878. $\bar{H}$ in 1912 was in this track 72 kms., or 80 per cent of its length.
- (10) LRT: Lerida-Reus-Tarragona was merged to Norte in 1884. It was assumed that $\bar{H}$ was $3/4$ of its length.
- (11) Granollers: In 1878, only the line between Granollers and Vich had been laid, see F. Wais, op. cit., In 1901, $\bar{H}$ was between two points equal to the length of the line. It was assumed to be unchanged in earlier years.
- (12) Medina: In 1878 this company had the same length and junctions as in 1912. It was assumed that $\bar{H}$ had remained unchanged.

Lines (15) to (18) refer to narrow gauge railways. Average hauls were inferred from 20th century data.

II). The 1912 Output:

TABLE A-2.

The 1912 Railway Economy.

Railway Co.		Tonnage (000' T)	O/T Kms.	O (10 ⁶ Tkm)	Receipts (000' Pta)	R/O (p/Tkm)
(1)	MZA	8,124.5	149	1,213.4	82,870	0.06812
(2)	Norte	8,115.9	160	1,302.5	91,816	0.07049
(6)	Andaluces	2,060	98	201.6	17,098	0.08481
(7)	MCP	674.7	137	92.8	6,463	0.06966
(9)	MZOV	324.7	72	23.6	2,194	0.09297
(12)	Medina-Salamanca	161	64	10.3	710	0.09709
(13)	Santiago	74.7	32	2.4	321	0.13375
(14)	Triano	866.7	8	6.5	1,805	0.2775
(19)	Fc del Estado	41	36	1.4	185	0.1321
(20)	Sur de España	722.8	76	54.7	4,370	0.0799
(21)	Central	307.6	140	43.6	2,666	0.0611
(22)	Salamanca-Port	131.8	59	7.8	707	0.09003
(23)	Zafra-Huelva	712.7	72	51.8	713	0.07137
(24)	Lorca-Baza	754.2	95	72.2	754	0.04753
(25)	Torralba-Soria	32.8	76	2.5	187	0.0748
(26)	Alcantarilla	73.6	37	2.7	292	0.1081
(27)	Pto Sta Maria	9.3	28	.3	56	0.2103
(28)	Valencia-Liria	82.7	32	2.6	161	0.0609
(29)	Bilbao-Portugalete	690.0	18	12.4	1,048	0.0844
(30)	Mollet-Caldas	47.9	14	.7	70	0.1047
TOTAL ₁		23,235.6	133	3,105.8	220,149	0.07088
(15)	Buitron	349	71	5.2		
(16)	Tharsis	579.6	42	24.6		
(17)	Langreo	699.0	37	26.3		
(31)	La Robla	327	125	40.9		
(32)	Andoain	1,283	10	13.5		
(33)	Sant-Bilbao	812	16	13.3		
(34)	Bilbao-2 Cam.	469	35	16.5		
(35)	Sant-Llanes	329.4	54	18.0		
(36)	Rio Tinto	2,161.4	84	182.4		
(37)	Other	4,579.5	73	333.7		
TOTAL ₂		11,588.9	58	674.4		
TOTAL _(1 + 2)		34,824.5	108	3,780.2		

Notes and Sources:

Dirección General de Obras Públicas, Memoria de 1912 relativa a Ferrocarriles y Tranvías.

Total₁ : Includes normal gauge tracks.

Total₂ : Unless otherwise stated, includes narrow gauge railways.

Notes and Sources contd. (Table A-2).

- (1) MZA: Cia de MZA, Memorias, 1912.
(2) Norte: Cia del Norte, op. cit., II
(6) Andaluces: Cia de Andaluces, Memorias, 1912.
(7) MCP: The tonnage figure in the Report for Public Works does not match Cambó's, op. cit., Table 11, p. 22. However, the average rate when applying the report figure is in accordance with other years.
(9) MZOV: There is again a slight difference (five per cent) between T in the Report and in Cambó.
(21) Central: T was taken from Cambó because the average rate was then in harmony with the average for the whole sector. F. Cambó, op. cit., Table 30, p. 34.
(14) Triano: T from Cambo, op. cit., Table 43, p. 84. Average rate as in Memoria de Obras Públicas for 1906.
(20) Sur: Average rate similar to 1906 and 1907, see Memoria de OP.

TABLE A-3.

Output from Spanish Broad Gauge Railways (1865-1914).

Year	Tonnage (000' T)	Receipts (10 ⁶ ptas.)	Output (10 ⁶ Tkms.)	O/T Kms.	Coverage %	
1868	2,579.0	40.56	437.46	91	91	
69	2,717.4	40.97	453.71	94	91	
1870	3,239.1	42.74	482.64	100	91	
71	3,452.5	47.00	542.47	112	90	
72	4,017.1	53.27	636.01	131	90	
73	3,946.0	52.07	625.35	128	89	
74	2,663.4	41.71	491.4	100	87	
1875	3,225.8	53.00	697.63	120	98	
76	4,528.7	60.95	701.59	132	88	
77	5,696.8	73.06	854.56	150	92	
78	5,332.0	72.25	864.41	140	97	
79	4,987.5	66.74	831.64	131	94	
1880	6,783.0	84.03	1,043.85	162	91	
81	6,370.0	80.21	1,000.39	192	71	
82	6,924.4	81.42	1,059.88	202	71	
83	8,865.7	104.61	1,381.26	195	91	
84	8,065.8	99.55	1,335.79	182	90	
1885	7,855.8	93.35	1,303.59	170	91	
86	8,480.0	99.36	1,219.81	154	92	
87	8,913.0	97.94	1,173.00	147	91	
88	8,668.1	97.89	1,207.62	151	92	
89	8,794.0	107.12	1,251.47	153	91	
1890	10,349.6	110.24	1,346.73	161	92	
91	9,698.1	109.73	1,287.97	151	92	
92		102.82	1,241.66	145	90	
93		107.88	1,327.24	147	91	
94		106.69	1,361.24	149	90	
1895		110.49	1,468.97	154	91	
96		119.69	1,552.36	161	89	
97	11,608.5		1,710.82	177	89	
98	11,884.9		1,885.47	185	93	
99	14,909.7	152.57	2,077.9	203	93	
1900	16,407.2	154.15	2,182.5	202	98	
O ₂						
1901	16,035.7	153.27	2,124.23	2,063	197	98
02	17,431.4	165.45	2,133.1	2,249	194	98
03	16,566.0	166.94	2,585.89	2,386	234	"
04	16,665.0	166.78	2,445.79	2,347	221	"
1905	17,925.0	165.00	2,357.5	2,303	213	"
06	19,142.0	177.50	2,400.0	2,404	217	"
07	19,485.5	184.00	2,536.55	2,568	229	"
08	19,584.5	186.98	2,526.4	2,546	228	"
09	19,678.4	186.72	2,519.9	2,510	228	"
1910	20,878.9	193.78	2,668.9	2,687	241	"
11	21,500.9	198.45	2,798.1	2,809	253	"
12	23,994.3	223.98	3,043.9	3,106	275	"
13	24,590.3	224.89	3,174.6	3,222	287	"
14	21,758.6	210.38	2,897.5	2,945	262	"

Notes and Sources: (Table A-3 - Appendix A).

Output₁ was estimated via freight receipts and an average rate inferred from Norte and MZA until 1902. From 1903 onwards, Andaluces' average rate was also included. For Norte, see Cia del Norte, op. cit., II, Table 10. For MZA, see Cia de MZA, Memorias 1868-1914, and Cia de Andaluces, Memorias 1903-14.

Output₂ was estimated via average hauls for each individual company.

The basic information on tonnage and receipts comes from Memorias de Obras Públicas. From 1900 onwards, these data were matched to the same data published in Cambo, op. cit., II. Finally, the Memorias for 1900-02 were completed with data coming from E. de la Torre, Anuarios de Ferrocarriles 1900-02. Output figures for 1897 and 1898 were estimated assuming a linear increase between 1896 and 1899 of 10.08 per cent per year.

Coverage refers to the total length of the companies included in the Memorias as percentage of the annual length of railway track.

APPENDIX B.

The Shipping Capacity of Coastal Trade.

Coastal trade statistics provide information on the volume of goods landed at each maritime province and on the sea board where coastal flows originate. By grouping ports according to their location, I was able to estimate coastwise flows along the Atlantic and Mediterranean sea boards, and the trade between ports of the Atlantic and ports of the Mediterranean.

Table B-1 reveals that the share of coastal trade along the Mediterranean sea board was 59 per cent of the total tonnage shipped, while the volume of goods exchanged between Atlantic and Mediterranean ports amounted to 15 per cent. However, measured in ton-kms., inter-seas trade accounted for half the demand for shipping capacity on account of the six times longer hauls.

TABLE B-1.

Estimate of Shipping Capacity in 1878.

	(1) Tonnage (000 'T)	(2) Capacity (10 ⁶ Tkm.)
Atlantic Trade	257.3	59.2
Mediterranean Trade	585.2	228.2
Atlantic-Mediterranean Trade	154.2	266.8
TOTAL:	996.7	554.2

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Notes and Sources:

I grouped ports on the Atlantic sea board between Gupuzcoa and Coruna, and ports on the Mediterranean between Huelva and Gerona.

Column 1: For the Atlantic (Mediterranean) trade: Tonnage of goods landed at ports of the Atlantic (Mediterranean) originating in Atlantic (Mediterranean) ports. For the Atlantic-Mediterranean trade: The sum of the tonnage landed at ports of the Atlantic (Mediterranean) coming from ports of the Mediterranean (Atlantic).

The data on tonnage as given in Estadística del Comercio de Cabotaje for the year 1878, p. XIV.

Notes and Sources contd. (Table B-1 - Appendix B).

Column 2: Output in ton-kms. as the result of Column 1 multiplied by the nautical distance between:

for row (1): Gijon-Santander, given that 53 per cent of the Atlantic trade was landed at ports in between these two.

for row (2): Cadiz-Alicante, given that two thirds of the Mediterranean trade took place there.

for row (3): Gijon-Alicante, given that these were the two major ports engaged in inter-seas trade.

Distances were measured on an atlas of Spain.

APPENDIX C.

Carting Capacity.

The carting capacity of the professional transportation sector will be estimated from the information contained in the Contribución Industrial. The Contribución gives a good insight into the relative numbers of people engaged in transportation. It is assumed that any under-statement of the numbers will affect carters and muleteers in the same way. Table C-1 shows the distribution of overland carriers.

TABLE C-1.

Overland Carriers in 1879.

	(1) Taxpayers	(2) Carriages	(3) Animals
(1) Ox Carts	507	768	
(2) Seasonal Carts and Waggon	8,548	9,028	
(3) Waggon on someone else's account	1,099	1,351	
(4) Carts	6,788	6,788 ^a	12,649
(5) Waggon	508	508 ^a	1,597
(6) Total ₁	17,450	18,443	14,246
(7) Muleteers on their own account	3,790		3,090
(8) Muleteers on someone else's account	12,951		19,799
(9) Total ₂	16,741		22,889

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Notes and Sources:

Dirección General de Contribuciones, Contribución Industrial y de Comercio (Madrid, 1879), Tables 30, 31 and 32, pp. 104-7.

a :- The Contribución fails to provide the actual figures both for Carts and Waggon (rows 4 and 5). It was assumed that each taxpayer owned only one carriage.

Row (6): Total₁ = (1) + (2) + (3) + (4) + (5)

Row (7): It includes Arrieros y Trajineros, but not in Column (3).

Row (9): Total₂ = (7) + (8)

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The Table indicates that the number of ox carts owned by each taxpayer (1.51) was higher than the number of carts and waggons engaged in seasonal transportation (1.05). The Table conceals, however, that muleteers used twice the number of horses and mules as they did donkeys when supplying transportation services.

In order to qualify the absolute numbers of carriages and pack animals, it is necessary to take into account the load carried by each class and the speed to which they could travel. Donkeys carry on average between 80 and 90 kgs. and travel 30 kilometres each day. They provide daily 2.4 ton-km. of transportation services.¹ Mules and pack horses load on average 120 kgs. at a similar distance, or 3.6 ton-km. each day.² Estimates on the average cart-load are, however, more difficult to assess because it depended heavily upon the nature of the load. Indeed, a cartload of wheat straw weighed 330 kgs. and 240 kgs. if it was barley straw.³ I assumed that the average cartload weighed 600 kgs. and that a cart travelled 30 kms. a day. Thus, a cart supplied 18 ton-kms. per day.⁴ Therefore, a cartload was equivalent to 7.5 donkeys or 5 mules (or horses) and one mule was equivalent to 1.5 donkeys. Moreover, assuming that there were twice as many horses and mules as donkeys, the total number of pack animals in row (9) of Table C-1 will be equivalent to 4,070 cartloads or 22 per cent of the capacity of all carriages devoted to transportation in the professional sector.

1. Evrard indicated that the maximum load for a donkey was 80 kgs., see A. Evrard, op. cit., p. 123. However, in Penārroya, mineral ore was carried on donkeys in baskets weighing 90 kgs., see Projet de Mr. Legrand sur un Chemin de Fer de Penārroya a Llerena, 1881, (Archive MZA, Box 13). I assumed that donkeys travel at a speed of four kms. per hour, see "Informe de la Sociedad de Amigos del Pais de Barcelona" in Crisis, p. 87. The average length of a working day was eight hours, see "Palencia", Ganadería, p. 147.
2. In Cartagena, mules could carry 120 kgs. each of mineral ore, see F. Gispert, loc cit., p. 233. Morin also estimated a similar weight for pack horses, see M. Lopez Martinez, Diccionario de Agricultura (Madrid, 1885).
3. See following page.

(Footnotes to Appendix C continued...)

3. The iron ore from Somorrostro was carried on carts to Galindo, each loading 12 to 13 Castilian hundredweights or 550 to 600 kgs., see D. Manes, "Noticia sobre las Minas de Hierro de Somorrostro", Revista Minera I (1850), p. 21. In Penarroya, waggons drawn by two mules carried one ton of ore, see Proje't de Mr. Legrand, op. cit. In Zaragoza, waggons carried around 30 Hls. of wine or 2.7 tons of wine each, answer given by Torrellas in the province of Zaragoza, Información Vinícola, leg., 88-3. In Guadalajara, a cart carried 60 'arrobas' or 690 kgs. of manure, see Guadalajara, Avance, II, p. 78. For grain, the average load was similar, 12 Hls. or 700 to 800 kgs., see Palecia, Avance, III, p. 586. Thus, all these examples show that the average cartload varied with the density of the commodity. In general, I assumed that the average volume of a cart was 0.50 - 0.70 cubic metres, see Evrard, op. cit., p. 252. Assuming an average density of one, the average cartload will be 600 kgs.

APPENDIX D.

Carting Prices in the Traditional Economy.

The carrying rates for traditional transportation used in the calculation of social savings come from an unpublished nation-wide questionnaire. In 1884, wine producers were required to provide details on the condition of roads and the cost of hauling wine as far as railway stations, and the price charged by railway companies to ship it to France.

From this information, I collected carrying rates for 27 provinces totalling 178 entries for carts and 59 entries for pack horses. The mean of these freight rates are set out in Table D-1 for different distance intervals.

TABLE D-1.

Carrying Rates of Traditional Transportation.

(in pesetas per ton-km.)

Distance (kms.)	(1) Carts		(2) Pack animals	
	(a)	(b)	(a)	(b)
0 - 14	66	1.0217	22	1.4711
15 - 29	53	0.7378	15	1.326
30 - 44	25	0.7139	9	1.3858
45 - 59	14	0.61	8	1.0182
60 - 74	10	0.649	4	1.0178
75 - 89	10	0.6494		

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Notes and Sources:

Columns 1-a and 2-a: number of entries for each distance interval.

Columns 1-b and 2-b: mean of carrying rates for each distance interval in pesetas per ton-km.

All calculations are based on the data collected from Información Vinícola (1886).

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1. See Appendix: Carting Rates, page 265.

I adjusted two curves to these rate distributions:

$$y = 0.6011 + \frac{3.063}{x} \quad \text{for carts.}$$

$$y = 1.0585 + \frac{3.2012}{x} \quad \text{for pack horses.}$$

where y stands for carting rates and x for the distance travelled.

As the distance lengthens, the carrying rate approximates the constant term. Assuming that 80 per cent of the transport capacity was supplied by carts, the final weighted rate will be 0.7937 pesetas per ton-km.¹

1. See text, (Section C.3., pp. 59-60) and Appendix C for transport capacity. The Sardá price index was used as a deflator.

APPENDIX E.

Norte and MZA's Social Saving on Coal Transportation.

In 1878, Norte hauled 145,000 tons of coal at an average distance of 221 kilometres, or 32.1 million ton-kms. The average railway rate per ton of coal is the result of dividing total coal receipts by the coal output measured in ton-kms. It comes to 0,0585 pesetas per ton-km. of freight.¹ However, in 1878, Norte's 'internal' rate was only 0.01425 pesetas per ton-km.²

MZA's data refer to coal receipts and to the tonnage of coal carried by the company in 1878. Assuming that the average rate charged per ton-km. of coal was similar to Norte's, MZA's coal output was 17.4 million ton-kms. and the average haul 238 kilometres.

Table E-1 combines these estimates. Coal shipments for Norte and MZA amounted to slightly under eight per cent of their aggregate total output, and over eight per cent of the aggregate total tonnage.

TABLE E-1.

Social Saving on Coal Transportation in 1878.

(1)	Coal Output	49.5	10^6	Tkms.
(2)	Railway Cost	0.834	10^6	pesetas.
(3)	Carting Cost	33.4	10^6	pesetas.
(4)	'Real' Carting Cost	3.4	10^6	pesetas.
(5)	Social Saving	32.6	10^6	pesetas.
(6)	New Social Saving	2.6	10^6	pesetas.

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Notes and Sources: see following page.

1. See Table 1, page 252.
2. Norte, Actuacion, II, Table 10.

Notes and Sources contd.: (Table E-1).

- Row (1): Coal Output for Norte and MZA.
Row (2): Railway Cost: Norte's internal rate, see footnote 3, p. 46. MZA's internal rate from row (3) in Table 3, p.69.
Row (3): Carting Cost: Carting rate multiplied by coal output. Carting rate from row (9) in Table 3, p. 69 and coal output adjusted for 'roundaboutness'.
Row (4): 'Real' Carting Cost: new carting rate from A.3. in Table 7, page 85, multiplied by coal output.
Row (5): Social Saving as Casting Cost minus Railway Cost.
Row (6): New Social Saving as Real Carting Cost minus Railway Cost.

PART TWO.

LINKAGES OF RAILWAYS TO THE

COAL AND IRON INDUSTRIES.

CHAPTER THREE.

RAILWAYS AND THE IRON INDUSTRY.

A). Introduction:

'... even if we assume that the lines on concession are only three: the so called Northern, the Madrid to Zaragoza and Alicante, and finally the Madrid to Cadiz, all three adding to 280 leagues, and taking for granted that the consumption of iron for each comes to 30 thousand hundredweight... 8.4 million hundredweight will enter the country free of duties in a few years time equalling the domestic output of ten and a half years... It is a mistake to think that the domestic works would have been unable to provide the vast amount of railway material required by these railways if only they had been slightly protected. In this way not only those huge capitals would have been prevented from leaving the country, but also the domestic works would have been highly encouraged, achieving what will not be achieved in many years, that is an improvement and economy for the mutual benefit of consumers and producers.' ¹

This long quotation, written on the eve of railway construction, reflects the views of a large number of Spanish historians on the limited feedbacks from railways to the domestic iron industry.² The construction of railways with imported railroad iron, so the argument runs, disappointed Spanish ironmasters and was to blame for the continued stagnation of the industry.

Until recently no attempt had been made to quantify the derived demand for iron from the railways over the period 1855 to 1913. Economic historians based their arguments on contemporary estimates, too often

1. "De la industria ferrera y los derechos", Revista Minera, VIII (1856), 408-9.
2. At the origin of the debate J. Nadal, El Fracaso de la Revolución industrial en España, 1814-1913, (Madrid, 1975) (hereafter Fracaso) in particular pp. 161-5, 183. For a recent survey of these views, see J. Harrison, An Economic History of Modern Spain, (Manchester, 1978) pp. 52-3.

biased, the reliability of which had not been checked.¹ More recently, however, R. Anes has produced an estimate of gross consumption of iron and steel by Spanish railways after 1875.²

This chapter measures the demand for permanent way iron, rails being the major component of railroad iron. It then proceeds to estimate the share of demand met by local ironworks once rail imports have been isolated. But railways were also suppliers of scrap iron. Therefore, section D focuses on net demand from railways, that is the difference between domestic supply and scrap sales to the rest of the Spanish economy. The final section analyses the counterfactual implications of a protectionist policy in the event that a tariff would have been imposed on the eve of railway construction in 1855. Moreover, net demand for railway iron is then converted into pig iron equivalent. The results will be examined in the light of the development of the iron industry.

B). The Demand for Permanent Way Iron:

Railway construction entailed a demand for railroad iron for the laying of tracks.³ As the original iron rails gradually wore out, they were replaced by steel rails. This process gave rise to an additional demand which will also be considered.

1. For example, Nadal provides a contemporary estimate of the total weight of steel rails laid down by 1879 and argues that 2/3 of the network had been renewed by then. Even if the average weight of the steel rails is overestimated, the estimate quoted by Nadal exceeds the total length of railways open in that year, see Nadal, op. cit., p. 164.
2. See R. Anes, "Relación entre el Ferrocarril y la Economía Española, 1865-1935" in M. Artola (ed.), Los Ferrocarriles en España, 1844-1943, (Madrid, 1978), pp. 461-71. Anes has estimated the total weight of the rails deployed in three different years 1879, 1899 and 1930 by normal gauge railways.
3. Iron for rolling stock can be regarded as a demand from the engineering sector, see B.R. Mitchell, "The Coming of the Railway and United Kingdom Economic Growth" reprinted in M.C. Reed (ed.), Railways and the Victorian Economy, (1969) p. 21.

B.1. The New Tracks:

Railway companies did not publish estimates of the total weight of rails laid during the second half of the 19th century. Evidence on direct purchases is scattered and it is only obtainable for the leading railway companies. An alternative calculation involves estimating first the total length of track annually laid and secondly an average weight for the rails laid on Spanish tracks.

(i) Annual additions to the railway network are the basic source to estimate the annual demand for rails from broad and narrow gauge railways. Although the early railway concessions foresaw the need for a double track, Spanish railways were constructed on a single track basis except in tunnels and bridges. Thus, in contrast to most European railway systems, the geographical mileage of the Spanish track equals the actual length laid apart from sidings and other subsidiary service tracks. By the turn of the century, once traffic density had reached a level which required a higher capacity of transportation, Norte became the first company to undertake the laying of a second track. First, along the Madrid-Irun line and later between the busy Manresa and Barcelona.¹ Compared to 17 per cent of double track for Norte, MZA had only 2.4 per cent by 1910.²

Annual additions to the network exclude, however, siding and other supplementary track. Unless an allowance is made for the latter, total consumption of railroad iron will be underestimated. Consequently, total imports expressed in length equivalent will exceed the actual length of the track. Evidence suggests that sidings amounted to 15 to

1. The actual additions to the double track network are ignored on a year to year basis. The total length for the period 1902-14 was averaged resulting in 48 kilometres laid each year.
2. MZA, Renovación del tendido, 1910 (Archive MZA).

20 per cent of the total length of the track. My calculations have been worked with the lower bound.¹

(ii) During railway construction in Spain, iron and steel rails were used in turn. The use of steel rails spread in the 1870's.

During the first railway mania from 1855 to 1872, three main types of rails were used: the 'double T' laid by some British railways, several types of 'Barlow' rails and finally the so called 'American' or 'Vignole' rail which was directly laid upon the sleepers without chairs.

From 1863 on, MZA substituted Vignole for Brunel and Barlow rails which had originally been laid on the Alicante line. The company sought to unify rail systems to achieve greater efficiency and also because it was increasingly difficult to purchase these former rails due to technical problems of manufacture. The use of Vignole rails became more and more widespread in the 1860's, not only in Spain but elsewhere on the Continent. Moreover, the initiative of the Spanish companies was backed by their French counterparts. For example, the 'Compagnie du Nord de la France' was the first European company to employ such rails.²

The fact that different rail systems were laid down before the 1860's hardly affects the calculations because the average weight on all three systems was very similar. My estimates set out in Table 1 reflect however, that Vignole rails were preponderant.³

1. Fifteen per cent is the extra allowance for rails granted in a number of railway concessions including the Madrid-Malpartida line (17 per cent), the Mérida-Sevilla line (23 per cent), the Gerona-Figueras line (14 per cent), the Francia-Figueras line (15 per cent) as calculated from the information provided by Pliegos de Condiciones, Boletín de Fomento, (1855-65). Besides, countries with single track railways are a useful source of comparison: Roumania (14 per cent), Finland (16 per cent), Denmark and Italy (14 per cent), see J.S. Jeans, Railway Problems (1884), p. 35.
2. "In Switzerland, Italy and Spain, this rail is quite the only one in use", see A. Perdonnet, De l'Exploitation des Chemins de Fer (1858-60) i. 374.
3. See notes to column 1 in Table 1, p. 123.

From 1873 onwards, most of the lines were laid with steel rails. Some others, however, persisted with iron rails because of the low density of traffic on their lines. Others, in particular the busy colliery lines, like for example the Zaragoza-Val de Zafran, replaced iron rails at a rapid pace. It was not possible, however, to assess accurately the share of iron rails in total consumption during the 1870's because the Spanish tariff failed to differentiate between iron and steel rails after 1875. Therefore, the length of the track laid with iron rails was guessed, out of French exports of iron rails to Spain.¹

My estimate for the average weight of the steel rails laid down during the long second railway mania between 1873 and 1900 is 32 kilogrammes per linear metre or 64 tons per kilometre of track.²

Railway companies of narrow gauge lines laid down rails lighter than those laid on broad gauge lines. Technically, the advisable weight of a rail was determined by traffic density, by the weight of the rolling stock and by the speed of trains. On narrow gauge lines, rolling stock was lighter and speed was lower because most of these railways hauled minerals rather than passengers. But for example on the outskirts of Bilbao, traffic density was much higher than for most broad gauge railways. Such lines were indeed laid with heavier rails.³

1. Until 1875, steel rails are classified under "steel bars". From 1875 on, rails imports include steel and iron rails, see JISI, I (1875), 312-3. This is one source of disparity between my import figures and those compiled by R. Anes, op. cit., p. 469. Anes regards all rail imports as steel rails. However, iron rails were being imported from France in the 1870's.
2. See notes to Column 1 in Table 1.
3. Among the narrow gauge lines of the Bilbao district, the Sestao-Galdames track was laid with 27.8 kgs. Vignole rails, the Orconera railway company consumed 28 kgs. rails and the Luchana-Regato 22 kgs. rails, see W. Gill, "The Iron Ore District of Bilbao", JISI, VIII (1882), Appendix IV. Also P. de Alzola, "Ferrocarriles de vía ancha y vía estrecha", Revista de Obras Públicas (1884), 353 and by the same author, "Ferrocarriles mineros en las inmediaciones de Bilbao", ROP (1875), 87 and 97.

(Footnote 3 continued on following page, (page 121)).

The average weight of the rails laid down by a number of narrow gauge companies comes to 23.7 kilogrammes per linear metre.¹ A report on a mineral railway line to serve the Penarroya coalfields stated that '... the 20 kgs. rails seem advisable based on the experience of the narrow gauge railway companies on operation ...'.² Finally, by the turn of the century at a time when the laying of narrow gauge tracks had sensibly progressed, the Spanish tariff made the distinction between rails of more and less than 25 kgs. per metre.

My demand for permanent-way iron laid on narrow gauge tracks make use of this last figure.³

Final results on the consumption of permanent-way iron show that 79 per cent of the rails laid over the period 1855 to 1913 expressed in weight terms was demanded by normal gauge companies. The two major building cycles from 1855 to 1866 and from 1873 to 1896 absorbed 85 per cent of this amount. Regarding narrow gauge tracks, results show that the laying was especially intensive after 1885. In fact, 87 per cent of the narrow gauge rails were laid in that period.

(Footnote 3 from page 120 continued...)

- (3) Other narrow gauge tracks in different districts were laid with rails of the following weights: Rio Tinto Railway Company, 25 Kgs., Tharsis Railway Company, 26.9 kgs., Catalanes and Tudela Railway Companies, 19.5 kgs., see P. de Alzola, "Ferrocarriles de vía ancha y de vía estrecha", ROP (1884), 358 and also "Ferrocarril de Tharsis al Ordiel", Rev. Min. XXXVII (1886), 311, 350.

(Footnotes accompanying page 121)

1. See footnote 3, page 120 (contd. on page 121)
2. Projet d'un Chemin de Fer Economique Peñarroya-Llerena. Mémoire p. 12 (Renfe Box 13).
3. See notes to Column 2 in Table 1, p. 123.

TABLE 1.

Derived Demand for Permanent-Way Iron, 1855-1913 (000' T).

Year	(1) Iron for New Tracks Broad C_t^{bnp}	(2) Narrow C_t^{nnp}	(3) Iron for Renewals. C_t^r	(4) Total Demand. C_t^T
1855	11.9	-	-	12.1
56	4.0	.1	-	4.1
57	12.3	.2	-	12.7
58	15.2	-	-	15.5
59	24.8	-	-	25.3
1860	63.7	-	-	65.0
61	38.0	1.0	-	39.8
62	30.0	1.0	-	31.6
63	68.9	.7	3.5	74.6
64	39.1	.7	4.7	45.4
1865	63.8	.7	6.4	72.3
66	26.7	.7	7.8	35.9
67	3.5	1.4	3.6	8.6
68	12.5	1.4	3.8	18.0
69	1.6	-	4.0	5.7
1870	2.3	-	3.9	6.3
71	1.5	-	3.4	5.0
72	2.6	-	4.1	6.8
73	9.0	.8	3.5	13.5
74	10.6	3.2	9.0	23.1
1875	16.5	2.6	15.0	34.5
76	12.2	3.7	19.5	35.7
77	13.2	1.1	33.7	48.3
78	12.9	1.1	50.2	64.5
79	28.1	1.8	41.9	72.4
1880	27.2	.9	46.2	74.9
81	18.3	.9	63.2	82.8
82	5.6	1.2	67.5	74.4
83	28.7	4.6	15.9	49.9
84	26.8	.8	1.7	29.8
1885	17.2	4.0	9.5	31.1
86	16.1	6.3	8.5	31.3
87	6.8	4.5	9.5	21.0
88	6.0	3.3	12.5	22.0
89	9.9	4.1	11.3	25.6
1890	11.5	9.1	14.7	35.7
91	13.8	15.1	6.2	35.8
92	19.4	5.5	10.2	35.8
93	25.4	14.6	8.2	49.2
94	15.1	8.6	9.1	33.4
1895	32.4	14.1	8.6	56.2
96	22.2	1.8	9.9	34.6
97	1.8	.5	8.5	11.0
98	5.6	.8	8.1	14.9
99	6.3	-	4.5	11.4

(Table 1 continued on following page...)

(Table 1 contd...)

TABLE 1.

Derived Demand for Permanent-Way Iron, 1855-1913 (000' T).

Year	(1) Iron for New Tracks. Broad	(2) Narrow	(3) Iron for Renewals.	(4) Total Demand.
	C_t^{bnp}	C_t^{nnp}	C_t^r	C_t^T
1900	3.3	1.5	4.6	9.6
01	11.1	3.5	8.1	23.1
02	10.4	4.2	12.5	27.6
03	6.2	7.2	20.5	34.6
04	8.3	13.3	18.0	40.4
1905	4.5	11.3	9.5	25.8
06	6.1	21.0	6.8	34.6
07	8.0	.5	8.7	17.5
08	4.5	5.8	9.6	20.3
09	4.5	1.7	14.6	21.2
1910	4.5	5.7	16.8	27.5
11	4.5	13.3	22.8	41.4
12	10.3	10.5	23.8	45.5
13	8.6	10.5	14.7	34.7

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Sources and Methods of Calculation:

Column 1: Consumption of iron rails for broad gauge track. Annual additions to the broad gauge network given in R. Cordero and F. Menendez, "El Sistema Ferroviario Español" in M. Artola (ed.), Los Ferrocarriles en España, 1844-1943, (Madrid, 1978), i, 324 Ap. II-2. Additions to the network include a 15 per cent allowance in sideways, garages, etc, for coefficient see footnote 1, page 119. Average weight of rails: for the period 1855-72, 73 tons per kilometre of track; for the period 1873-80, 73 tons per kilometre of iron rail track which amounted in those years to an annual addition of 37.5 kilometres, and 64 tons per kilometre of steel track; for the period 1880-1902, 64 tons per kilometre and from 1903 on, 82.5 tons per kilometre. Over the period 1902-14 additions to double track were averaged as 48 kilometres per year, see footnote 2, page 3. The major source of information on the weight of the iron rails laid before 1862 are the technical specifications to the railway concessions granted over the period 1855-62, see 'Pliegos de Condiciones' in Boletín de Fomento, 1855-62. The average weight for a sample of 23 lines was 70 tons per kilometre of track. After 1863, Vignole rails weighting 73 tons were widely used. It was assumed that some track was still laid down with iron rails after 1873 and until 1880 when French exports of iron rails to Spain ended. Regarding steel rails, light rails were in widespread use at the beginning. For instance, 30 kgs. rails were laid down on the Madrid-Ciudad Real line. As tonnage increased, lighter steel rails were replaced by heavier ones. For instance, 32.5 kgs. rails were originally used on the Valladolid-Ariza line. Railway companies which were eventually amalgamated to MZA like TBF were also laid down with this latter rail. Weight estimates for this period come to 32 kgs. or 64 tons per kilometre of track.

(Contd. on following page...)

B.2. Rail Consumption for Renewals:

The renewal policy of most railway companies is practically unknown. Norte and MZA were exceptional, publishing on a regular basis the amount of track renewed every year. I will extend the pattern of these renewals to the rest of the normal gauge companies. Given that most of the narrow gauge railways were laid down after 1885, their steel rails presumably did not wear out before 1913. On these grounds I will analyse:

First, the pattern of renewals. Three periods may be distinguished, 1863-72, 1873-1900 and 1901-13. During the first, different iron rail systems were unified. During the second, renewal means the substitution of steel for worn-out iron rails. After 1900 on, MZA and Norte undertook the replacement of their lighter steel rails by heavier ones.

Second, the average life of iron rails based on the information provided by the two leading companies.

The start of railway building in Spain was relatively late compared to most European countries. It took place only a few years before the switch to steel rails and accordingly it depressed the demand for permanent-way iron. The life of iron rails compared to steel rails was short and they had to be renewed quite often. In countries like the United States where the building of railways was also mainly met through rail imports, the maintenance of the network generated a demand

(Sources and Methods of Calculation contd.)

Column 2: Consumption of rails for narrow gauge track. Annual additions to the narrow gauge network given in E. de la Torre, Anuarios de Ferrocarriles and also in Memorias de Obras Públicas referring to railways. Additions include a 15 per cent allowance for supplementary track, see footnote 1, page 119. Average weight of rails was set at 50 tons per kilometre of track, see text and footnote 3, page 120.

Column 3: Total consumption of rails for renewals. Only normal gauge track was assumed to be renewed, see text. See appendix to this chapter for data on average life of iron rails. Average weight of the rails renewed in each period is similar to Column 1.

Column 4: Total demand of rails. Annual figures include a 2 per cent allowance for defective rails. This coefficient was assumed on the basis of 'Pliegos de Condiciones', Bol. de Fom.

for iron rails stimulating production in a number of iron mills.¹ As the first iron rails wore out in Spain, they were replaced by steel rails, the life of which was much longer.

Rails deteriorated because of the continuous passage of trains, apart from the effect of mechanical or chemical factors such as corrosion near the seaside. In stations or crossings, they wore out quickly owing to the uninterrupted effect of braking. If traffic was not intense and on flat land, iron rails could last very long. Furthermore, renewal of old rails was never compulsory but was constrained by the financial position of Spanish companies. In adverse years, companies used depreciation funds to pay up interest on credits, and were forced to postpone renewal merely by reinforcing the fastenings on old sections of the track.

According to Sir I. Lowthian Bell, the average life of a rail of the British North Eastern Company was ten years.² In Spain, MZA owned in 1910 one hundred kilometres of iron track laid 38 years before.³ As for steel rails, the more enthusiastic supporters suggested in the 1870's that their life was endless. But in the first decade of the new century, MZA engineers declared '... the more optimistic believe that they can reach 75 years... but the more practical share the view that a good steel track would last about fifty years'.⁴ These estimates were certainly long enough to justify the assumption that steel rails never wore out before 1913.⁵ Although steel rails did not deteriorate nearly so rapidly as iron rails, they could snap if placed under heavy

1. See A. Fishlow, American Railroads and the Transformation of the Ante-Bellum Economy, (Harvard, 1965), p. 139.
2. I.L. Bell, The Iron Trade in the United Kingdom (1886), pp. 34-5, quoted in B.R. Mitchell, "The Coming of the Railway and United Kingdom Economic Growth", JEH, XXIV (1964), Table 2 notes to Column 1.
3. MZA, Informe sobre Renovación de Vía para 1910, p. 18 (Archive MZA), hereafter, Informe).
4. Ibidem p. 18.
5. In 1910, two thirds of the 'old network' of MZA (Red Antigua) were laid with 30 kilogrammes steel rails, 16 to 34 years old. Moreover, when these light rails were replaced by heavier rails they were deployed on secondary tracks.

weight. After the turn of the century, heavier rails were laid down, as will be described further down.

Between 1863 and 1872, MZA substituted Vignole for Barlow rails on the Alicante line. If we assume that this policy was extended to the rest of the network laid down before the arrival of foreign capital, only 150 additional kilometres were renewed.

From 1872 on, MZA started to substitute Bessemer steel for iron rails. Norte's turn came in 1874, and one year later ZPB and TBF started their renewals.¹ The coincidence in the timing of the renewal policy among these companies suggests that it was general for all railway companies. Nadal stated that by 1879 'two thirds of the network consisted of steel rails'.² But it is hard to believe that Spanish railways could have undertaken renewals at a more intensive pace than those in England where only one third of the network had been renewed with steel rails by this time.³ Particularly as the supremacy of steel rails had not yet been fully established.⁴ Furthermore, the pattern of renewals by Spanish leading companies does not show such an intensive rate of renewals.⁵ A more realistic percentage would seem to be around 35 to 40 per cent of the total network open to the public in 1878.

The substitution of steel for iron rails laid before 1873 proceeded at a swift pace by Norte and MZA, and peaked between 1879 and

1. See MZA, Memoria (1873), Norte, Memoria (1875) and MZA, Informe.
2. J. Nadal, Fracaso, p. 164. This percentage has been fully accepted by R. Anes, op. cit., pp. 463-4.
3. JISI (1879), p. 257.
4. The debates at the Iron and Steel Institute reflect this state of things. See in particular R. Price Williams, "Economy in Railway Working. The Relative Endurance of iron and steel rails", JISI (1879) and also M.G. Field, "Different views on the relative endurance of iron and steel rails", letter to the Engineer reprinted in JISI (1879), 262.
5. For example, Norte had renewed 32 per cent of its network by 1878, see Norte, Memoria (1879). In 1879, 31 per cent of MZA's network was laid with steel rails, see MZA, Procès Verbaux du Comité de Paris, 14 May 1880. Finally, ZPB had substituted steel for iron rails in 28 per cent of its 1877 network, see ZPB, Actas del Comité Ejecutivo, 4 October 1877.

1883, coinciding with a downward trend in railway prices on European markets. Thus, over the period 1873-80, an average of 90 kilometres had been renewed yearly; in the first half of the 1880's this figure rose by 60 per cent. MZA engineers slowed down the rate of renewal to bring it down with the levels of tonnage hauled. By the end of the nineteenth century, Norte and MZA had nearly achieved the substitution of steel for all iron rails. I have estimated that the life of the iron rails when the replacement took place was on average 18 years.¹ Therefore it was assumed that renewals during the period 1873 to 1898 fit to a point distribution with a constant average life.

By the turn of the century, increased traffic forced both companies to purchase modern and heavier rolling stock which exceeded the capacity of the lighter rails. Thus, from 1900 onwards Norte and MZA engaged in a policy of substituting heavier for lighter steel rails.² The joint ratio length renewed in one year to length of network to be renewed by Norte and MZA was assumed to hold true for the rest of the Spanish network.

C). Rail Imports:

Feedbacks on the iron industry from railroad demand cannot be fully assessed unless rail imports are previously isolated. In this section I will focus on:

- railway legislation on railroad iron imports which channeled rail demand towards the external markets.
- the volume of rail imports.

1. See Appendix to this chapter, pp. 154-5.

2. MZA substituted 40, 42.5 and 45 kilogrammes rails for 30 and 32 kilogrammes steel rails, see MZA, Informe.

C.1. Legal Aspects of Rail Imports:

The General Railway Law of 1855 granted an exemption from customs duties on all railway material cleared by companies during the construction of the track and for the ten subsequent years. Railway companies took advantage of this facility to import all sort of commodities in spite of the fact that some could have been easily supplied locally.¹ When in 1872 the dead line set by the 1855 law came to an end for most of the leading railways, the exemption was extended for all permanent way equipment.²

When this extension ended in 1877, the Government created a special tariff for iron and steel rails. Imports had to pay a duty of 18 pesetas per ton of rails.³ However, companies which had not previously enjoyed state subsidies were liable to pay half of this duty.

Parliament finally put an end to all exemptions in 1888. The decision was especially significant as it coincided with the construction of the narrow gauge network. The new duty on rail imports 'was large enough to ensure that all rails consumed in the country would be manufactured in Spain. Once the advantage enjoyed by Great Britain in the cheapness of fuel could be fully compensated by the cheapness of iron ore in Spain'.⁴

1. Act of 3 May 1864. The goods liable to pay duties included the furniture of railway stations and stationery.
2. Act of 26 August 1872. The exemption from customs duties had ended for MZA, Norte, TBF, LRT, Langreo, Triano, Sevilla-Jerez y Cadiz, Cordoba-Sevilla and Utrera-Monzon.
3. Budget Law of 11 July 1877. The new duty was in fact a 10 per cent ad valorem duty on rail imports. The law explicitly mentioned that the new tariff aimed at promoting the assembly of locomotives and other rolling stock since a 10 per cent ad valorem rate was also levied on chassis, buffers and other parts imports.
4. "Los Derechos del Material de Ferrocarriles a propósito del Proyecto de Ley de Navarro Reverter", Rev. Min. XL (1888), 178.

The economic crisis of the late 1880's was followed by a revival of protectionism. The landed interest formed allies with iron, textile and shipping interests and all claimed for further protection. During the meetings of a 'Committee for the Reform of Tariffs', a proposal to put an end to 'railway privileges' led to an 'excited' discussion in the course of which the railway interest reminded members of the Committee of the low profits made by the companies and of the large benefits brought to the country through the operation of railways.¹ Although the proposal was eventually rejected at that stage, the tariff of 1891 marked the end of free trade in Spain. Protection was reinforced in the 1890's with the gradual fall in the exchange rate of the peseta.

By this time, railway companies had almost completed the renewal of their tracks. They were more willing to give up the exemption from customs as part of a far reaching agreement with the Government. This agreement involved for example, the extension of railway concessions, the payment of a state subsidy, the permit to levy charges for loading and unloading goods and permission to lay narrow gauge lines connecting cities deprived of railway service.² On its side, Norte engaged to carry grain, flour, cattle and agricultural implements at a 10 per cent reduced rate and agricultural labourers at half fare. Moreover, railway companies agreed to raise a loan for the Government of one billion pesetas. This shift in state policy culminated in 1896 when customs duties on rail imports were raised from 18 to 54 pesetas per ton with the agreement of railway companies.

1. '... some 3 billion pesetas had been invested in railways and they yielded only 2 per cent... the proposal will mean the ruin of those enterprises... ', El Liberal, 29 October 1890 reprinted in Parl. Papers, 1892, LXXXVIII, p. 312.
2. Norte, Exposición de hechos formulada por Norte para la información abierta por la Comisión del Senado con motivo del convenio firmado con el Estado el 2 de Julio de 1896, (Madrid, 1896).

C.2. The Volume of Rail Imports:

Spanish foreign trade statistics conceal rail imports for the period 1855 to 1869. From 1862, rails were included under bar iron of different shapes. Consequently, it seemed preferable that I should calculate import estimates from alternative Belgian, British and French export statistics. According to Spanish sources, imports from Germany (including those via Holland) were not recorded during this period.

Table 2 shows that rail imports during the first construction boom were very large. British manufacturers prevailed over their Belgian and French competitors in the supply of the Spanish market in spite of the close financial links between Belgium and France and Spain's railway companies. These links between Spanish and French railway companies reflected in the practice of the 'fournisseur habituel'. For example, Aciéries de France, Denain Anzin and Terre Noire were common suppliers to both the French Compagnie du Nord and MZA.¹ However, the main contracts for iron rails supplied to MZA during these early years went to British iron mills.² On the other hand, Norte turned to Belgian mills.³ An important contract between a Belgian cartel and Norte for 37,500 tons of iron rails was financed by the Société Générale de Bruxelles. The importance of the contract and the insistence of the Péreire agents in Belgium compelled Cockerill to join the cartel because it was sufficient to 'keep the works rolling rails during three years

1. For Compagnie du Nord, see F. Caron, Histoire de l'exploitation d'un grand réseau: la Compagnie des Chemins de Fer du Nord, 1846-1937, (Paris, 1973), p. 335 and for MZA, Procès Verbaux, 24 December 1863, 29 January 1875, 6 June 1900.
2. Aberdare Iron, Foreman, Skymney, Banks and Perry supplied iron rails to MZA between 1859 and 1871, see MZA, Procès Verbaux, 22 October 1859, 9 January 1862, 30 July 1863, 5 March 1868 and 14 July 1871.
3. This preference for Belgian rails may be explained by the fact that the Belgian Société Générale and the Banque de Belgique subscribed 15 per cent of Norte's debentures, see R. Cameron, France and the Economic Development of Europe, (Princeton, 1961), p. 251.

and a half... ' .¹

In the compilation of rail imports over the period 1873 to 1913, Spanish foreign trade statistics have been used.² Annual imports in Table 3 include both imports free from customs duties and imports under the general tariff.³ Imports have not been broken down by country of origin because the Spanish source conceals transit trade and as a result official figures may be heavily distorted. For example, one third of Belgian exports to Spain between 1876 and 1880 were in fact Prussian rails.

After 1872, the range of suppliers was more diversified for Norte with Belgian mills still prevailing (Blondiaux, Cockerill and Aciéries Belges). German mills (Krupp and Rhurholt) increasingly supplied steel rails after 1875. Among MZA's suppliers two or three names re-occur. The German 'offensive' of the 1880's led eventually to the disappearance of contracts with British mills. The price of German rails was highly competitive on the international markets because exports were partially subsidised.⁴ '... Belgian and Prussian have succeeded in ousting British railway material... ' was sadly asserted by the British Consul at Santander in 1881.⁵ The steady decreasing trend in the price of steel rails favoured some large contracts with German steel works. In the late 1880's, however, British ironmasters had regained the command of the market.

1. I am grateful to R. Fremdling for letting me have this information, Minutes du conseil d'administration de la Société Anonyme Cockerill, 17 September 1858.
2. See Column 3, Table 3.
3. Regulations to benefit from the exemption from customs duties were so complex and strict that for some railway companies, especially the modest ones, advantages and disadvantages were balanced. See "El Material de los Ferrocarriles", Rev. Min. XL (1888), 139. The inclusion of rail imports under the general tariff in column 3 of Table 3 is the main source of disparity between my calculations and R. Anes' rail imports. As a result, Anes' total imports over the period 1873-1900 are 45 per cent lower than mine, see R. Anes, op. cit., Table V-58, p.469.
4. See in particular D.L.Burn, The Economic History of Steel Making, (1940), p. 74. This system of export bounties was repeatedly denounced by the Revista Minera when commenting upon a contract secured by Andaluces with the Krupp works for the supply of steel rails at 113 pesetas the ton in Cadiz: '... those same rails would have been sold at 140 pesetas

(Notes contd. on following page...)

TABLE 2.

Rail Exports to Spain, 1855-1872

Year	Britain (1)	Belgium (2)	France (3)	Total (4)
1855	4,055	-	-	4,055
56	10,352	-	-	10,352
57	17,135	-	-	17,135
58	22,192	-	-	22,192
59	16,910	16,852	4,600	38,362
1860	29,219	27,836	240	57,295
61	28,271	19,295	295	47,861
62	41,820	9,613	1,291	52,724
63	48,154	22,900	1,009	72,063
64	21,337	34,056	21,740	77,133
1865	2,866	8,913	6,277	18,056
66	-	1,747	221	1,968
67	10,673	103	-	10,776
68	9,600	130	-	9,730
69	10,585	36	290	10,911
1870	10,406	2,651	1,228	14,285
71	11,879	468	731	12,988
72	10,489	6,352	-	16,841
Total:	305,943	150,952	37,922	494,817
%:	61.8%	30.5%	7.7%	

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Sources and Methods of Calculation:

Column 1: British rail exports to Spain given in Trade and Navigation Accounts, British Parl. Papers 1856-73. However, official exports for 1855 and 1856 include bar iron. The average amount of bar iron exported to Spain between 1857 and 1859 was deducted. For the period 1857-61, exports include all iron railroad. A coefficient of 60 per cent was applied to make an allowance for axles, chairs, wheels, iron sleepers, bolts, etc. on the basis of the relative weight of each of these items per kilometre of track given in 'Pliegos de Condiciones', Bol. de Fom. In the years 1862 to 1864, exports to Spain include chairs. Assuming that the ratio chairs to rails was 0.4 expressed in weight, rails will amount to 85 per cent of total imports, see Sir I.L. Bell, op. cit., p.31. Finally, over 1865 to 1872, exports include tie rods. The share of rails was assumed to be 0.95 on the basis of 'Pliegos de Condiciones', Bol. de Fom.

Column 2: Belgian rail exports to Spain given in Commerce Extérieur de la Belgique, 1855-72.

Column 3: French rail exports to Spain given in Annales du Commerce extérieur de la France, 1855-72.

(Footnotes from page 131 contd...)

had they been laid down on German railways. If this is not an export bounty it is a device sly enough to manufacture rails which are consumed in Germany and also those which are consumed in Spain', in Rev. Min. XL (1888), 254.

5. Consular Report for the year 1882 at Bilbao (Parl.Papers, 1882,LXXI), 1501.

TABLE 3.

Demand for Permanent-Way Iron and Rail Imports (000' T).

Year	(1) Total Demand.	(2)	(3) Imports.	(4)
1855-56	7.9		7.2	
56-57	8.1		13.7	
57-58	13.7		19.7	
58-59	20.0		30.3	
59-60	44.2	94	47.8	118.7
1860-61	51.3		52.6	
61-62	35.0		50.1	
62-63	53.1		62.3	
63-64	60.0		74.6	
64-65	58.8		47.6	
65-66	54.1	312	10.0	297.2
1866-67	22.2		6.4	
67-68	13.3		10.2	
68-69	11.8		10.3	
69-70	6.0		12.6	
70-71	5.6		13.6	
71-72	6.9	66	14.9	68
1872-73	10.0		16.3	
73-74	18.0		24.0	
74-75	34.5		29.7	
75-76	47.6		30.2	
76-77	48.5		42.4	
77-78	56.1	214.8	54.5	197.2
1878-79	68.0		47.0	
79-80	73.0		43.0	
80-81	78.3		60.8	
81-82	78.3		68.0	
82-83	62.0		69.4	
83-84	39.2	398.7	70.0	358
1884-85	30.0		42.8	
85-86	30.8		23.4	
86-87	25.8		23.7	
87-88	21.3		21.5	
88-89	23.6		28.1	
89-90	30.3	161.8	41.2	181
1890-91	35.6		37.8	
91-92	35.8		27.7	
92-93	42.5		26.2	
93-94	41.3		20.6	
94-95	44.8		13.0	
95-96	45.6	245.3	11.3	136.7

(Table 3 contd...)

(Table 3 contd...)

TABLE 3.

Demand for Permanent-Way Iron and Rail Imports (000' T).

Year	(1) Total Demand.	(2)	(3) Imports.	(4)
1896-97	22.8		11.4	
97-98	13.0		8.8	
98-99	13.1		9.3	
99-00	10.5		16.3	
00-01	16.3		21.1	
01-02	25.3	101.1	14.6	81.5
1902-03	31.1		9.0	
03-04	37.5		8.7	
04-05	33.1		8.1	
05-06	30.2		7.6	
06-07	26.0		8.7	
07-08	18.9	177	6.5	48.6
1908-09	20.7		2.6	
09-10	24.3		4.0	
10-11	34.4		4.7	
11-12	43.4		7.5	
12-13	40.1		13.1	
13-14	33.7	196.6	18.2	50.1

- 0 -

Sources and Notes:

Column 1: Estimated total demand for permanent-way iron as given in Column 4 of Table 1.

Column 2: 6 year aggregate demand for permanent-way iron.

Column 3: Rail imports, as given in Column 4 of Table 2 for the period 1855 to 1872. From 1873 on, imports exempted from customs duties and imports under the general tariff as given in Estadística del Comercio Exterior de España, 1873-1913. It should be noticed however, that for individual years and for some six-year periods imports exceed estimated consumption. This divergence arises from the fact that demand for rails was assumed to take place once the laying of the track had already been accomplished.

D). Net Derived Demand for Iron:

Railways not only demanded large amounts of iron but supplied old iron (scrap rails, scrap rolling stock, etc.). It must be emphasised that the significant magnitude for our attempt to estimate the impact of railways upon the iron industry is net demand, that is deducting from gross demand scrap iron recycled into the economy by the railway companies.

Evidence suggests that some old iron rails were used by the companies themselves, for instance in sidings or as telegraph poles. Steel rails were deployed as secondary track. But most of the scrapped rails were sold by the companies inside and outside Spain.

In fact, early railway legislation sought to prevent scrap metal from being channeled towards other uses outside railways because the metal had been imported free from customs duties solely to encourage railway construction. Scrap railroad iron to be used outside railways became subject to duties payable on different classes of non manufactured iron.¹ Railroad scrap could be re-exported to foreign countries within three months of rail renewal.² Moreover, railway companies were not allowed to transform scrap iron.³

These laws, enforced throughout the 19th century, deprived the local iron and steel industries of a continuous flow of cheap scrap iron, a basic input for the modern manufacture of steel.

Norte and MZA did not reroll scrap rails in their workshops. Nor did these companies cut scrap rail in different shapes for sale in Spain. Some quantities of scrap rails were sold in Spain, in particular to the Girona ironworks closely linked to the railway interest.⁴ These works had been the first to establish rerolling mills in Spain and they praised themselves for having been the first to manufacture rails

1. Act of 30 July 1865. This legal arrangement was denounced by the iron interest as helping railway companies to accomplish an illegal trade in manufactured iron: '... to maintain this sort of arrangement shows a complete ignorance on the uses of scrap... it also enables railway companies to undertake some smuggling, because if they can sell scrap iron with the mentioned duty, they might just as well transform the scrapped metal with rolling mills. As they enjoy and exemption from customs duties, it could be the case that they were selling manufactured iron which they had imported free of duties as it was scrap', see Observaciones de algunos fabricantes de hierros, Información sobre el derecho diferencial de Bandera y sobre las aduanas exigibles a los hierros, el carbon de piedra y los algodones (Madrid, 1867), ii. 223, (hereafter, Información).
2. Bill of 30 November 1869.
3. Bill of 15 July 1870.
4. Girona had subscribed an important share of the capital of the ZPB. An early contract was passed with ZPB for the sale of scrap rails, see ZPB, Actas del Consejo, 23 April 1870.

in Spain although on a very limited scale.¹ Norte and MZA complained about the languid development of the domestic iron industry with reason because the cost of renewing one ton of new rails in France came to 1.66 tons of scrap rails, whereas in Spain it amounted to 3.25 tons. It was acknowledged that in Spain there '... were not still works capable of rerolling scrap rails at a competitive price with foreign mills...'.²

Legal restrictions on the use of scrap rails within Spain entailed the development of a flourishing export trade. Italy was the main importing country. In the period 1873 to 1914, she consumed 272,000 tons of Spanish old rails or 84 per cent of total exports of scrap rails from Spain.

Spanish trade statistics become thereby a prime source to estimate the different uses of the annual supply of scrap rails. Scrap sales were classified under the following headings:

- exports to foreign countries which amounted to 48 per cent of total supply. (SX_t)
- scrap rails recycled into the economy and subject to normal customs duties which amounted to 15 per cent of supply. (SR_t)
- sales among railway companies exempted from customs duties.

The annual supply of scrap rails (S_t) can easily be derived from the track renewal estimates compiled in Table 1.³ The difference between S_t and the 'legal' sales, either for export to foreign countries

1. See Información, ii., 307 and Gaceta de los Caminos de Hierro, X (1865), 537.
2. MZA, Memoria (1869), p. 20.
3. See section B.2. Scrap rails available each year were calculated assuming that 3/8 inch was the average wearing depth, see R. Price-Williams, op. cit. Given the density of an iron rail, this depth is equivalent to a 11 per cent loss in the weight of an iron rail, see MZA, Informe. Thus, one ton of new iron rails will weigh when worn out 0.89 tons. Alternatively, one kilometre of iron track (73 tons) will weigh when it is renewed 65 tons.

or recycled into the economy, becomes a rough estimate of 'illegal' sales by railway companies within Spain (SS_t). 'Illegal' suggests that railway companies might have been liable to some extent to smuggle into the country scrap rails as manufactured iron.¹ But railway companies might just as well have evaded the law by reusing scrap rails themselves. Both uses had a different effect, as the former enlarged the annual supply of pig iron and the latter decreased demand for railroad iron or for rails only, in the event that replaced rails were laid again on new track. However, both effects weakened the impact of railways on the iron industry. These calculations are set out in Table 4.

TABLE 4.

Scrap Rails and the Illegal Trade (000' T).

Year	(1) S_t	(2) SR_t	(3) SX_t	(4) SS_t	(5) SS_t/S_t
1855-72	40	-	2	38	0.96
1873-90	439	63	249	127	0.29
1891-02	96	22	39	35	0.36
1903-06	38	9	7	22	0.58
TOTAL :	613	94	297	222	0.36

- 0 -

Sources and Methods of Calculation:

Column 1: S_t was estimated from Column 4 in Table 1 assuming that the loss of weight in scrap rails because of wear and tear is 11 per cent. Consequently, the length of track renewed every year was multiplied by the weight of a worn out rail. For coefficient, see footnote 3 p. 136.

Column 2: SR_t is given in Estadística del Comercio Exterior de España, 1855-1906.

Column 3: Ibid.

Column 4: The supply of scrap rails minus scrap rails recycled into the economy minus scrap rails exported to foreign countries.

Column 5: Illegal sales of scrap rails as a percentage of total supply.

1. See footnote 1, page 135.

The table stops in 1906 because the duty levied on scrap iron was finally removed in that year.¹ Moreover, we will obtain two sets of net demand according to whether we deduct from gross demand legal and illegal sales of scrap rails or simply legal sales. These two sets must be viewed as an upper and lower bound of the net derived demand. The calculations in Table 5 show that as a result of taking into account the recycling of illegal scrap rails, the final net demand for iron would be halved.

The next step in the argument will be to confront net demand for iron expressed in pig iron equivalent with pig iron output to determine to what extent railways drew the iron industry after them and in which period.

TABLE 5.

Net Derived Demand for Iron, 1855-1913 (000' T).

Year	(1) Total Demand	(2) Imports	(3) Domestic Supply	(4) Scrap Rails	(5) Net Demand ₁	(6) Net Demand ₂
1855-56/ 71-72	484	484	---	---	653	601
1872-73/ 89-90	776	736	40	63	- 31	- 202
1890-91/ 01-02	346	218	128	22	143	96
1902-03/ 13-14	373	99	274	68	379	349
<u>TOTAL</u> :	1,967	1,537	442	153	491 ^a	243 ^a

Sources and Methods of Calculation: ^a1855-56/1871-72 excluded.

Column 1: Total rail consumption as given in Tables 1 and 4.

Column 2: Total rail imports as given in Tables 3 and 4.

Column 3: Total rail consumption supplied by the domestic iron industry as the difference between total rail consumption(1) and total rail imports (2).

(Contd. on following page...)

1. Therefore, net demand₂ in Column 6 of Table 5 excludes concealed sales and refers only to the legal trade within Spain.

E). Demand from Railways and the Development of the Iron Industry:

Results from Tables 1 and 5 have been combined to set up Table 6. Four periods are distinguished: the two construction booms from 1855 to 1872 and from 1873 to 1890, and the two protective decades of the 1890's and 1900's.

E.1. The First Construction Boom, 1855-1872:

For this period, the similarity between consumption and import figures (see Columns 1 and 2 in Table 5) implies that Spanish railway companies met their needs for permanent-way iron abroad. The share left to the domestic ironworks was thus extremely limited, being confined to some small experiments.¹

Thus, railways used large quantities of rails before 1872 but these rails were largely imported. Therefore, it seems that the relevant question to ask is what would have been the level of domestic pig iron output necessary to match demand for rails and fastenings.

- My estimates imply that the output of pig iron would have to double over the period 1855 to 1872 if the railway companies had been

(Sources and Methods of Calculation (for Table 5) contd...)

Column 4: Scrap rails legally recycled into the economy, see text and Table 4. From 1906 on, the estimate is directly derived from the estimated total availability of old rails assuming that no illegal trade took place once the duty on scrap rails was removed.

Column 5: Net demand for iron in pig iron equivalent as (3) plus rail exports from Spain minus scrap rails. The pig iron multiplier 1,35 is based on the evidence provided by the ironworks of Nuestra Sra del Carmen, Estadística Minera (1875), p. 84. It is, however, slightly higher than the multiplier applied by Nadal which comes to 1.307, see J. Nadal, "La Economía española, 1829-1931" in El Banco de España: Una Historia Económica, (Madrid, 1970).

Column 6: Net demand for iron in pig iron equivalent as (5) minus illegal sales of scrap rails, for illegal trade see calculations in Table 4 and text.

1. The Girona iron mills manufactured 1,000 tons whilst Duro rerolled 2,000 tons in 1869, see Nadal, Fracaso, p. 163.

compelled to depend entirely on the local iron industry. Adding the pig iron equivalent for rail fastenings, Spanish pig iron output would have to increase between 113 and 121 per cent in just under two decades.¹ In terms of wrought iron output, the corresponding increment comes to 83 per cent.

These calculations lead inevitably to question whether the arguments for protection were economically viable. Such arguments posit that the freedom to import railway material free from customs duties deprived the domestic iron industry of a steady source of demand and inevitably lead to the stagnation of the industry. Following this line of reasoning, we may wonder about the economic implications of a prohibitive tariff being imposed on the eve of railway construction. As a result of a price increase for iron rails in the domestic market, protected iron mills would have increased their output to meet the rail requirements of the companies. However, the argument is based on number of assumptions:

- (1) No capital constraints in the protected iron industry.

It will be assumed that impelled by the prospects of future profits, capital would have been easily drained towards the iron industry in the amount required to cope with the enlargement of capacity.

1. These calculations are based on the technical specifications of some railway concessions granted between 1855 and 1872. It was assumed that 25 per cent of the track was laid with chairs, the weight of which is 25 tons per kilometre of track. 75 per cent of the track made use of spikes and other rail fastenings weighing 0.5 tons per kilometre. Consequently, rail fastenings will weigh 14 tons per kilometre of track, see 'Pliegos de Condiciones', Bol. de Fom., 1855-1872. The conversion rate into pig iron equivalent was assumed to be 1.29 to show the predominance of wrought iron fastenings over cast iron chairs.

- (2) No technical constraints. Backward techniques in the local iron mills could have been quickly supplemented by the importation of the appropriate innovations from the more advanced countries in the light of the later development of the Bilbao iron industry. Altos Hornos and other Biscayan iron mills were founded in the early 1880's. It took only three years to manufacture the first Bessemer steel ingot. In this short span of time, capacity was enlarged up to one quarter million tons. Engineers from the French works at Terre Noire and also English engineers cooperated and managed the Altos Hornos plant, while the Vizcaya furnaces were erected under Cockerill's supervision.¹ Bilbao pig iron output increased 4.5 times in eight years and by 1888 amounted to 83 per cent of the national output.
- (3) Railway demand for rails was completely inelastic. Thus, it is stated that the pattern of rail consumption would have remained unaltered in spite of the increase in the price of rails. Removal of this assumption would entail a slowing down of the laying of the tracks. Its economic costs were measured as part of the social savings from railways.
- (4) Foreign investment in railways would have also been unaffected, The removal of this assumption will also affect the pattern of railway construction. One might speculate whether foreign investment and the railway legislation were linked together but higher costs of construction would have raised railway rates. Assuming a high elasticity of substitution between alternative modes of transportation,

1. See Le Fer, 12 June 1883 quoted in JISI (1883), 862.

the profitability prospects of railway investment would have been negatively affected.¹

- (5) Other sectors of the economy would have been unaffected by the tariff. This ceteris paribus assumption ensures that the feedbacks from the iron industry on the rest of the economy would have been minor.

TABLE 6.

Railways and the Iron Industry, 1855-1913 (000' T and %).

Year	(1)	(2)	(3)	(4)	(5)
1855-56/ 71-72	637.5	-	102	-	-
1872-73/ 89-90	1,813.4	170	58	-	3.0
1890-91/ 01-02	3,328	1,117	14	31	5.2
1902-03/ 13-14	4,727	3,457	10	11	7.8
<u>Total :</u>	10,506	4,744	25	15	5.5

Year	(6)	(7)	(8)	(9)	(10)	(11)
1855-56/ 71-72	-	-	-	-	-	83
1872-73/ 89-90	-	-	-	-	-	89
1890-91/ 01-02	11.4	4.3	9.5	2.9	6.3	
1902-03/ 13-14	7.9	8.0	8.1	7.4	7.5	
<u>Total :</u>	9.1					

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Sources and Methods of Calculation: (See following page)

1. To Nadal, the exemption from customs duties was granted to railway companies under foreign capital pressure, see Nadal, Fracaso, p. 162.

Sources and Methods of Calculation: (Table 6).

- Column 1: Spanish pig iron output for 1855-90 as given in J. Nadal, Fracaso, Appendix 6. From 1890 on, as given in Return relating to Iron and Steel (Parl. Papers, 1910, XCIV), p. 875. After 1910 as given in B.R. Mitchell, European Historical Statistics, 1750-1970 (1978), p. 218.
- Column 2: Spanish steel output. For 1886-89 as given in Estadística Minera. Before 1886, a constant average output of 300 tons per year was applied. From 1890 to 1902, R.R. to Iron and Steel (P.P. 1910, XCIV), p. 877. From 1902 to 1913, estimated output is the mean of the output as given in B.R. Mitchell, op. cit., pp. 223, 225 and in H. Paris Eguilaz, Problemas de la Expansión Siderúrgica en España (Madrid, 1954), p. 16.
- Column 3: Gross demand for permanent-way iron expressed as pig iron equivalent as a share of pig iron output.
- Column 4: Gross demand for permanent-way steel as a share of steel output.
- Column 5: Supply of domestic rails expressed as pig iron equivalent as a share of pig iron output. The pig iron equivalent for steel rails is also 1.35 and was estimated on the basis of the pig iron required by the Biscayan ironworks to manufacture the 1913 steel output, see Estadística Minera, 1913.
- Column 6: Supply of domestic rails as a share of steel output.
- Column 7: Net demand for iron expressed as pig iron equivalent as a share of pig iron output, as the result of deducting the legal trade of scrap rails from supply of domestic rails.
- Column 8: Net demand for steel as a share of steel output after deducting the legal trade of scrap rails from the supply of domestic rails. Net demand estimates from Column 5 in Table 5 were expressed in steel dividing by the 1.35 coefficient.
- Column 9: Net demand for iron expressed as pig iron equivalent as a share of pig iron output, as a result of deducting the illegal trade of scrap rails from the supply of domestic rails.
- Column 10: Net demand for steel as a share of steel output after deducting from the supply of domestic rails the illegal sales of scrap rails. Net demand estimates from Column 6 in Table 5 were transformed into steel by dividing by 1.35.
- Column 11: Gross demand for permanent-way iron as a share of wrought iron output. For wrought iron output estimates until 1886, see J. Nadal, "La Economía Española, 1829-1931", op. cit., Table 7, p. 364. From 1886 on, as given in Estadística Minera. For the period 1855 to 1871, output comes to 582,000 tons and 691,000 tons from 1872 until 1890.

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Partial equilibrium analysis provides a useful framework to calculate the cost of protection. It will consist of a production and a consumption cost.¹ Assumption (3) ensures the removal of the consumption cost given that the volume of consumed rails will remain unaltered. The cost of production is illustrated in Chart 1.

1. In particular, W.M. Corden, "The Calculation of the Cost of Protection", Economic Record XXXIII (1957), 29-51.

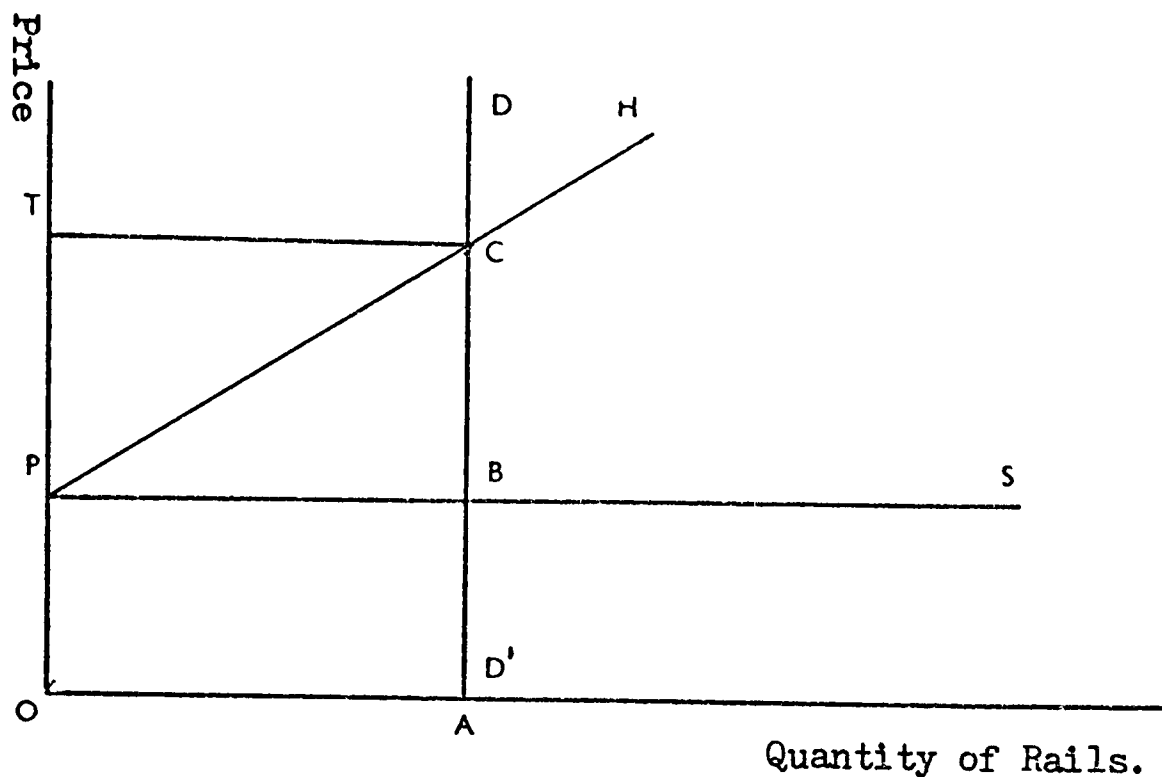


Chart 1: The Cost of Production.

The foreign supply curve of iron rails is PS, showing that Spain could in no possible way alter the international price (the small country assumption). Domestic demand for rails is DD'. Under free trade, the quantity of iron rails consumed will be OA at a price OP (this is a cif price), all rails being imported as the domestic supply curve lies above the foreign supply for this quantity.

A prohibitive tariff PT is imposed so that the internal price of iron rails is raised to OT. At this price, domestic manufacturers will start production matching domestic demand. This is ensured by assumption (1) and (2). The cost of producing OA in the domestic iron works is OACF, while its cost in the international market remains invariable (OAPB). The difference between both costs (the triangle BCP) will be the cost of production.

Railway companies will meet an excess cost equal to BCFT and larger than the production cost because we have assumed that the curve of domestic supply was upwards. Thus, the excess cost or

redistribution of income between consumers and producers becomes an upper bound of the protection cost, both costs being eventually equalised if there were constant or decreasing costs in the protective industry.

Given that Spanish iron mills did not manufacture rails in this early period, at least on a sustained basis, it will be necessary to estimate the price of these rails had they been manufactured. I have chosen as a proxy the price of pig iron which is the main input for the manufacture of rails. Furthermore, I have assumed that the ratio price of pig iron to price of iron rails in England holds for Spain. Declared values for British exports of pig iron and iron rails were thus averaged for the period 1865 to 1871. This ratio at fob prices comes to 0.40.

The Asturian district enjoyed a locational advantage for the manufacture of pig iron conferred by a large supply of coal.¹ Thereby, if railways had been supplied by local ironworks, it is the price of Asturian pig iron which becomes the relevant magnitude. If we apply to the price of Asturian pig the 40 per cent ratio, we will obtain a lower bound for the potential price of iron rails had they been manufactured in Spain. Even if manufacturing methods were imported from England, it will be unrealistic to assume that Spanish mills would be as efficient as the English. Indeed, it may be expected that fuel and labour productivities were lower in Spain than in England. Spanish coal was of poor quality to produce good coke, and the country lacked the skilled labour necessary to run the ironworks. This difference in productivity explains that Spanish pig was more expensive than English pig iron. The price of imported rails is compared to the price of 'Spanish' rails in Table 7.

1. See Section D in Chapter 4, p.173.

TABLE 7.

Excess Cost of 'Spanish' Iron Rails over Imported Rails

(in pesetas per ton of rails).

Year	(1) English Rails at fob prices	(2) English Rails at cif prices	(3) Price of Spanish Rails	(4) Excess Cost
1865	177	196	245	48
1867	170	191	253	62
1869	167	190	350	160
1871	190	219	250	31

- 0 -

Sources and Methods of Calculation:

Column 1: Declared Values of Rail Exports to Spain, Trade and Navigation Accounts, British Parl. Papers, 1866 to 1872.

Column 2: Cif price of British rails in Spain as a result of fob prices plus freight and insurance. Freight rates were given in Consular Reports for Bilbao for the shipping of iron ore from Bilbao to England in the 1880's. This series of freight was deflated according to North's index of ocean freights, see D.C. North, "Ocean Freights and Economic Development, 1750-1913", JEH XVIII (1958). The iron ore freight was transformed into a pig iron freight, as a proxy for iron rails, applying a 1.77 coefficient. This coefficient was assumed on the basis of Consular Report for Bilbao in 1898, (Parl. Papers, 1899, CII), 506 Insurance rates are those applied to the shipping of iron ore from Malaga amounting to $7.5 \cdot 10^{-3}$ per cent of the value of the cargo at fob prices. It was assumed that the higher value of iron rails was offset by the smaller distance from Bilbao.

Column 3: Price of 'Spanish' rails was calculated on assumed ratios between pig iron and iron rails prices, see text. For the price of Asturian pig iron, see Nadal, op. cit., Table 4, p. 176.

Column 4: Excess cost as the difference between the price of 'Spanish' rails and the price of imported rails.

- 0 -

The difference in favour of imported rails becomes a lower bound of the prohibitive tariff necessary to force railway companies into buying iron rails from the local ironworks. Average excess cost for the seven years after 1865 would have been 95 to 100 pesetas per ton of iron rails. Assuming that it remained constant at this level for the whole period 1855 to 1872, railway companies would have put up with an additional expense of 50 million pesetas given that the total rail imports during the first construction boom amounted to

484,000 tons. With respect to MZA, the supply of iron rails by local mills would have meant an additional bill of 10 million pesetas or 32 per cent of its total expenses on permanent-way material by 1872. Finally, it must be emphasised that two biases of different sign have been introduced in the calculations. The estimated cost of production exceeds the actual cost of protection (by the area CPT in Figure 1). On the other hand, the estimated price of domestic rails is underated because Spanish productivity was assumed to be comparable to English. In the aggregate, both effects will partially offset each other.

The constant pattern of construction requires that aggregate output of pig iron over the period 1855 to 1872 had been twice the actual figure. Assuming that capacity on the iron industry was fully employed on the eve of railway construction, the required increments in capacity would have followed a pattern similar to the laying of the track. Table 8 shows that the first railway construction boom would have entailed a 12-fold increase in capacity between 1855 and 1864, reaching a peak of 155,000 tons during that year.

It was observed that rail consumption for renewals was affected in Spain by the quick technical obsolescence of iron rails. Consequently, the large consumption levels attained during the first construction cycle were reached again only when the substitution of steel for iron rails started.

This pattern of rail consumption would have entailed high levels of idle capacity for the iron industry, around 60 per cent after 1865 when railway construction temporarily slowed down. This idle capacity could have only been absorbed after 1877 with the start of a second construction cycle which coincided with peak renewals of the former. Capacity would have been enlarged between 1877 and 1885 to match railway demand. With the end of the second cycle, excess capacity would have stemmed up again, though at lower levels. The

excess capacity levels in Table 8 must be viewed, however, as lower bounds because they exclude scrap rails recycled into the economy by railway companies. Percentages would then change slightly upwards, especially after 1873 when idle capacity would have been boosted from 32 to 41 per cent. A successful pig iron import substitution would have absorbed only partially the excess capacity. For example, it would have dropped to 40-66 per cent in the period 1865 to 1872.

TABLE 8.

Excess Capacity in the Iron Industry, 1855-1889 (000' T and %).

Year	(1) Pig Iron Output	(2) Rail Imports	(3) Required Capacity	(4) Capacity Increments	(5) (4)/(3)
1855	12.9	5.4	18.3	5.3	
56	15.2	13.9	29.1	10.8	
57	17.9	23.1	41.0	11.9	
58	21.1	30.0	51.1	10.1	
59	24.8	51.8	76.6	25.5	
1860	29.3	77.3	106.6	30.0	
61	34.5	64.7	99.2	- 7.4	6.9
62	48.1	71.1	119.2	12.6	
63	45.3	97.2	142.5	23.3	
64	50.8	104.1	155.0	13.5	
1865	49.5	24.3	73.8	- 81.2	52.4
66	39.2	2.7	41.9	-113.1	72.9
67	42.0	14.6	56.6	- 98.4	63.4
68	43.2	13.1	56.3	- 98.7	63.7
69	34.5	14.7	49.2	-105.8	68.2
1870	54.0	19.3	73.3	- 81.2	52.4
71	53.6	17.6	71.2	- 83.8	54.1
72	56.5	22.7	79.2	- 75.8	48.9
73	42.8	21.3	64.1	- 90.9	58.6
74	37.9	43.6	81.5	- 73.5	47.4
1875	36.9	36.6	73.5	- 81.5	52.6
76	44.5	45.1	89.6	- 65.4	42.2
77	46.7	69.4	116.1	- 38.9	25.1
78	66.8	77.8	144.6	- 10.4	6.7
79	68.7	49.1	117.8	- 37.2	24.0
1880	85.9	67.1	153.0	- 2.0	1.3
81	114.4	97.1	211.5	56.5	
82	120.1	85.7	205.8	- 5.7	2.7
83	139.9	101.2	241.1	29.6	
84	124.4	87.2	211.6	- 29.5	12.2
1885	159.2	28.5	187.7	- 53.4	22.1
86	147.7	34.8	182.5	- 58.4	24.3
87	184.0	29.3	213.3	- 27.8	8.7
88	185.7	28.7	214.4	- 26.7	11.0
89	179.4	47.2	224.9	- 16.2	6.7

Notes and Sources: (Table 8)

- Column 1: Pig iron output reprinted in Nadal, op. cit., Appendix 6.
Column 2: Rail imports expressed in pig iron equivalent are given in Table 3 and for pig iron coefficient see notes to Column 5 in Table 5.
Column 3: Required capacity as the sum of pig iron output and rail imports.
Column 4: Increments in capacity. A (-) sign denotes idle capacity.
Column 5: Excess capacity in terms of total capacity.

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E.2. The Second Construction Boom, 1873-1890:

In this period, local ironworks supplied only 5 per cent of rail demand. This share of total demand is probably a lower bound because the extraordinary demand due to the Carlist war was not taken into account. However, evidence suggests that the material damages caused by the Carlists afflicted rolling stock and railway stations rather than the permanent way.

After the lapse of the war years, the Spanish iron industry was partially modernised with the influx of foreign capital. It was reported that 'rolling mills were very limited, the principal being those of Sres Duro, the scrap works of Girona, Ibarra and Mieres. They all have rail trains, which are not, however, on a very large scale at work, being chiefly engaged on tramway rails, the import of which is checked by a duty...'.¹ Tramways were indeed excluded from the exemption of duties granted to railway companies not benefiting from any state subsidy.² Rail imports included rails to be laid on tramway tracks. Although a minor source of demand, its exclusion would underestimate the share of railway demand met by local ironworks. Demand from tramway

1. Report on the Iron Trade in Foreign Countries, JISI (1879), 407.
2. The Bill of 21 July 1876 made a distinction between steam and animal power.

companies amounted to 6,700 tons during this period. It will raise the final percentage of the consumption of rails met by domestic works to 6 per cent.¹

Although gross demand in pig iron equivalent came to 54,000 tons or 3 per cent of domestic output, net demand will turn negative. On a comparative basis, the flow of scrap rails will represent between 1.7 and 11.1 per cent of pig iron output whether 'illegal' scrap rails are included or not.

Following the opportunity lost argument, aggregate pig iron output over the period 1873 to 1890 would have to increase by 58 per cent had demand from railways been matched by local iron mills. If pig iron embodied in fastenings is added, this last percentage will be raised to 67 per cent.

E.3. The Protective Decade, 1891-1902:

In the course of the 1890's, the broad gauge network was finally completed, whilst the extension of narrow gauge track was substantially improved. Protectionism was increasingly reinforced and the rapid fall in the exchange rate ensured for Biscayan works the monopoly of the domestic market and the possibility of exporting pig iron although in limited quantities.² It was reported that 'the price that the ironmaster can afford is governed by that of pig iron and although a change in the exchange rate may bring no profit to the

1. The length of tramway lines open by 1890 is unknown. It was assumed that annual additions to the tramway network amounted to 18 kilometres between 1895 and 1900. There were two rail systems: under the 'Loubat' rails weighted 18-20 kgs. and under the 'Bazaine' rails weighted 13-14 kgs. In my calculations, I rated rails to weight 18 kgs. or 36 tons the kilometre of track in order to reflect the predominance of mining tramways on urban lines, see F. Serafon, Etude sur les Chemins de Fer, les Tramways et les Moyens de Transport en commun à Paris et à Londres, (Paris, 1872). An allowance for 2 per cent defective rails was made, see notes to Column 4 in Table 1, p. 124.
2. After 1895, MZA negotiated all its contracts with Altos Hornos. From 1890 onwards, Norte purchased only Biscayan rails.

ironmaster, at least it brings him no loss even indirectly for although a high rate of exchange enables Bilbao to export pig iron, the total quantity is very small and makes no serious competition with what is produced in Great Britain'.¹

The fruits of this highly protective economic policy were reaped as the rail import substitution process finally succeeded in taking down the share of imports to 63 per cent of gross rail demand. In terms of pig iron output, the share of total demand supplied by domestic ironworks amounted to 5.2 per cent whereas in terms of steel output it amounted to 11.4 per cent.² Again the disparity between gross and net figures is clearly reflected by taking into account the scrap rails recycled into the iron manufacture (see Columns 7 and 10 in Table 6).

E.4. The Reinforcement of Protection, 1903-1913:

After the turn of the century, the position enjoyed by the Biscayan works both in the internal and external markets was secured. The mergence in 1902 between the three main iron concerns (Altos Hornos, La Vizcaya and La Iberia) gave birth to the 'huge' Altos Hornos de Vizcaya which contributed to consolidate the role that Spanish metallurgy was due to play henceforth. The British Consul at Bilbao observed: '... it is quite impossible for British rails to compete in this district with local works. The import duty being about £1.15s. per ton is absolutely effective in keeping out British rails. The benefit of this state of things is enjoyed by local manufacturers only to the detriment of the consumer who, but for this duty, would be able to buy his rails

1. Consular Report for the year 1895 on Bilbao (Parl. Papers, 1896 LXXXVIII), 645.

2. These percentages raise up to 5.9 and 13.6 per cent when including demand for iron from tramways and 'private' railways.

nearly £2 per ton cheaper. Local makers are kept well informed on the current price of rails in the United Kingdom and in making their calculations simply add the amount of freight and duties to the British quotation and send in their tenders and secure the business at a few shillings the ton less'.¹

Evidence on rail purchases by Norte and MZA suggests that they did not secure any tender from foreign rail makers in the 1900's. All rails were supplied by Altos Hornos. Moreover, pig iron exports favoured by the fall in the exchange rate (an average 58,000 tons were exported yearly during the previous decade) were followed after 1906 by large exports of rails, 21 years after their manufacture was started in Spain.²

Demand met in the domestic market reached a peak figure of 274 thousand tons of rails, or 8 per cent of both the pig iron and steel output over the period 1903 to 1913.³

According to Nadal, the production of rails in the Biscayan factories would have come to one fifth of the production of forged iron and steel between 1904 and 1913, concluding that '... railway demand, weaker than in previous periods, gave birth to steel production in the last years of the 19th century. This fact reinforces a fortiori the loss opportunity argument for the pig iron and steel industries... that could have taken place thirty years before.'⁴

1. Consular Report for the year 1903 on Bilbao (Parl.Papers, 1903, CXXVIII) 862-3.
2. Exports included a contract passed by a Californian railway for the delivery of 21,000 tons of steel rails. In 1908, 27,000 tons were supplied to Turkey. The British Consul in Bilbao observed that the 1906 contract attracted the attention of the Rail Manufacturer's combine in the Continent, see Consular Report (Parl.Papers, 1906, CXXVIII) 496.
3. Demand for permanent-way iron from tramways and 'private' railways amounted to 26,700 tons over the period. Rail exports came to 74,800 tons. The share of domestic supply will raise to 11 per cent.
4. Nadal, Fracaso, p. 183. This conclusion is shared by R. Anes, op. cit., pp. 470-1.

The first part of the argument has been partially confirmed by my own results. Gross demand for rails from all railway companies came to 13.6 per cent of the steel output over the period 1890-91/1901-02, and this level was not reached ever again, falling to an average of 11.5 per cent from then onwards. On these grounds, the feedbacks from railway derived demand for iron were especially intensive in the 1890's, although after the turn of the century there were hardly one third of Nadal's percentage. This disparity is further emphasised in net terms, net demand being only 8 per cent of the domestic pig iron and steel outputs or 2.5 times lower than stated by Nadal.

F. Concluding Remarks:

Under the umbrella of free trade, railway companies imported large quantities of permanent-way iron and rolling stock. I have shown that this trend was reversed in the course of the 1890's after a protectionist economic policy had been installed.

So far, my calculations seem to validate Nadal's argument on the great opportunity lost to develop in the 1850's a modern iron metallurgy on the basis of railway demand. Indeed, supply of domestic rails more than doubled between the 1890's and the first decade of the 20th century as a result of a 100 per cent decrease in imports. The breaking point for domestic iron production also coincided with this shift to protection.

My estimates, however, fail to recreate the magnitude of the impact of railways on iron production. Feedbacks from railways were much more limited than it is suggested by Nadal after 1900. Consequently, it is difficult to view railways as a sole leading sector responsible for the progress of the iron industry. The late development of iron production must be explained by the combined effect of other sectors apart from railways.

APPENDIX.

Average Life of Iron Rails.

The average life of iron rails is estimated on the basis of the actual renewals undertaken by MZA and Norte and on the assumption that the oldest rails were substituted first. The calculation involves two steps. First, an assessment of the dates when the iron tracks were originally laid. Second, the annual length of track renewed.

At the outset of the substitution of steel for iron rails, MZA had just proceeded to substitute Vignole for Barlow and Brunel iron rails along the Madrid-Alicante line.¹ In contrast, with MZA, the Madrid-Irun line was originally laid with Vignole rails. Norte's preference rested upon the experience of its French counterpart, the Compagnie du Midi, and the high maintenance costs of alternative rail systems.² Accordingly, the age of the rails for MZA was lower than for Norte in 1872 (see Table 1).

TABLE 1.

Age Distribution of Iron Rails, 1872.

	(1)		(2)	
	MZA		Norte	
	(a)	(b)	(a)	(b)
1 - 4	212	13.7	-	-
5 - 8	485	31.3	64	4.6
9 - 12	553	35.7	911	65.6
13 - 16	300	19.3	414	30.0

- 0 -

Notes and Sources:

Column 1: (a) Length of track in kilometres in each age group. It includes the Madrid-Alicante, Madrid-Zaragoza, Alcazar-Ciudad Real,

1. See Section B.2., p. 124.

2. Norte, Procès Verbaux des Réunions du Comité de Paris, 4 Jan. 1858.

Notes and Sources contd. (Table 1 - Appendix).

(Column 1 contd.) ... Alicante-Cartagena and Manzanare-Córdoba lines. The dates when each track was opened are given in F. Wais, Historia de los Ferrocarriles Españoles, (Madrid, 1974), Appendix. The extension of track renewed each year along the Madrid-Alicante line was adequately recorded after 1863 in MZA's Memorias.

(b) Percentages of rails in each age group.
Column 2: (a) Length of track in kilometres in each age group. It includes the Madrid-Irun, Alar-Santander, Bilbao-Tudela and Zaragoza-Pamplona-Barcelona lines. Except for the first, all three lines were amalgamated to Norte in 1878. The ZPB Company had renewed 277 kms. of iron track by 1878. Thereby, the remaining iron track was exclusively included in the calculations. The dates of opening of each track were given in Norte, Historia. Actuación. Concesiones. Ingresos. Gastos y Balance (Madrid, 1940), I, p. 49.

(b) Length of track in each age group in percentage.

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In effect 2/3 of Norte's network was between 9 and 12 years old in 1872.¹

The next step in the calculation of the average life of iron rails involves matching the age distribution to the combined renewals undertaken by MZA and Norte from 1872 onwards. The basic assumption is that substitution will start among the older age groups and then proceed to younger rails. Table 2 shows the distribution of renewals according to the age of the rails. The average life of rails comes to 17.52 or 18 years.

However, a contemporary estimate puts the average life of iron rails at 15 years.²

TABLE 2.

Distribution of Iron Rail Renewals according to Age.

AGE	Kms.
15	428
16	100
17	706
18	1,219
19	474

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Notes and Sources:

The annual extension of track renewed was recorded in MZA and Norte's Memorias, 1873-88. See also text for method of calculation.

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1. Including the lines which were amalgamated to Norte in 1878 already laid by 1872.
2. M. Matallana, Manual Práctico de la Conservación de las Vías Ferreas (Barcelona, 1873), p. 178.

CHAPTER FOUR.

RAILWAYS AND THE COAL MINING INDUSTRY.

A). Introduction:

Until the mid 19th century, locomotives burnt wood and coke in their fire boxes instead of coal because the early steam engines had to burn 'their own smoke'. Research on new techniques that would reduce the volume of smoke and the reaction of sulphur on copper boilers was encouraged, however, by rising coke prices. And when railway development started in Spain, most European railways were substituting coal for coke. Although some early Spanish railways continued to use coke and wood for a number of years, after 1865 coal became widespread in use.¹

The object of this chapter is to estimate the derived demand for coal from railways. In contrast to the demand for railroad iron, the demand for coal was largely met by local coalfields. Evidence on linkages between coal mining and railway consumption is scarce. The best data come once again from Norte and MZA, and coal consumption for the whole railway sector will be inferred from the pattern of consumption of these two leading companies. The economy used millions of tons of imported coal. To assess fully the feedback effects from railways,

1. TBF substituted gradually coal for coke. For example, in 1862 its consumption of coke trebled coal consumption. And two years later, coal consumption was already four times larger, see Compañía de los Caminos de Hierro de Tarragona, Barcelona y Francia, Memorias del Consejo de Administración 1862-5.

the share of imported coal in railway coal consumption must be isolated. This will be done in Section C. Former calculations by other authors failed to assess the volume of imported coal in railway total coal consumption.¹

Section D will be devoted to estimate indirect coal requirements for the manufacture of railroad iron.

B). Direct Requirements:

Norte was the only railway company to publish yearly its coal consumption figures.² Similar data were available for MZA only from 1910 onwards.³

Coal consumption will increase proportionally to the output of railways. Other factors like, for example, speed, gradients, or the quality of fuel will also affect consumption. Since Norte covered such a large area of Spain, it can be safely assumed that its consumption is representative of the rest of the sector.⁴

1. Anes confined himself to estimate Norte and MZA's coal consumption, on the assumption that the latter had the same consumption as Norte. His feedback estimates are, however, upper bounds because he is assuming that all railway demand was matched by local supply, see R. Anes, "Relación entre el Ferrocarril y la Economía Española (1865-1935)" in M. Artola, ed., Los Ferrocarriles en España 1844-1943 (Madrid, 1978) ii, pp. 457-8. Casares has built an estimate of the coal consumption for the whole railway sector in the 19th century but neither did he assess the share of imports, see A. Casares, Estudio Histórico-Económico de las Construcciones Ferroviarias Españolas en el S. XIX, (Madrid, 1973), pp. 343-6.
2. Norte, Historia, Actuación, Concesiones, Ingresos, Gastos y Balance (Madrid, 1940) Vol. II, Table 35 (hereafter, Actuación).
3. MZA, Memorias del Consejo de Administración (1910 on), (hereafter, Memorias).
4. The average consumption per train-km. for Norte between 1909 and 1913 was 18 per cent higher than for MZA, see Norte, Actuación, Table 35 and MZA, Memorias (1914). This difference must be accounted for by the steeper gradients of Norte's network. Other railway companies consumed more coal than Norte, for example the narrow gauge Galdames Railway consumed in 1884 20 kgs. per train-km. while Norte's consumption came to 16 kgs., see P. de Alzola, "Ferrocarriles de vía ancha y de vía estrecha", Revista de Obras Públicas (1884), 341.

The basic information required in order to calculate coal consumption is engine mileage. It shows some straight advantages over the more commonly used train mileage. For example, it includes shunting, pilotage, empty returns and trains operated with two engines.¹

Final results have been outlined in Table 1. The details of the calculations are given in the footnotes to the table. Coal consumption per engine-km. for Norte was applied to the estimated total engine mileage for the sector. The calculation assumes that fuel mix and the average coal quality is similar to all companies. Column 5 in Table 1 shows that the aggregate consumption of coal by the three leading companies amounted to half of all railway demand between 1865 and 1885. After 1885, that share rose steadily to reach a peak by the end of the century as these companies took over secondary railway companies. But, once the narrow gauge network had extended, their share declined and settled around two thirds of total demand.

The accuracy of the final figures is validated by the fact that estimated consumption for MZA falls within a 10 per cent range of the actual consumption after 1910.² Furthermore, my figures and independent estimates by Casares are almost identical for the period 1865-96 and a further comparison between my 1872 estimate and a contemporary estimate

1. For MZA, trains operated by two engines amounted to three per cent of the aggregate train mileage, see MZA, Aprovisionamiento de Combustible para 1910 (Archive MZA), p. 4. In his calculations, Casares chose train-mileage instead of engine-mileage, see Casares, op.cit., chapter XVI.

2. MZA's Coal Consumption: (000' T).

Year	Actual	Estimated
1910	339	305
1912	375	336
1914	403.4	365

See MZA, Memoria (1914).

reveals similar results.¹ Nevertheless, the lack of homogeneity in the fuel used by railway companies deserves some attention. After 1865, coke was displaced by coal as railway fuel, but the companies preferred briquettes or 'cakes' to coal because they always burnt 'in the same way' and were easy to store. It is difficult, however, to assess the exact proportion of briquettes in total consumption. At least 50 per cent of the fuel used by Norte and MZA consisted of briquettes the rest being small and screened coal.² Briquettes emerge from compressing small coal into a cake shaped fuel by using tar which acts as an agglutinative. The smaller proportion (92 per cent) of coal per ton of briquettes is nevertheless compensated by the coal which is embodied in the tar and the coal which is consumed during the manufacturing process. Thus, it can safely be assumed that to some extent there was a perfect homogeneity within the fuel mix (with respect to coal equivalent units) consumed by the railways from 1865 onwards.

1. The difference between Casares' estimates and my own comes to only 3.6 per cent between 1865 and 1896. Oriol y Vidal's contemporary estimate of the demand for coal from Spanish railways in 1872 exceeds mine by 8.6 per cent, see R. Oriol y Vidal, Carbones Minerales de Espana. Su Importancia, descripción, producción y consumo (Madrid, 1873), pp. 189-191. In a later article, Oriol estimated the derived demand for coal from a number of sectors:

	1872	1890 (000' T)
Iron and Steel	450	1100
Manufacturing	140	460
Railways	173	320
Gas and Electricity	100	450
Shipping industry	125	285
Household	50	250
Other	190	455
<u>Total</u>	1228	3320

Source: R. Oriol y Vidal, "La Industria Minero-Metalúrgica de España en 1891", Revista Minera XLIV (1892) p. 1 and following.

2. Norte, Procès Verbaux des Réunions du Comité de Paris, 24 November 1906, and MZA, Aprovisionamiento.

TABLE 1.

Derived Demand for Coal from Railways, 1865-1913 (in tons and %).

Year	(1) 10 ⁶ Train-kms.	(2) 10 ⁶ Engine-kms.	(3) Kgs. Coal/(2)	(4) Total Coal (10 ³)	(5) N+MZA+A/(4)
1865	10.4	11.5	10.05	115.6	54.7
66	11.5	12.7	11.87	151.0	45.3
67	12.7	14.0	11.20	157.4	42.8
68	13.3	14.7	10.81	159.1	43.4
69	13.2	14.6	11.40	166.7	43.8
70	12.5	14.1	13.7	193	43.3
1871	13.3	15.0	12.66	189.9	44.3
72	14.1	15.9	11.82	188.0	39.2
73	15.4	17.3	12.38	214.5	44.3
74	15.9	17.9	13.34	238.6	43.5
75	17.3	20.5	13.07	267.7	38.9
1876	20.4	24.2	12.41	300.7	37.1
77	20.4	24.2	11.91	287.8	41.1
78	25.8	30.6	11.01	337.0	43.8
79	27.3	32.4	10.88	352.3	46.9
80	28.7	35.6	11.46	405.0	49.4
1881	29.9	36.8	11.85	436.3	50.4
82	31.1	38.2	11.18	427.0	54.0
83	32.3	39.7	12.24	486.4	52.7
84	25.9	31.8	12.14	386.1	60.7
85	23.4	29.4	12.38	363.9	65.3
1886	26.2	32.8	11.86	389.4	67.3
87	26.9	33.8	12.02	406.2	66.5
88	29.1	36.5	12.14	442.9	62.6
89	29.8	37.3	11.51	429.7	63.8
90	29.4	36.1	13.18	475.7	69.7
1891	28.2	34.6	13.68	473.8	75.8
92	29.6	36.2	13.32	482.8	77.8
93	29.3	35.9	12.97	464.3	76.0
94	29.7	36.4	13.16	479.3	76.0
95	34.3	42.6	13.10	557.6	70.2
1896	32.3	40.1	13.20	529.7	75.5
97	30.6	38.0	13.23	502.8	79.4
98	32.0	39.8	13.32	529.7	81.2
99	37.6	46.6	13.16	613.7	79.0
00	39.4	49.6	13.66	178.3	78.9
1901	41.3	52.9	13.56	716.9	85.2
02	42.8	54.7	13.96	764.3	78.6
03	44.0	56.3	14.35	807.4	79.0
04	45.9	58.8	14.55	855.0	78.4
05	54.1	69.2	14.84	1,027.9	64.6

(Table 1 contd. on following page...)

(Table 1 contd...)

TABLE 1.

Derived Demand for Coal from Railways, 1865-1913 (in tons and %).

Year	(1) 10 ⁶ Train-kms.	(2) 10 ⁶ Engine-kms.	(3) Kgs. Coal/(2)	(4) Total Coal (10 ³)	(5) N+MZA+A/(4)
1906	58.7	74.6	14.57	1,087.1	62.0
07	60.6	77.5	14.60	1,132.3	61.6
08	67.0	85.9	14.54	1,249.3	61.6
09	65.1	83.5	14.93	1,246.0	60.0
10	68.6	89.6	15.06	1,348.9	56.5
1911	66.5	86.9	14.98	1,301.6	60.7
12	68.9	89.9	15.57	1,400.0	63.0
13	72.3	94.4	16.24	1,534.2	63.0

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Notes and Sources:

Column 1: Train-kilometres. Until 1885, train-mileage is based upon A. Casares, Estudio Historico-Económico de las construcciones ferroviarias en el siglo XIX, (Madrid, 1973), Table 66, p. 353, and R. Cordero and F. Menendez, "El Sistema Ferroviario Espanol", op. cit., Appendix II-6, pp. 336-7. Train-mileage was, however, revised to reflect the actual data for Norte, MZA and Andaluces. Compañía de los Caminos de Hierro del Norte de España, Historia, Actuación, Concesiones, Ingresos, Gastos y Balance. (Madrid, 1940), ii, Table 29. For MZA and Andaluces, Memorias. The corresponding figures for 1881 and 1882 were extrapolated assuming an annual rate of growth of 3.95 per cent. From 1886 onwards, Dirección de Obras Públicas, Memorias relativas a ferrocarriles. The figures for 1899 and 1900 were estimated assuming a constant share (0.85) for Norte, MZA and Andaluces with respect to the total.

Column 2: Engine-kilometres as the result of (1) x average value of engine-mileage/train-mileage for Norte and MZA. Norte, op. cit., Table 35.

Column 3: Fuel-kgs. per engine-kilometre. Norte, op. cit., Table 35.

Column 4: Total consumption of coal in thousand tons as:-
Column (2) x Column (3).

Column 5: Total consumption of Norte, MZA and Andaluces as a share of railway consumption. Norte, op. cit., Table 35. Consumption figures for MZA and Andaluces were estimated from their engine-mileage and Column (3).

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C). Domestic or Imported Coal?

By comparison with other European countries, Spain was poorly endowed with coal deposits and the country's coal seams were difficult and expensive to work. Furthermore, 'small' coal amounted to around 70 per cent of total production.¹ Thus, the dependence of the Spanish economy on the cheaper and better quality foreign coal is not surprising. Once import figures have been corrected to exclude coke imports (which should be considered as a different commodity), two different phases can be distinguished in the pattern of coal imports, as it is shown by the data in Table 2:

- (a) 1865-94: imports rose at a higher rate than domestic production.
- (b) 1895 onwards: domestic output rose at 7.5 per cent compared to 2.5 per cent for coal imports.

The falling share of imports is also reflected in the overall share of domestic consumption met by imported coal. Between 1885 and 1894, this ratio was over 50 per cent, but a reinforcement of protectionism in Spain, the depreciation of the exchange rate, the improved integration of the Spanish home market and a tax on British coal exports succeeded in forcing down this share to around 38 per cent. Meanwhile, the bottleneck to overland transportation of local coal was partially overcome by laying down several colliery railway lines. For example, the Valmaseda-la Robla Railway established a link between the Leon coalfields and the large Biscayan market.

Thus, large imports of foreign coal must be explained by their relative cheapness and also on account of their far better quality. Because of this feature, railway fuel becomes highly unhomogeneous. In

1. L. de Adaro, Los Carbones Nacionales y la Marina de Guerra (Madrid, 1912), p. 351, (hereafter, Carbones).

other words, for a similar quantity of coal, the volume of steam raised could be quite different. This means that when we assess the feedbacks from railways on the local coal industry, coal consumption must be carefully qualified to reflect the relative qualities of coal. This will be done in the next section, whereas section C.2 will focus on the actual demand for local coal by railway companies.

TABLE 2.

Output, Imports and Domestic Consumption of Coal,
(annual averages in 000' T and %).

Year	(1) Output	(2) Imports	(3) Imports/Consumption
1865-74	571	401	41.2
1875-84	852	823	49.0
1885-94	1,212	1,378	53.2
1895-04	2,377	1,766	42.6
1905-14	3,565	2,190	38.0

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Notes and Sources:

Column 1: Output of coal. J. Nadal, Fracaso, Appendix 5. The output figures for the years 1887 to 1893 were inferred assuming an even output along the financial years compiled by Nadal.

Column 2: Coal Imports, under the general tariff and free of duties f for railway companies. Estadística del Comercio Exterior de España, 1865-1914. The ratio between British exports of coal to Spain and exports of coal and coke to Spain was applied to the figure compiled in the Estadística for the years 1876 to 1880 which does not differentiate between coal and coke imports. British figures are based upon Trade and Navigation Accounts, (Parl. Papers 1877-1881).

Column 3: Share of domestic consumption met by imports.

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C.1. The Quality of Domestic Coal:

An official enquiry into Spanish coal deposits concluded in 1906 that the small size of Spanish coal is 'the only disadvantage it has over the better quality British coal'.¹ For the railway companies,

1. Comisión de Estudio de la Riqueza Hullera Nacional, Memoria (1906).

however, the advantages of imported coal were indisputable: 'their content in the form of ashes, volatile substances, calories, sulphur, carbon, agglutinative power' allowed a lower consumption per unit of output.¹ The former Commission also published the results of experiments undertaken in the arsenals of the Navy with Asturian and British coals. In one of these experiments, it was shown that the volume of water which could be turned into steam with the combustion of one kg. of Cardiff coal outweighed by 15 per cent the best Langreo coal, and by 12 per cent the standard Aller coal.² Complaints about the poor quality of Spanish coal were frequent, for example: 'it is found cheaper to consume Cardiff coal in Madrid at 22 reals per hundredweight than Asturian coal at 15 reals because... the one comes into the market clean, in lumps and unmixed with other matter, while the other is half dust and mixed with earth and stones.'³ In my calculations below, I have adopted a 15 per cent mark-up to reflect the better quality of imported coal over Spanish coal.

C.2. Domestic Coal in Railway Consumption:

The full linkage between coalmining and railways can only be assessed by establishing the share of railway demand met by the local coalfields. This will be done by, first, examining the evolution of the different coal districts in Spain and their location vis a vis the main railway companies. Second, by concentrating on the price differentials

1. Asociación General de Transportes por vía ferrea, El Problema del Carbon en los Ferrocarriles (Madrid, 1934), p. 37.
2. L. de Adaro, Carbones, Appendix 3.
3. See Estadística Minera (1869), p. 29.
4. Nadal mentioned that English coal was 10-15 per cent better in quality than Spanish coal, see J. Nadal, Fracaso, p. 136.

in favour of imported coal in different regional markets. Third, by modelling a pattern of coal consumption based on the above evidence.

The data in Table 3 show the evolution of the coal output in the main Spanish coal districts. The importance of the Asturian district is two fold. First, it was the richest in Spain. Second, because of its proximity to the sea, it could compete with imported coal on the periphery. Indeed, the Asturian coal mines are on average only 40 miles away from the busy Gijon harbour and linked to it by a completed railway network. As for the other Northern coal fields, it should be emphasised how the Palencia district gradually lost its share of the market to the neighbouring Leon district. But for the railway companies, it was the development of the South coalfields which was significant because of their central location.

TABLE 3.

Spanish Coal Districts (000' T).

Year	Asturias	Leon	Palencia	South	Spain
1865-74	3,752	43	916	966	5,712
%	66	0.7	16	17	100
1875-84	4,217	95	1,852	2,176	8,517
%	49	1	22	25	100
1885-94	5,368	235	1,108	3,005	10,128
%	53	2	11	30	100
1895-04	13,752	1,632	1,172	6,922	23,765
%	58	7	5	30	100
1905-14	20,127	2,509	1,084	7,694	31,515
%	64	8	3	24	100

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Notes and Sources:

South includes the coal districts at Ciudad Real, Cordoba and Seville.

J. Nadal, Fracaso, Appendix 6.

Contemporary and recent studies have analysed the problems facing Spanish coal mining in the 19th century in similar ways. Coal (a commodity of high weight and low value) was very expensive to transport around Spain. British coal was already cheaper than Spanish coal at the pithead, but the deciding factor in its cost advantage was the low freight rates on British ships. British ships brought in ballast coal and coke, and they shipped away mineral ores. While the lack of return cargoes in the commercial exchanges between Spanish coastal towns put up the domestic freight rates over foreign.

Nadal's estimates indicate that at two different times of the 19th century British coal became cheaper than Spanish in most markets of the Spanish periphery. Table 4 contains Nadal's figures, properly amended to reflect the higher quality of British coal. The table shows that in 1865, when mineral ore exports to Great Britain had not yet started, Asturian coal competed successfully along the Northern sea board (San Sebastian to La Coruña). Although the duties on coal imports were raised between 1865 and 1882, Asturian coal lost all its markets along the periphery after 1882. Thus the limited rate of growth of Asturian coal between 1865-74 and 1875-84 can be explained in terms of the price differential in favour of imported coal.

TABLE 4.

Price Differentials of British over Asturian Coal (%).

	1865	1882
San Sebastian	- 26	+ 21
Bilbao	- 42	+ 21
Santander	- 23	+ 29
La Coruña	- 2	+ 19
Cadiz	+ 14	+ 32
Seville	+ 8	
Málaga	+ 11	+ 24
Cartagena	+ 20	
Valencia	+ 2	
Barcelona	+ 10	+ 20

Notes and Sources: See following page.

Notes and Sources: (Table 4.)

+ reflects a price differential in favour of British coal over Spanish coal. - reflects a price differential in favour of Spanish coal over British. British coal at cif prices included customs duties, and a 15 per cent mark-up for better quality (see text for quality coefficient). Spanish and British prices from J. Nadal, Fracaso, Tables 1 and 2, pp. 137 and 142.

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In core markets, the situation was quite different. Both Asturian (and in general Spanish) and imported coal were equally affected by the protective barrier of distance. It is interesting to note the concluding remark of the Commission set up to study the Spanish coalfields: '... imported coal hardly travels further than the shore, little or nothing ever reaches the inner markets. High transportation rates protect the inner coalfields...'.¹

Two distinct areas could be distinguished with respect to coal-marketing in Spain. First, a periphery where imported coal predominated for most of the second half of the 19th century, but with increasing signs of a greater penetration from Asturian coal. Second, inner markets with lower levels of consumption (urban being larger than industrial demand) supplied essentially by central coalfields.

Railway consumption for domestic coal is likely to be congruent with demand patterns for the rest of Spain. Thus, it seems reasonable to assume that railway companies with a railhead at a harbour were supplied with imported coal while railway companies serving the interior were supplied entirely by local coalfields.

Evidence on a number of railway companies will be matched against this consumption hypothesis to assess the share of imported coal in total railway consumption. Railway companies will be divided into two groups according to whether or not they had a terminus at a port.

1. A. Navarrete, El Carbón Nacional y su Transporte (Madrid, 1910), p.10.

In the first group are Norte, MZOV, Andaluces, MZA, the Eastern network of Norte and the Catalan network of MZA (the former TBF). Narrow gauge railway companies have been deliberately omitted because they nearly all traverse mining districts and therefore it can be assumed that they consumed imported coal. Among the second group, apart from the inner networks of the three leading companies, are MZOV and MCP.

The mining railway from Bilbao to Portugalete (in group 1) consumed some four thousand tons of fuel in 1906, equally shared by domestic and 'Cardiff' imported coal. MZOV consumed 7,000 tons of imported briquettes and only 1,000 tons of Asturian coal in that year. And the Zafra-Huelva Railway Company consumed only screened 'Newport' coal.¹

As for the three leading companies, from the beginning they relied heavily on local supplies disregarding the clause on free imports granted under the 1855 Railway General Law. All three companies laid lines to provide easy access to coalfields mined by subsidiary companies. However, they seldom published statistics on the coal output of the mines. Only MZA informed its shareholders regularly about the working of the mines which the company owned in the Villanueva del Río district. Norte failed to provide a similar information about the Barruelo concessions although the company relied heavily on Barruelo production. Contracts with the mining concerns were set up in different ways. MZA managed directly the working of the mines supplying its inner network in coal. The short supply during the early years was offset by imported

1. Comisión de Estudio de la Riqueza Hullera Nacional, Memoria. It includes a summary of the answers to the questionnaire sent by the Commission to the railway companies. Other railway companies which have not been mentioned include the Zaragoza-Cariñena Company which consumed 6-700 tons of domestic briquettes; the La Robla-Valmaseda which consumed 12-14,000 tons of small coal from the Leon district; Madrid-Caceres-Portugal consumed 30,000 tons of Spanish coal and briquettes, and finally the Langreo Railway which consumed 7,000 tons of Asturian coal.

coal. From 1882 onwards, deliveries from the Reunión mines (small coal and briquettes) amounted to 2/3 of MZA's needs and the rest was supplied by the local fields of Puertollano and Peñarroya or coal imported through Alicante.

In contrast, the Barruelo coalfields were managed in the early stages by the Spanish Crédit Mobilier. These mines supplied Norte at a fixed price.¹ In the 1870's purchases in other markets were limited in volume and sporadic, showing that at least in these years fuel requirements were met through the production of the Barruelo mines. In 1885, when Norte was amalgamated to the Noroeste Railway Company, its inner network was supplied by Asturian coal once the rail link had been built. Its eastern network was, however, too distant from the Asturian coalfields, even when coal was carried at the 'internal rate'.²

In 1909, the arrangements for coal supplies to MZA carried on in the same way. Deliveries to the 'old' network from the company's own mines accounted for 43 per cent of its consumption. The Andalusian and Extremadoure lines were supplied by local coal from Peñarroya and Puertollano (11 per cent of its total consumption). Although the quality of coal in these two coalfields was extremely poor, they enjoyed the advantage of a good location, being equidistant from all the inner coal deposits of the railway company. At pithead, the price differential of this coal over British coal at Alicante was 7.5 pesetas per ton. Applying MZA's internal rate to Puertollano coal, it was cheaper than British coal within 500 kms. around the Puertollano coalfields.³ Within this distance, it paid the company to buy local coal.

1. In 1868 a contract was passed with the Spanish Crédit for delivery of briquettes at 30 pesetas per ton and screened coal at 18 pesetas during 3 years, see Norte, Procès, 3 November, 1868.
2. On the 'internal' rate, see the discussion in Chapter 2 on social savings, pp. 46-7.
3. MZA, Aprovisionamiento, p. 2.

Beyond this boundary, it paid the company to purchase imported coal. Alicante and the 'Catalan' network, both more than 500 kms. away, were supplied by imported coal.

Finally, the Andaluces Company consumed coal from its own mines in the rich Belmez district. Although no direct evidence has been found, my estimates show that coal consumption could easily be matched by the output from the Belmez mines.¹

Among the second group of railway companies, evidence on coal purchases was only found for the Medina-Salamanca Railway. In 1906, this company consumed only Asturian coal.²

Thus, the qualitative evidence seem to accord with the consumption hypothesis previously made. The high share of coal delivered to Norte and MZA has already been pointed out. These two companies, included after 1900 a number of lines which were already in operation over the 2nd half of the 19th century. It can be safely assumed that the coal requirements of those lines from 1860 to 1900 were met in a similar way as they were after 1900. According to my reasoning, the rest of the broad gauge network except the shore sections of MZOV and Zafra Railway Company would have consumed domestic coal.

As for MZA, the share of domestic coal to total consumption in 1905, 1910 and 1912 was on average 75 per cent.³ Norte bought in the domestic market 78 per cent of all coal purchased during 1907.⁴ Andaluces would have consumed only domestic coal. Applied to the figures in

1. In fact, my estimates for the period 1896-9 are only 15 per cent higher than the deliveries from the coal mines owned by the company in the Belmez district, Compañía de los Caminos de Hierro Andaluces, Memorias del Consejo de Administración (Madrid, 1896-9). This was confirmed by the Revista Minera: '... coal raised in the Cordoba district is entirely used to supply Andaluces and partially the Mediodía Company...', in 'Cuenca Carbonífera de Belmez y Espiel', Rev.Min., XLIII (1891), 51.
2. Comisión de Estudio de la Riqueza Hullera Nacional, Memoria.
3. MZA, Adquisición de Combustible para 1905, 1910 y 1915 (Archive MZA).
4. In 1907, tenders were passed with the Barruelo mines for the supply of 110,000 tons (33 per cent of total needs), with other Spanish coalfields for 150,000 tons (45%) and foreign suppliers for 75,000 tons (22%), see Norte, Proces, 24 November, 1906.

Column (5) of Table 1, the share of imported coal to total coal consumption by the three leading companies averaged 22 per cent for 1900, 1905 and 1910. In terms of the aggregate consumption of coal by railway companies, the share of imported coal by these three companies would have been 15 per cent.

In 1905, narrow gauge railways accounted for 20 per cent of aggregate train-miles. Since coal consumption is proportional to train-mileage, some 20 per cent of total coal consumption would have been met through imports. Thus, after the turn of the century, railways would have met a third of their consumption from imported coal.

Before 1900 when the narrow gauge network hardly existed, the relative share of the post 1900 Norte and MZA's networks was logically unchanged. Given that on average 85 per cent of the engine mileage was supplied by these companies, and assuming that the structure of coal purchases also remained unchanged, then also one third of all coal would have been purchased abroad.¹

However, an upper bound estimate of 'feedbacks' from railways to the coal mining industry could be calculated on the assumption that the whole consumption was met by domestic coal. A lower bound could be estimated on the assumption that railways consumed the same share of imported coal as the rest of the economy. Thus, we arrive at three estimates: an upper bound (Column 1), my own estimate (the basis of which is elaborated in the text, Column 2) and a lower bound (Column 3).

1. This conclusion is consistent with a contemporary estimate according to which the consumption of Spanish coal from railways came to 400,000 tons or one third of the overall Spanish output, see "Los Ferrocarriles y los Carbones Españoles", Rev. Min., XLIV, (1893), pp. 246-7.

TABLE 5.

Feedbacks from Railways on Coal Mining

(as a percentage of total coal output, 1865-1914)

	(1)	(2)	(3)
1865-74	31	21	18
1875-84	40	27	20
1885-94	36	24	17
1895-04	28	18	16
1905-14	36	24	22

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Notes and Sources:

Column 1: Upper bound, see text, p. . Railway Fuel consumption and coal output from Column 4 in Table 1 and Column 1 in Table 2.

Column 2: Two thirds of total coal consumption / Total Coal Output. For the 2/3 coefficient, see discussion in text, pp.

Column 3: The figures from Column 3 in Table 2 were applied to railway consumption.

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These results in Column 2 show a fairly stable ratio between domestic coal consumption by railways and aggregate coal output in all periods but 1895-04 when coal output increased at a higher rate than coal consumption by railways. Given that 'growth takes place at the margin', it can be estimated that 39 per cent of the increase in coal output between 1875 and 1884 was delivered to railways.

In sum, feedbacks from railways on coal mining will be overstated unless the share of imported coal in total fuel requirements is properly assessed. It would have paid railways with terminus stations on the sea shore to purchase imported British coal because of the decisive price advantage conferred by low freight rates from England. However, most central lines and in particular the three leading companies were supplied by local coalfields. It has been estimated that direct consumption of domestic coal by railways accounted on average for 22 per cent of domestic output. It is, however, necessary to incorporate into these results the coal inputs consumed

in the manufacture of domestic railroad iron. This will be done in the next section.

D). Indirect Requirements:

In 1855, coal mined in the Asturian district accounted for 3/4 of the short domestic production. No other coal district in Spain had attained such a level of development stimulated by the construction of an early railway line and the advantage conferred by the vicinity of the sea. However, this early development must be related to a small iron industry located near the coalfields. Asturian foundries were the first in Spain to produce coke pig iron, competing successfully with the iron works in the Southeast, hampered by the use of charcoal.¹ Asturias and Vizcaya would seem to have the best locational advantages for the development of a modern iron industry. Asturias had the advantage of cheap fuel over Bilbao, but had to import part of its requirements for ore from Vizcaya. The advantage of one district over the other was, however, determined by the technical coefficients of pig iron production, and in particular, the volume of coal required to smelt one ton of pig iron. In England, this volume had dropped steadily throughout the 19th century. From nearly 5 tons around 1800, it had fallen to 4 by 1851 and by 1869 only 3 tons of coal were required.² In fact, in 1871, the Duro works consumed 1.75 tons of coke per ton of pig iron, or 2.7 tons of coal.³ As for the iron

1. Charcoal pig was nearly double the price of coke pig iron due to a four-fold increase in fuel costs, see Nadal, Fracaso, p. 174.
2. See R. Mead, The Coal and Iron Industries of the United Kingdom (1882) p. 813 quoted in W. Isard, "Some Locational Factors in the Iron and Steel Industry since the 19th Century", Journal of Political Economy (1948), p. 204.
3. See Estadística Minera (1871), pp. 62-3.

ore, the iron content of the phosphoric ores of Asturias and the Biscayan hematites was quite similar.¹ The ratio of coal to iron ore came to 1.40 per ton of pig in the 1870's.² Therefore, as more coal than iron ore was required to manufacture one ton of pig iron and given that Asturian and Biscayan iron ores had similar iron contents, the abundance of coal seems to have been a dominant factor in explaining the location of the Spanish early iron industry in Asturias.

The pull of coal resources must be, however, qualified by taking into account the freight rates for shipping coal and iron ore. In 1889, the freight rates for shipping Asturian coke from Gijon into the iron works in the surroundings of Bilbao was 60 per cent higher than the freight rate for shipping iron ore on the reverse journey.³ Thus, as long as the quality and cost of fuel required for the manufacture of one ton of pig iron remained larger than the ore requirements, it paid to locate the iron works close to coal resources.⁴ This 'pull' to fuel is further strengthened when we consider the second stage of rail manufacture. In the 1860's, the English rolling mills consumed an additional 2.2 tons of coal per ton of rails.⁵

1. The actual yield of phosphoric Asturian ore was 48 per cent while the hematites from Bilbao yielded 52 per cent, see F. Gascue, "La Industria del Acero en el Norte de España", in Rev. Min., XLII (1890), 83.
2. Gascue, loc. cit., p. 66.
3. Gascue, loc. cit., p. 51.
4. Thus, assuming that this freight rate differential was similar in the 1870's to that in 1889, the cost of shipping the Biscayan iron ore to Asturias would have amounted to $1.92^t \times 5.5^p = 10.6^p$ per ton of pig. A Bilbao iron work consuming Asturian coal would have paid for its coke requirements per ton of pig 14.9^p ($1.75^t \times 8.5^p$). Had it imported coal instead of coke, the shipping costs would have been higher still, $2.7^t \times 5.5^p = 14.85^p$. These figures show that the advantage of establishing an iron work in Asturias would have resulted in a 40 per cent saving in transportation costs. In general, for the discussion about the pull of coal resources, see W. Isard, loc. cit., pp. 203-17.
5. See R.C. Allen, "International Competition in Iron and Steel", in Journal of Economic History XXXIX (1979), Table 5, p. 924.

A related but similar problem is the cost for iron works of manufacturing coke in situ rather than purchasing it. In 1889, the freight rate differential of shipping coal rather than coke compensated almost exactly for the larger volume of coal. Only when the distance between the coke manufacturer and the consumer was large (i.e. the case of British exporters and Bilbao consumers), would it pay the iron works to import coal rather than coke.

So far, we have examined the coal and iron ore requirements to manufacture one ton of pig iron before the Bessemer process was developed. It was found that the pull of coal resources was stronger than the pull of ore deposits in pushing the iron industry to locate itself in the vicinity of coalfields. The next step is to examine the changes introduced by the development of the Bessemer process.

With the Bessemer process, the potentialities of the Bilbao district, rich in non-phosphoric ores, could be fully developed. Fuel consumption was sharply cut through the enlargement of furnaces and by heating the blast in order to double the temperature. Because of this reduction in fuel consumption, the Bessemer process was particularly suited to manufacture rails. An active export trade in iron ore from the Biscayan deposits gave rise to return shipments of coal from England at relatively low freight rates. Thus, cheap British coal could be used to manufacture coke in the Bilbao iron works. Coke imports into Bilbao dropped steadily from about double the level of coal imports in 1885, to only 20 per cent of all coal imports in 1913.¹

1. In these calculations, coke imports were expressed in coal equivalent units (by using a 1.55 coefficient) to reflect the volume of coal which would have been necessary to raise in Spain to obtain the same amount of coke. Import figures for coal and coke through Bilbao from Estadística del Comercio de España (Madrid, 1885 and 1913).

Table 6 compares the manufacturing price of pig iron in Asturias and Bilbao. Pig iron with non-phosphoric Biscayan ores was in 1890 21 per cent more expensive in Asturias because the fall in the price of British coal in Bilbao compensated largely for the abundance of coal in Asturias. Furthermore, the ratio coal to iron ore had fallen from 1.40 of the pre-Bessemer period to 0.81 and therefore the ore bill compensated largely for the fuel bill in the Bilbao district. Thus, the upsurge of the iron industry in the Biscayan district after 1870 can be explained by the introduction of the basic process as a fundamental factor in cutting fuel costs. Rather than by the availability of cheap imported coal which in itself was not a sufficient explanatory factor.¹

TABLE 6.

Differentials in the Costs of Manufacturing Pig Iron
between Asturias and Vizcaya in 1890 (pesetas per ton
of pig iron).

	Bilbao	Asturias	
		(1) non-phosphoric	(2) mixed
Iron Ore	13.44	29.76 (2.21)	24.89 (1.85)
Fuel	25.22	18.50 (0.73)	17.14 (0.68)
Limestone	1.58	1.58 (1.00)	2.11 (1.33)
Labour	4.50	5.00 (1.10)	5.00 (1.11)
Other	3.50	3.50 (1.00)	3.50 (1.00)
Total	48.24	58.24 (1.21)	52.74 (1.09)

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Notes and Sources:

In brackets index numbers Bilbao = 100.

F. Gascue, "La Industria del Acero en el Norte de España", Revista Minera XLII (1890), 66.

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1. For example, Nadal has strongly emphasised the relationship between development of the Bilbao iron industry and the availability of cheap imported coal, see Nadal, Fracaso, p. 176.

In the counterfactual case that railways could have been laid down with locally made railroad iron, constraints due to the technical backwardness of the iron industry would have been lessened through the introduction of innovations from other countries.¹ In the primary stage of iron manufacture, that is the smelting of the iron ore, fuel consumption was set by the special characteristics of Asturian coal and iron ore because Asturias would have provided the best location to develop a modern iron industry.

In the counterfactual case, if railways had been laid with locally rolled rails made with local pig iron, nearly 2.5 million additional tons of coal would have been required, or an increase of 129 per cent over the aggregate coal output mined in the Asturian district between 1855 and 1864. The railway slump after 1865-72 would have, however, required a 21 per cent increase over the total coal output. To follow the counterfactual argument, in the period 1873 to 1890, railway construction would have required an increase of 22 per cent in the Asturian coal output to supply the rail mills.

Table 7 contains my coal consumption estimates for the manufacture of rails.

TABLE 7.

Coal Requirements for the Manufacture of Rails, 1855-1913 (000' T).

Year	(1) Rails	(2) Domestic Rails	(3) Coal
1855-72	484	-	(2981)
1873-90	776	40	90
1891-02	346	128	289
1903-13	373	274	619

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Notes and Sources: See following page.

1. See Chapter 3, Railways and the Iron Industry, Section E. 1.

Notes and Sources: (Table 7)

In brackets, coal consumption in the counterfactual case, see text.

Column 1: Rails refer to consumption of rails, from Column 1 of Table 5 in Chapter 3.

Column 2: Consumption of domestic rails, as given in Column 3 of Table 5 in Chapter 3.

Column 3: Coal consumption for the manufacture of rails consumed by Spanish railways. Estimate in brackets for the period 1855-72 refers to the coal consumed in the manufacture of 484 thousand tons of rails. Other periods refer to the coal consumed in manufacturing rails in domestic rolling mills.

1855-72: Coal requirements per ton of iron rails were worked out in the following way: in 1871, the Duro and Cie iron works in Asturias consumed 1.75 tons of coke per ton of pig iron, see Estadística Minera (1871), pp. 62-3. In the Mieres district (Asturias), 1.55 tons of coal were consumed to manufacture one ton of coke, see F. Gascué, "La Industria del Acero en el Norte de España", Revista Minera XLII (1890), 51. Thus, the coal requirements per ton of Asturian pig iron come to 2.70 tons. Given that 1.35 tons of coke pig iron were needed to manufacture one ton of wrought iron (for coefficient see Table 5 in Chapter 3). 3.70 tons of coal will be required to manufacture one ton of wrought iron. In England, rolling mills required an additional 2.50 tons per ton of iron rails, see I. Lowthian Bell, Manufacture of Iron and Steel (1884), p. 586. Therefore, the aggregate consumption of coal per ton of iron rails will come to 6.16 tons.

1873-90 to 1891-13: It was assumed that the pig iron equivalent of one ton of steel was 1.35, for the coefficient see Column 5 of Table 6 in Chapter 3, even if it is slightly higher than the estimate provided by Gascué, which comes to 1.107, see F. Gascué, "La Industria del Acero...", Rev. Min. (1890), 105. One ton of Bessemer pig required 0.97 tons of coke, see F. Gascue, op. cit., p. 66. Assuming that this coke was manufactured with Asturian coal, the coal requirements to manufacture 1.35 tons of Bessemer pig could have been 2.0 tons. In the second stage of the rail manufacturing process, Gascue states that an additional 0.18^t of coal and 0.05^t of coke were consumed, or, all together, 2.26 tons of coal per ton of Bessemer steel rails.

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In line with the railways, only a share of the coal consumed by the blast furnaces was mined locally. Bilbao ironworks were especially well located to enjoy the advantages of cheap imported coal as it has been shown. Table 8 shows that, in spite of the proximity to the Asturian coal district, most of the coal demanded by these ironworks was supplied from Britain. Furthermore, coke imports from abroad declined steadily, reflecting the fact that the Bilbao ironworks found it more profitable to manufacture coke in situ. In 1902, the coke ovens owned by Altos Hornos could carbonise around 110 thousand tons per year.

TABLE 8.

Bilbao Coal Imports (000' Tons).

Year	(1) Foreign Imports Coal Coke		(2) Domestic Imports Coastwise Rwy.		(3) Total	(4) (2)/(3)
1880	60		18 ^a		104 ^e	0.17
1885	80	147	12 ^a		335	0.03
1890	312	205			(682)	-
1895	179	143	103		531	0.19
1900	518	117	104	67 ^b	950	0.18
1905	504	64	128	81 ^b	889	0.23
1910	458	35	253	85 ^c	920	0.37
1912	537	76		395 ^d	1,132	0.35

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Notes and Sources:

Column 1: Foreign Imports, as given in Estadística del Comercio Exterior de España, various years.

Column 2: Domestic Imports:

- a includes an unknown volume of coke;
- b includes 2.2 thousand tons of coke carried by railway expressed in coal equivalent units. It was assumed that one ton of Spanish coke was equivalent to 1.55 tons of Spanish coal, for coefficient see Notes to Table 7, Column 3;
- c includes 16.4 thousand tons of coke expressed in coal equivalent units;
- d includes 12.6 thousand tons of coke expressed in coal equivalent units. For coastwise imports, Estadística del Comercio de Cabotaje, various years. For railway imports, (Parl. papers, 1905, XCII,) 444.

Column 3: Total Coal and Coke imports into Bilbao expressed in coal equivalent units. British coal reckoned to yield 73 per cent of coke, or 1.37 tons of coal = 1 ton of coke. For coefficient, see F. Gascue, "La Industria del Acero...", loc. cit., p. 66. Equivalent Coal Units were qualified by taking into account the better quality of British coal. One Ton of British Coal = 1.15 Tons of Spanish Coal, for coefficient see text above, pp.

- e coke imports from abroad were assumed to count for 2/3 of total coal and coke imports as in 1885.

The figure in brackets refers only to total foreign imports.

Column 4: Share of Imports of Spanish coal as percentage of total imports.

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According to the British Consul at Bilbao, this import substitution process had to be considered also in accordance with the development of a beet root industry which consumed some of the by-products of coking¹.

1. Consular Report at Bilbao (Parl. Papers, 1903, LXXVIII), 860.

As a result, coke output went up in the Bilbao district by 68 per cent between 1900 and 1910. Finally, Spanish coal increased its share of the Bilbao market after 1905. This process must be accounted for by a number of factors. First, communications between Asturias and Vizcaya were greatly improved by the construction of colliery railway lines, and by the new harbours which enabled larger steamers to dock. Second, in 1906 the coal duty was raised from 2.5 to 3.5 pesetas per ton. Therefore, higher duties and lower transportation costs enabled Asturian coal to be cheaper than British coal in the Bilbao market for the first time.¹

Ironworks were the main single consumer of coal in Bilbao.² But the exact share of domestic coal purchased by these ironworks is unknown. However, in 1905, Altos Hornos consumed 313 thousand tons of foreign coal and only 82 thousand tons of local coal.³ Thus, for Altos Hornos (which was the main ironwork) the share of locally mined coal in its total coal consumption was slightly higher than the share for the whole Bilbao industry. Therefore, I will assume in my calculations that the consumption of Spanish coal by the Bilbao ironworks was similar to the share of local coal in total coal imports (percentages in Column 4 of Table 8). In line with railways, an upper bound would be set by assuming that all coal consumed by the ironworks was Spanish.

Thus, when we combine the figures from Tables 4, 7 and 8, it can be concluded that Spanish coal entered the manufacture of Spanish rails in the following quantities:

- (1) 1873-90: all fuel requirements were met through foreign imports. The small share of Spanish coal in the Bilbao market was explained by a 21 per cent price differential

1. See Chapter 7.
2. Coke household consumption amounted to only 4,000 tons a year (Parl. Papers 1905, XCII), 444
3. Comision de Estudio de la Riqueza Nacional, Memoria.

in favour of British coal.

- (2) 1891-1902: about one fifth of the fuel requirements was supplied by Spanish mines, or only 58 thousand tons of coal (0.3 per cent of the aggregate coal output).
- (3) 1903-1913: around 40 per cent was supplied by Spanish mines, or 248 thousand tons of coal (0.7 per cent of the aggregate coal output).

The respective upper bounds for the two latter periods will be 1.5 per cent and 1.75 per cent of the aggregate coal output.

To conclude this chapter, it must be emphasised that feedbacks from railways on the coal mining industry came mainly from the fuel requirements of the railway companies. Spanish coal embodied in the manufacture of locally rolled rails played a very minor role. However, in the counterfactual case of a railway network laid with Spanish rails rather than imported, the Asturian coal output over the period 1855-72 would have to increase by 60 per cent, and by 129 per cent over the first ten years of that period. In line with the discussion on the feedbacks from railways on the iron industry, these figures reassert that the 'lost opportunity' argument defended by some Spanish historians would have resulted in a delayed construction of the railway network.

PART THREE.

THE EXTENSION OF THE MARKET.

Railways removed barriers to internal trade by providing cheaper transportation. They affected economic activity in two ways: first, they contributed to re-allocate resources from less to more efficient units of production. Second, they created new industries. Both effects are related to the widening of the market.

Before the construction of railways, Spanish regions exchanged small volumes of goods. Goods in common use were widely produced regions consumed basically local products. The high cost of transport prevented the low cost producers selling their surpluses in other markets. By bringing regions closer, railways released resources, as less inputs were required to provide transport services, and as economic activity could shift towards the most efficient location.

The reduction in transportation costs between two regions created new trade to the detriment of regions not served by railways. As a result of railway construction, regions shifted their demand to the low cost producers within the railway network and this led to a gain in welfare as resources were allocated in a more efficient way. However, if the low cost producer was left outside the railway network, this increase in trade would, in fact, end up in a loss in economic efficiency. By bringing regions into competition, railways also promoted price reductions.¹

A second effect arising from the construction of railways was the changes in the location of economic activity. Railways extended the margin of cultivation, opened up new industries and made possible the exploitation of new mines and coalfields.

1. N. Sanchez Albornoz discusses the integration of the grain market through the convergence of regional prices in Los Precios Agrícolas durante la 2ª mitad del siglo XIX, (Madrid, 1975).

The benefits reaped by the Spanish economy from the extension of the domestic market is the subject of this part of the thesis. I will discuss the effects of railways on grain, flour, wine and minerals in two ways: first, by estimating the share of the output marketed by rail. Second, by examining to what degree railways affected trading patterns and created new trade.

CHAPTER FIVE.

RAILWAYS AND THE GRAIN TRADE.

A). Introduction:

Throughout the 19th century, grain output expanded in response to an extension of the area under cultivation rather than to an improvement in farming techniques. Favoured by protection from the 1820's onwards, Spain was probably self sufficient in grain by the middle decades of the century. The introduction of free trade policies by Figuerola in 1869 preceded the great fall in international wheat prices which accompanied the influx of cheap American grain. Poor yields and high costs meant Spanish farmers could not compete with foreign imports in the coastal towns and protection re-emerged in the 1890's.

Knowledge on production and the grain trade in pre and post rail Spain is poor. Reliable general statistics were not recorded before the 1890's. The picture of the market drawn for the mid century from contemporary works reveals a multitude of local markets with limited exchanges between them. One analysis of wheat prices fluctuations during the 1857 food crisis disclosed that 'continental' and 'maritime' prices diverged.¹ Their fluctuations in the periphery were far less violent although the general level was higher than in

1. See N. Sanchez Albornoz, "La Crisis de Subsistencias de 1857" in España hace un siglo: una economía dual (Madrid, 1977), p. 37.

the grain producing regions. The co-existence of these two markets leads to question about the supposed self sufficiency in grain achieved by mid century. The fact that exports exceeded imports could signify a badly integrated home market. Regions better endowed with communications or with a well established tradition in grain exports could manage to sell on world markets. While in other parts of Spain, self sufficiency was achieved through lower levels of consumption patterns.

From 1882 onwards, Spain became a net importer of wheat. The consumption of foreign wheat at the Spanish periphery was encouraged by the fall in world prices. The failure of Spanish agriculture to supply the markets of the periphery stemmed basically from its low yields. But to Nadal, the inefficiency of the railway system contributed to making Spanish grain uncompetitive.¹ In the first section, I will consider the role of railways in the commercialisation of domestic wheat and flour over the period 1878-1913. I will then proceed to analyse the pattern of grain and flour flows between surplus and deficit regions in the light of free trade in the 1880's and protection after 1901. Railway data on freight rates will be complemented with regional grain prices to check whether railway companies could have cut rates and thereby protect Spanish agriculture.

B). Railways and the Wheat Economy, 1882-1913:

Tables 1A and 1B show the growing importance of railways in the domestic wheat and flour trades. The share of domestic consumption

1. J. Nadal, El Fracaso de la Revolución Industrial en España 1814-1913 (Barcelona, 1975), p. 70.

of wheat and flour carried on trains went up over the period 1882/1913.¹ The commercialisation of wheat and flour accelerated after 1901 because the quantities carried by railways increased more rapidly than domestic output.

The tables, however, do not tell when a turning point took place.² For Norte, the tonnage of wheat and flour, expressed in tons per kilometre of track, decreased sharply between 1870/2 and 1880/2 and remained unchanged in the following decade. While MZA's tonnage of wheat decreased by 35 per cent in the 1880's. For both companies, traffic recovered in the 1890's though the growth of tonnage was more spectacular for MZA than for Norte. Therefore, under free trade policies, traffic in wheat and flour stagnated and the share of domestic consumption of wheat and flour carried by rail was low. After protection duties were installed in the 1890's, railways carried rising volumes of grain and flour.

TABLE 1-A.

Railway Traffic and Wheat Production (000' T and %).

Year	(1) Norte	(2) MZA	(3) Other	(4) Transit Trade	(5) Total
1882	213.6	184.6	192.8	84.7	506.5
1886	247.8	175.5	165.2	67.3	521.2
1901	605.1	407.9	-	205.7	807.3
1905	540.0	378.4	133.6	129.4	922.6
1909	716.5	437.6	141.7	222.0	1073.8
1913	760.0	563.0	174.0	236.5	1260.5
Year	(6) Output	(7) Domestic Consumption	(8) 5 / 6	(9) 6 / 7	
1882	1754	2025	0.29	0.25	
1886	2122	2358	0.24	0.22	
1901	3146	3289	0.26	0.24	
1905	2018	2843	0.46	0.32	
1909	3332	3428	0.32	0.31	
1913	2523	2697	0.50	0.47	

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1. See Columns 8 and 9 in Table 1A and Column 8 in Table 1B. These percentages are upper bounds because railway statistics include other grain apart from wheat.
2. Unfortunately, the lack of railway data between 1887 and 1900 impedes working out the volume of grain exchanged among railway companies.

Notes and Sources: (Table 1A).

Column 1: Norte's data include wheat and other grain, Norte, Datos Estadísticos, 1882-1913.

Column 2: MZA's data include wheat and other grain, MZA, Memorias 1882-1913.

Column 3: Until 1886, Other include Andaluces, TBF, AVT, MCP and the Medina-Salamanca Railway Companies. Source: Andaluces, wheat and other grain, Memorias 1882 and Crisis VII, pp. 251 and 260; TBF includes wheat and other grain, Memorias 1882-86; AVT includes all classes of grain, Crisis VII, p. 312; MCP also includes all grain, Crisis VII, p. 372; Medina-Salamanca includes only wheat, Memorias, 1882-86.

Column 4: Transit trade refers to grain exchanged among railway companies, in particular Norte with MZA at Madrid, Valladolid, Zaragoza, Barcelona, La Encina, Reus and Tarragona. Norte with TBF until 1886 at Barcelona and Tarragona, with AVT at Tarragona in 1886, with Salamanca at Medina, source: Norte, Datos Estadísticos 1882-1913. MZA with AVT at La Encina until 1886 and with Andaluces at Espeluy, Seville, Córdoba and Belmez, see Crisis VII, pp. 142-52. After 1901, Transit trade includes only grain flows exchanged between Norte and MZA.

Column 6: Wheat Cash Crop after deducting from wheat output seed requirements. For wheat output, in 1882-86, E. Abela, Crisis VI, p. 137, quoted in N. Sanchez Albornoz, Los Precios Agrícolas (Madrid, 1975) fn. 2, p. 32. After 1901, see E. de la Sotilla, "Producción y Riqueza Agrícola de España en el ultimo decenio del siglo XIX y primero del XX", Boletín de Agricultura Técnica y Económica (1911) in J. Sanz et al., Los Precios del Trigo y la Cebada en España, 1891-1907 (Madrid, 1980), Table 15, p. 102. For 1913, see B.R. Mitchell, European Historical Statistics, 1750-1970, p. 123. Seed allowance at 2 Hls. per Ha. For coefficient, see Palencia, Cultivo Cereal y de Leguminosas Asociadas en España, (Madrid, 1891) II, p. 559. For wheat acreage in 1882-86, constant yields per Ha. at their 1891 level. For acreage after 1901, see E. de la Sotilla, op. cit.

Column 5: Grain tonnage hauled by rail as a result of
(1) + (2) + (3) - (4)

Column 7: Domestic Consumption of Wheat as the difference between Cash Crop (Column 6) and exports minus imports. Foreign trade data from Estadística del Comercio Exterior, 1882-1913.

Column 8: Railway tonnage as a percentage of the wheat cash crop.

Column 9: Railway tonnage as a percentage of domestic consumption of wheat.

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Table 1B indicates that the share of flour consumed in Spain carried by rail doubled between 1882 and 1913. It means growing commercialisation by rail. But at the same time, interprovincial flour flows as a share of Norte's flour tonnage decreased over the period.¹ For example, in the 1880's, two thirds of Norte's tonnage

1. Interprovincial flows consist of the sum of the net balance of flour flows for every province served by Norte. See also Appendix to Part III, page 250.

TABLE 1-B.

Railway Traffic and Flour Consumption (000' T and %).

Year	(1) Norte	(2) MZA	(3) Other	(4) Transit Trade
1882	114.7	55.0	70.4	12.2
1886	156.0	47.3	82.7	22.3
1901	228.4	213.8	-	30.7
1905	270.4	360.0	66.3	43.4
1909	296.8	351.2	72.4	39.3
1913	353.5	243.0	100.0	55.2

Year	(5) Total	(6) Output	(7) Domestic Consumption	(8) 5/7
1882	228	1417	1406	0.16
1886	264	1651	1641	0.16
1901	411	2302	2305	0.18
1905	653	1990	2048	0.32
1909	681	2400	2400	0.28
1913	641	1888	1886	0.34

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Notes and Sources:

Column 1: Flour tonnage for Norte, see Datos Estadísticos, 1882-1913.

Column 2: Flour tonnage for MZA includes in 1905 and 1909 fodder crops and feedstuffs, see Memorias, 1882-1913.

Column 3: Until 1886 under Other Andaluces, TBF, AVT, MCP and Medina-Salamanca, see Crisis VII, pp. 242, 319, 372, and for TBF and Medina-Salamanca, see Memorias for 1882 and 1886. After 1905, under Other only Andaluces, see Memorias.

Column 4: See notes to Column 4 in Part A.

Column 5: Flour tonnage hauled by rail as a result of:
(1) + (2) + (3) - (4).

Column 6: Estimated flour output. It was assumed that one ton of wheat yielded 0.70 tons of flour, for coefficient see the Asociación de Fabricantes de Harina del Reino de Valencia and the Asociación de Fabricantes de Harina de Barcelona in 1910, (Archive MZA Box 129-88). Furthermore, it was assumed that domestic and imported wheat yielded the same amount of flour and that all the wheat available for domestic consumption was milled into flour. For wheat output, see Column 7, in Part A of the Table.

Column 7: Domestic consumption of flour after adding imports and deducting exports from output. For foreign trade figures, see Estadística del Comercio Exterior, 1882-1913.

Column 8: Railway tonnage of flour as a share of domestic consumption.

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was carried across provincial boundaries while after 1901, intraprovincial flows were overwhelming. Growing intraregional trade implied that flour

was carried at shorter hauls. For example, in 1878 Norte hauled flour at 200 kilometres and in 1913 the average haul dropped by one quarter.¹ The reduction in average hauls for MZA was even larger.² Falling average hauls and growing intraregional trade is accounted for a growing specialisation in flour milling in the wheat deficit areas.

This growing specialisation is endorsed by the results presented in Table 1A. The flour mills demanded increasing volumes of wheat and accounted for the rising share of domestic wheat output carried by railways.³ Furthermore, the interprovincial wheat flows as a share of Norte's wheat tonnage also went up after 1901 following a decreasing trend in the 1880's, though intraprovincial flows prevailed throughout the period. The falling percentages of the 1880's suggest that wheat flows from surplus areas to deficit markets were declining under the competition from foreign wheat. With protection, the share of domestic output of wheat carried by rail doubled between 1901 and 1913. Besides, the commercialisation by rail was much more intense when the harvest was poor.⁴ At that time, however, interprovincial flows represented only 16 per cent of the wheat hauled by Norte.⁵

Although the share of domestic output always exceeded the share of domestic consumption carried by rail, the gap between the two

1. Calculations for the 1878 average haul are based upon the evidence provided in Norte, Datos Estadísticos for 1878. The average haul for 1913 was worked out in the following way: first, I estimated Norte's wheat output for that year, deflating the rate charged on wheat flows in 1878 by Norte's general freight rate, and dividing wheat receipts by this rate. Wheat output was then divided by the tonnage of wheat.
2. From 280 kilometres in 1886 down to 150 kilometres in 1913.
3. See Column 8 in Table 1A.
4. The share of domestic consumption of wheat carried by rail raised in 1905 and 1913, see Column 9 in Table 1A.
5. Interprovincial flows of wheat hauled by Norte amounted to 87,000 tons in 1905, see Table 2A, p. 194.

widened when the harvest was poor. For example, in 1905 half of the wheat grown in Spain was commercialised by rail whereas only one third of the wheat consumed was hauled by railways. While railway statistics include probably some imported wheat, the divergence between the two ratios suggest that imported wheat was either consumed near the ports or moved by alternative means of overland transportation. Indeed, railways did not haul foreign wheat over long distances except occasionally at times of dearth. For example, in 1878 wheat shipped by rail from Barcelona and Bilbao travelled at an average distance of 96 and 15 kilometres respectively.¹ In the assumption that all this grain was foreign, imported grain flows amounted to only 3.8 per cent of Norte's grain tonnage in 1878.

Finally, the two Tables suggest that the haulage of grain and flour was profitable for all the leading railway companies, though the tonnage carried by Norte was always larger than that of MZA. For the two companies, however, flour and grain traffic declined over time as a share of the total traffic. For example, traffic in grain and flour contributed over 30 per cent of Norte's tonnage and receipts in 1878 and in 1912 that share had been halved. Expressed in output, Norte provided in 1878 over 90 million ton-kms. of grain and flour services or a third of its aggregate output. Although by 1912, the output of grain and flour had doubled, their share dropped to 14 per cent.²

I have already stressed that during the 1870's and 1880's the tonnage of wheat and flour hauled by railways either fell or remained stagnant. In fact, the agricultural crisis of the 1880's had a more

1. These hauls were estimated from the evidence on coal flows provided by Datos Estadísticos, 1878.
2. The method of calculation for the grain and wheat output in 1912 is similar to the one described in footnote 1, page 190.

profound effect on MZA and Andaluces than on Norte. In effect, the tonnage carried by MZA did not exceed its 1884 level until 1894. And receipts from the grain and flour traffic remained below their 1880 level for Andaluces until 1897.¹ The crisis was first recorded by Norte's data in 1884 and lasted until 1889. This dissimilarity should be explained by the fact that the grain producing regions serviced by MZA were far more distant from their natural markets along the Mediterranean sea board than the grain regions served by Norte from their outlets along the Northern coast.² MZA was more exposed to suffer from foreign wheat competition than Norte and in 1892 Norte hauled three times more grain than MZA.

Railways commercialised increasing volumes of wheat and flour both as a share of domestic production and consumption. While long distance shipments of grain increased in volume over time, there was a tendency for flour flows to become intraprovincial. In the 1880's, free trade policies did not favour railway traffic whereas the import duties levied on grain imports after 1890 boosted demand for railway services.

C). The Grain Trade in Spain, 1878-1913:

The information on surplus and deficit regions collected in Tables 2A and 2B maps the grain and flour trades in Spain over the period 1878-1913. The grain surplus areas in the core were concentrated around the two Castiles. Deficit areas (except for Madrid) were all located along the periphery. This map is congruent with the

1. See P. Tedde, "La Compañía de los Ferrocarriles Andaluces (1878-1920): una empresa de transporte en la España de la Restauración", Investigaciones Económicas (1980), 63.
2. Grain carried by MZA travelled on average 280 kilometres, while the average haul for Norte was 210 kilometres. For MZA, Crisis, VII, p.141. For Norte, my grain output estimate for 1878.

qualitative evidence available on the grain trade for earlier periods:

'Old Castile is a plentiful granary which supplies Galicia, Asturias and Madrid. La Mancha and Aragon provide grain to Valencia, Murcia and Catalonia. Granada and Seville deliver their wheat to the provinces of the interior...'.¹

While the railways did not alter the traditional grain trade in a fundamental way, they did have an impact upon it.

The volume of grain carried across provincial boundaries expanded rapidly after 1900 in absolute terms whereas the flour trade remained stagnant. The volume of grain exchanged between provinces along Norte's network trebled between 1886 and 1909, but in relative terms (expressed as a share of Norte's grain tonnage), interregional grain flows fell from a peak of 43 per cent in 1878 to around 38 per cent in the period 1900-13. However, at times of crop failures, intraprovincial flows rose to 84 per cent of Norte's grain tonnage because the periphery became increasingly dependent on grain imports which were landed at the nearest point to the consumption market.² On the other hand, interprovincial flour flows remained unchanged in absolute terms but expressed as a share of Norte's flour tonnage, flour flows between the regions fell sharply from two thirds in the 1880's to one third after 1900.

It is apparent that Northern wheat producing regions specialised in flour milling more than Southern regions in the 1880's: 95 per cent of the flour exchanges between regions in 1886 originated in Old Castile and Aragon. This could be explained by the availability of cheap water

1. J. Canga Arguelles, *Diccionario de Hacienda* (Madrid, 1833) I, p. 391. See also V. Palacio Atard, *El Comercio de Castilla y el Puerto de Santander en el siglo XVIII* (Madrid, 1960) in particular chapter IV, P. Madoz, *Diccionario Geográfico-estadístico-histórico de España y sus posesiones de ultramar*, (Madrid, 1848-50) in particular the provincial accounts, and D.R. Ringrose, *Transportation*, map 5.
2. See footnote number 5, page 190.

TABLE 2-A.

Interregional Flows of Grain, 1878-1913 (000' T).

	1878	1882	1886	1901	1905	1909	1913
MADRID:							
(Norte)	- 2.1	-14.3	- 5.7	-- 4.3	-11.4	- 5.1	-11.4
(MZA)		-51.9	-38.0				
Total :	- 2.1	-66.2	-43.7	- 4.3	-11.4	- 5.1	-11.4
Basque-							
Santander	-60.4	-26.3	-46.6	- 68.5	-26.6	- 66.2	-40.2
CATALONIA:	-50.6	- 1.9	-22.6	-146.8	-29.7	-173.0	-80.8
NORTH-							
WEST :			+13.5	- 9.8	- 6.4	- 8.5	- 8.7
LEVANTE :		+32.9	-27.7	- 8.5	+ 6.3	- 16.7	-14.3
ANDA-							
LOUSIA :		-37.2	-16.9				
ARAGON :	- 4.8	-22.7	+ 4.8	+ 11.2	-19.4	+ 11.0	- 8.9
RIOJA :	+11.3	-11.0	+ 2.8	+ 18.4	+11.5	+ 43.3	+32.3
OLD							
CASTILE :	+88.3	+47.5	+30.6	+127.6	+74.8	+135.5	+92.4
NEW							
CASTILE :		+72.9	+38.9				
BADAJOS :		+11.2	+63.3				
Balance							
of Trade :	-22.8	-14.1	- 3.6	- 80.7	- 1.0	- 79.7	-39.6

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Notes and Sources:

A (+) sign implies a net outflow of grain.

A (-) sign implies a net inflow of grain.

The 'Balance of Trade' refers to the overall trade for the territory served by the three leading companies MZA, Norte and Andaluces. A (-) sign reflects that this territory was importing grain from the rest of Spain. 1901 to 1913 refer only to Norte.

Row 1: Madrid and its province.

Row 2: The Basque provinces and the province of Santander.

Row 3: Catalonia.

Row 4: Northwest refers to the Galician provinces of La Coruña, Lugo and Orense. After 1901, it incorporates Leon and Oviedo.

Row 5: Levante includes the provinces of Alicante and Murcia for 1878-86. From 1901 on, Levante includes the provinces of Valencia and Castellon.

Row 6: Andalousia includes the provinces of Cadiz, Córdoba, Granada, Jaen, Málaga, Seville and Huelva.

Row 7: Aragon includes only Huesca and Zaragoza.

Row 8: Rioja incorporates Logroño and Navarre.

Row 9: Old Castile lumps Avila, Burgos, Palencia, Segovia and Valladolid.

Row 10: New Castile includes Albacete, Ciudad Real, Guadalajara and Toledo.

Calculations for Norte are based on the evidence provided by Datos Estadísticos, 1878-1913. For MZA, Crisis, VII, pp. 121-57 and for Andaluces, Crisis, VII, pp. 243-60.

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TABLE 2-B.

Interregional Flows of Flour, 1878-1913 (000' T).

	1878	1882	1886	1901	1905	1909	1913
MADRID:							
(Norte)	- 1.9	- 5.3	- 7.1	- 4.5	- 4.2	- 2.9	- 4.5
(MZA)		- 4.2	- 4.7				
Total :	- 1.9	- 9.5	-11.8	- 4.5	- 4.2	- 2.9	- 4.5
Basque-							
Santander	-68.1	-51.9	-46.5	-30.8	-12.9	-24.9	- 35.4
NORTH-							
WEST :			-24.0	-28.2	-19.7	-28.3	- 48.3
LEVANTE :		- 0.1	- 2.9	- 8.2	-15.7	-12.7	- 23.5
ANDA-							
LOUSIA :		-23.7	- 5.5				
CATALONIA	-16.5	- 6.4	-11.6	+ 3.1	+ 6.4	- 3.8	- 4.7
ARAGON :	+21.0	+17.4	+24.3	+ 2.1	+ 0.6	+ 9.0	+ 12.5
RIOJA :	+ 0.3	- 2.9	- 0.6	- 5.3	+ 1.2	+ 7.5	+ 11.8
OLD							
CASTILE :	+94.3	+64.0	+83.5	+82.7	+66.8	+81.7	+105.4
NEW							
CASTILE :		+ 9.3	+ 5.3				
Balance							
of Trade:	+29.1	- 3.8	+10.0	+21.5	+22.5	+25.6	+ 13.3

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Notes and Sources:

Row 5: Andalousia incorporates Badajoz.

Row 9: Old Catile incorporates Leon after 1886.

The remaining rows are as in Table 2-A.

Calculations for Norte are based on the evidence provided by Datos Estadísticos 1878-1913. For MZA, Crisis, VII, pp. 158-69. For Andaluces, Crisis, VII, pp. 234-42.

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power in Palencia or Zaragoza at a time when railways had not yet freed Southern grain districts from fuel constraints.¹

Railways also facilitated the inclusion of new areas into the grain circuit including Badajoz which became the main single grain exporter to the rest of Spain after 1880.

1. Flour mills were established along the Canal of Castile and the Imperial of Aragon. On the fuel constraints in Southern Spain, see Chapter 7, section B, p. 236.

The territory served by the three major railway companies was a net importer of grain from other regions in the 1880's, in particular from Western wheat growing areas.¹ But it exported flour to the rest of Spain, especially from the surplus flour regions served by Norte.

It can be seen that when the crop failed, the whole pattern was reversed. Grain supplied to the Catalan market fell sharply in 1882, 1905 and 1913 and in each of these years, a large share of Spain's wheat imports landed at Barcelona.² In years of deficient harvests, normal supplies of domestic grain to deficit regions declined sharply and imported grain was carried into surplus regions. For example, this happened in 1882 and 1905 for Levante.

The routes along which grain and flour were carried can also be identified. In the Northern half of Spain, served by Norte, grain travelled along two main routes: first, from Old Castile to Santander for export to the Spanish colonies or to be carried coastwise to Mediterranean markets.³ Second, from Zaragoza to the Catalan market.⁴ In the course of the 1880's, the dependence of Andalousian markets on Northern wheat was greatly reduced when the availability of cheap imported coal made the milling of imported wheat possible near the

1. See 'Balance of Trade' in Table 2A and 2B. Also Appendix to Part III.
2. The share of wheat imports landed at Barcelona was 38 per cent in 1882, 49 per cent in 1905, and 63 per cent in 1913, as given in Estadística del Comercio Exterior for 1882, 1905 and 1913.
3. On the export trade for the colonies, see in particular, M. de Teran, "Santander, puerto de embarque para las harinas de Castilla", Estudios Geográficos (1947) 746-58. After Norte was amalgamated in 1878 to ZPB, coastwise exports from Santander fell by 50 per cent, see Estadística del Comercio de Cabotaje.
4. These flows originated in the Southern part of the province of Zaragoza served by MZA and are not recorded on Table 2A.

major consumption centres.¹ In the regions not served by Norte, the trade in wheat and flour seems to follow the traditional centre-periphery pattern. For example, surplus grain from Badajoz was carried along the Merida-Seville line for distribution among Southern towns and Alicante was supplied in wheat from La Mancha.

In the 1900's, the direction of the trade continued to be fan-shaped and surplus grain was moved from Old Castile to the long strip of land running from Galicia to Valencia. The distribution flows to supply towns such as Barcelona, Bilbao and Zaragoza was broadly the same as it had been.² Thus, 80 per cent of the grain supplied to Barcelona originated in regions directly served by Norte. Old Castile contributed 50 per cent which amounted to two thirds of its grain surplus. The rest of the grain originated in the Zaragoza-Lérida region (37 per cent), Rioja (7 per cent) and La Mancha (7 per cent). Finally, long distance shipments of grain had resumed under protection and in 1909 Barcelona was supplied with grain which travelled distances which in some cases exceeded 800 kilometres.³ And long distance flows of Northern grain towards Southern markets had also resumed via Madrid.

Data on the coastal trade traffic suggest that railways steadily replaced sea borne wheat flows. For example, wheat from Extremadoure formerly shipped to Barcelona from Seville and Huelva, now travelled by rail. Sea borne wheat flows landed at Barcelona which originated along the Mediterranean dropped from 16,300 tons on average in 1860/4

1. For example, in 1877/9, 17,100 tons of Castilian flour on average were passed over by Norte to MZA. Imports into Southern Spain of Castilian flour fell by 80 per cent in 1884/6, from Norte, Datos Estadísticos 1877-86.
2. Peticiones de la Industria Harinera del Norte, Valencia y Barcelona 1910, (Archive MZA, Box 129-88).
3. A third of the grain supplied to Barcelona originated in the provinces of Valladolid and Segovia, 800 kilometres away, same source as footnote 2 above.

to 6,900 tons in 1880/4.¹ But, it is difficult to ascertain how far the decrease in coastal trade was due to competition from railways or from imported grain. And wheat supplied by MZA and AVT Companies to the Catalan region also decreased from an average 72,000 tons in 1877/9 to 46,000 tons in 1884/6.²

Table 2A and 2B reveal the weakening of commercial exchanges between core and periphery. For example, the share of wheat moved by Norte into deficit regions of the periphery went down. In 1878, the North and Catalonia absorbed over 94 per cent of the wheat carried across regions, but in 1886 their share was down to 78 per cent. Meanwhile, imports of foreign wheat landed at Barcelona had trebled and a flour industry developed there competing with Castilian flour.³ The agricultural interest explained the fall in prices and the general crisis of the 1880's in terms of the increased imports into the towns of the periphery. Similarly, wheat and flour flows supplied to Santander after 1900 declined sharply, affected by the loss of the last colonial markets.⁴

To sum up: the grain trade evolved from its traditional pattern with a grain producing core selling both grain and flour to the rest of Spain. In the 1880's, free trade promoted the development of a flourishing milling industry of the periphery. This specialisation persisted under protection after 1900.

But the question is to determine how far the railways promoted these changes. Table 3 presents data on price differences between

1. Estadística del Comercio de Cabotaje for Barcelona.
2. See MZA, Crisis, VII, p. 139 and AVT, Memorias, 1877-86.
3. See 'Sociedad Fomento de la Producción Nacional de Zaragoza', in Crisis, II, p. 259.
4. The loss of the colonies meant a reduction in demand of 40 to 50,000 tons of flour. This led to excess capacity problems in the milling industry of Palencia and surplus flour marketed by rail dropped by 80 per cent between the 1880's and 1901-13. But at the same time, surplus grain carried by Norte boosted to 73,000 tons in 1901 compared to 33,000 tons in 1886, Norte, Datos Estadísticos and Asamblea de Harineros Españoles (Madrid, 1899), pp. 3-4.

foreign wheat at the periphery and domestic wheat in two major wheat growing areas served by Norte. In every year, the price (cif) of imported wheat was cheaper than that of the local wheat at the producing centres and the wheat consumers of the periphery gained from free trade.

In 1878, if the duty on wheat imports is added to the price, the Catalan consumer would have bought Castilian grain because the rail freight from Palencia or Saragossa to Barcelona made it profitable to do so.¹ But foreign wheat became more and more competitive at the periphery. International prices fell sharply as cheap American and Russian wheat entered Spain. Except for 1882 when bad harvests boosted prices in the core, Castilian farmers continued to sell to traditional outlets in the north because the markets were close to centres of production.² By the late 1880's, the competitive position of the core had deteriorated to such a degree that foreign wheat threatened to invade its 'natural' markets. As one observer saw it: 'soon enough flour will be produced in Barcelona with imported wheat to supply Castile putting an end to grain farming.'³ As alarm grew among the agricultural interest, railway companies were urged to charge higher rates for the trans-shipment of flour from the periphery towards the centre, and lower rates for the flows from the centre to the periphery.⁴

1. The rail distance from Barcelona to Palencia and Zaragoza is 790 and 365 kilometres respectively.
2. On the other hand, when the harvest failed, imported wheat was carried by rail towards the interior of Spain. This is reflected by the (+) sign of wheat flows from Levante in 1882 and 1905, see Table 2A.
3. See answers given by 'Cervera del Rio Alhama' in Crisis, II, p. 608.
4. Railway companies agreed reluctantly to decrease their freight rates: '...le Comité (MZA) n'est nullement convaincu de l'efficacité des rabais pour lutter contre l'importation étrangère... toutefois, les promesses de baisser les tarifs par le Nord ablige à notre Compagnie à suivre ce facheux mouvement", MZA, Procès, 20 April 1888.

TABLE 3.

Railways and the Competition from Foreign Wheat (ptas per ton).

Year	(1) Palencia	(2) Zaragoza	(3) Foreign	(4) Duty
1878	236.5	288.6	270.5	58.2
1882	302.8	338.4	262.6	58.2
1886	227.6	218.5	185.8	58.2
1890	212.0	201.6	200.6	80.0
1901	258.7	288.4	225.0	80.0
1905	290.7	325.8	159.0	74.0

Year	(5) (3) + (4)	(6) Mark-up in Kilometres.	(7)
1878	328.7	815	425
1882	320.8	136	-200
1886	276.7	540	675
1890	280.6	852	995
1901	305.0	714	256
1905	233.0	-903	-1450

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Notes and Sources:

Columns (1) and (2): Average price of domestic wheat in Palencia and Zaragoza from N. Sanchez Alborno, Los Precios Agrícolas durante la 2ª mitad del Siglo XIX (Madrid, 1975) pp. 97 and 111 and for 1901-05, J. Sanz et al., Los Precios del Trigo y la Cebada en España, 1891-1907, (Madrid, 1980), pp.151 and 153.

Column (3): Average price of foreign wheat in the London market in pesetas per ton. It was assumed that lower freight rates from America to England would be offset by lower rates from Odessa to the Mediterranean sea board. For prices of British imports, of wheat, see Report on Wholesale and Retail Prices, p. 80.

Column (4): Spanish duty on wheat imports in pesetas per ton, see J. Sanz et al., op. cit., Table 14, p. 96.

Column (5): Estimated price of foreign wheat in the Spanish periphery: cif price plus customs duties. The calculation ignores unloading costs, port dues and other minor charges because it was assumed that they would be cancelled out by loading and unloading charges of railway stations.

Columns (6) and (7): Price mark-ups for Palencian and Saragossan wheat expressed in kilometres. These distances result from dividing the difference in price between foreign wheat at the periphery and domestic wheat at the production point by a railway rate. The 1878 rate is the estimated rate charged by Norte for the carriage of wheat. It was built up from the information contained in Datos Estadísticos for 1878, as a result of dividing total receipts from the grain traffic by the estimated output in ton-kms. of grain. This rate comes to 0.09437 pesetas per ton-km. of grain. For other years, it was assumed that the rate for grain transport had fluctuated according to Norte's general rate index, see Norte, Actuación, vol. II, Table 10.

A negative sign reflects the margin within which it would have been profitable to purchase foreign rather than domestic wheat.

To make Castilian grain competitive with foreign grain at the periphery, railway companies would, however, have had to reduce their rates down by 30 per cent.¹ In any case, the rise in customs duties in the 1890's together with the depreciation of the peseta helped Castilian grain to recover Catalan markets.²

D). Final Comments:

A paucity of information on the grain trade before 1850 prevents us from drawing firm conclusions about the impact of railways on that trade. Along certain routes (e.g. the Castile-Santander), railways simply confirmed traditional patterns of trade. For other routes, especially for long distance shipments, railways substituted for sea borne transport. It is difficult to find evidence that railways created new patterns of trade.

In the early 20th century, flour milling became localised close to the market. But this tendency owed more to the availability of cheap American grain than to railways.

Without the protection afforded by the tariffs of the 1890's, American grain could have flooded into the grain producing areas, helped by those very railways which had been welcomed by the landed interest twenty years earlier. Under protection, the long distance carriage of wheat resumed and railways helped to forge a national market behind tariff barriers. The market in wheat became more integrated and presumably more efficient. Regional prices converged towards

1. Capital costs were estimated to amount to 0.051 pesetas per ton-km. of freight whilst operating costs amounted to 0.036 pesetas per ton-km., see Norte, Crisis, VII, p. 9.
2. The impact of the protectionist tariff of the 1890's has been recently discussed in J. Sanz et al., Los Precios del Trigo y la Cebada en España, 1891-1907 (Madrid, 1980), pp. 92-111.

the national average.¹ Interest groups complained that railways, through their pricing policies, benefited some regions against others.² Such attacks against railway companies intensified after the loss of the colonial markets in 1898 brought the milling industry of the periphery into direct competition with industry of the interior. Mills of the periphery were faced with the haulage of wheat and bran, whereas the mills of the interior shipped flour directly.³

Blame for the protectionist policies of the 1890's cannot be laid exclusively on the failure of railway companies to provide reductions in transportation costs although they were accused of charging the same rates for the haulage of wheat from Castile to Barcelona as the cost of shipping it from America. True, a 30 per cent reduction in railway rates would have provided protection against foreign competition as effectively as the increase in customs duties of 1890. But railway companies were certainly not prepared to grant such reductions without compensation from the state at a time when they faced rising capital costs.⁴ Subsidised transport could have

1. See J. Sanz et al., op. cit., p. 32.

2. For example '... the protection granted by Andalus to the province of Málaga to our detriment...', see Cámara Oficial de Comercio e Industria de Granada, Informe referente a la Revisión de Tarifas de Ferrocarriles (Granada, 1901), p. 21.

3. It was cheaper to ship flour than wheat because 1.43 tons of wheat were required to mill one ton of flour, for coefficient, see notes to Column 6 in Table 1B. See also Peticiones de la Industria Harinera..., op. cit.

4. 'Le Comité prend connaissance de la R. O. relative aux remerciements adressés aux Compagnies pour le patriotique désir de contribuer a faire cesser la crise agricole... le Comité espère que le Gouvernement se souviendra opportunément de la phrase de préambule dans laquelle il reconait que la situation précaire des compagnies ne permet pas de sacrifices sans que l'Etat les indemnise', MZA, Procès, 20 April 1888.

been a valid alternative to protection. But the effect of protection either in the form of a rise in customs duties or subsidised transport was to delay even further the necessary reform of grain farming characterised by low yields and high costs of production. In 1880 after all, a well known agronomist, Abela, had assessed that mechanisation and the diffusion of fertilizers could undercut production costs by the 30 per cent tariff required to enable Spanish grain to compete with American.¹

1. E. Abela, "La Producción de Cereales en España", Gaceta Agrícola, XV (1880), 558.

CHAPTER SIX.

RAILWAYS AND THE WINE TRADE.

A). Introduction:

Over the second half of the 19th century, red wine became the main staple commodity in Spain's exports.¹ The spread of vine disease throughout Europe, such as the Oidium Tuckeri in the 1850's and the Phylloxera from 1865 through to the 20th century, boosted foreign demand for Spanish wines. Spanish vines were spared the ravages of disease suffered by French, Italian and Portuguese vineyards. At the same time, Spanish wines of high alcoholic content and strong colour were in great demand in France where they were mixed with weaker and lighter wines for coupage. Spanish viticulture responded by planting more vines, by improvements in quality, while the construction of railways enabled producers in the interior to move huge volumes of wine at low cost.

In the twenty years between the Oidium crisis of 1855 and the invasion of France by Phylloxera, over 5,500 kilometres of railway trunk lines had been laid down which traversed the most important wine districts and the more populous urban areas. Early in 1857, a railway track was laid across Alicante which connected the main wine growing areas of that district to the sea. By the end of 1860, the vineyards of Lérida and upper Barcelona were linked by rail to Barcelona. In

1. In value terms, wine exports amounted to 26 per cent of total exports in 1861. In 1913, wine exports ranked third next to metals and minerals, amounting to 8.5 per cent of total exports.

1863, a railway link had been established between Haro, at the centre of the Rioja vineyards, and Bilbao, an active export centre. The completion of Norte's network in the Basque provinces in 1865 established direct connections between the expanding Castilian vineyards (Zamora, Valladolid and the Ribera del Duero) with the French border. Norte fixed its rates at low levels to encourage traffic to shift from the sea route onto the French Compagnie du Midi. The potential of the rich Valdepenas district was realised with the completion of the Southern network of MZA and the establishment of a link with the Alicante line in 1862, which facilitated the shipment of wine towards Madrid and the sea. Finally, all wine districts gained from the merger of railway companies which provided direct links and avoided costly trans-shipments.

The progress of the wine industry in Spain was a response to two sets of factors. Before 1900, its growth was export led and exceptional external demand conditions prompted its development. After 1900, the recovery of the French vineyards, the loss of the last colonial markets and the spread of Phylloxera to Spain combined to depress output and exports. Nevertheless, the relative stability in the volume of wine carried by rail despite the fall in exports suggests that internal demand sustained the growth of the wine trade after 1900. And it did so because railways had integrated the home market and promoted regional specialisation.

This chapter will analyse the contribution of railways to the prosperity of the wine trade after 1865. Only common red wines will be considered because they dominate the trade and were produced everywhere, in contrast to sweet and other fortified wines whose production was concentrated at Malaga, Cadiz and some small regions along the Mediterranean sea board. First, the analysis will focus on the general

evolution of the wine trade and its connection to the expansion of railways. Then, the internal market for wines will be described in Section C.

B). The Wine Industry in Spain, 1850-1913:

During the second half of the 19th century, Spanish vineyards were spared twice from the ravages of vine diseases. On both occasions, wine growers took advantage of the falls in European supplies to increase Spain's exports. The European crises of 1855 and 1875 provide an illuminating way of comparing the response of Spanish vineyards to foreign demand before and after the establishment of a railway network. First, I will analyse the response of the wine trade during the Oidium crisis of the 1850's at a time when just 500 kilometres of railway lines had been laid down in Spain. I will then proceed to analyse the response of the wine trade throughout the Phylloxera years, 1865-1913.

B.1. The Pre-Railway Age and the Oidium Crisis, 1850-65.

Before 1860, the wine industry was hampered by difficult internal transportation and backward techniques of production. The combination of these factors prevented long distance shipments. Wine was produced almost everywhere in Spain and markets were supplied from local vineyards.

Primitive methods in wine production contributed to low quality. Most common wines deteriorated rapidly.¹ Moreover, wine was kept in large casks which made it difficult to handle with care during the early months of maturation.² Spanish wines tasted strongly of pitch

1. D. Navarro y Soler, "Elaboración de los vinos tintos del Marques de Riscal en el Ciego de Alava", Gaceta Agrícola 4 (1877), p. 46. Many examples will also be found in A. Huetz de Lemp, Vignobles et Vins du Nord-Ouest de l'Espagne (Bordeaux, 1967), i, pp. 294, 351, 360.

2. D. Navarro y Soler, op. cit., p. 46.

because they were usually carried on the backs of animals in hog's skins treated with pitch.¹

Contemporaries realised that poor transportation was a severe handicap to the progress of the wine trade.² Peasants engaged in the wine trade pointed to the bad state of the roads linking vineyards to railway lines as the prime obstacle to the development of the wine trade.³ While English traders observed:

'the capabilities are extremely great... but owing to the bad state of roads, the mixed cultivation of different varieties of vines... vines have tended to be kept in an unimproved state for many years past...'.⁴

For wine growers in the interior, long distance shipments were restricted by high costs of transport compared to the cheapness of the wine and the effects of deterioration as the wine travelled along bad roads. The wine districts of the interior produced for local consumption rather than for a national market. Interregional flows were confined to exchanges for fish or some colonial produce.⁵ On the other hand, the districts of the periphery enjoyed the advantages provided by the sea, which nourished a prosperous and well established trade with foreign markets. Catalanian wines had been exported to colonial markets since the 18th century and the commercial links between the Jerez district and England were also well established. Catalanian wine was also shipped coastwise.⁶

1. Select Committee on Import Duties on Wine (Parl. Papers, 1852, XVII), QQ. 2337-8, 5355, 5723. Also in Huetz de Lemp, op. cit., p. 809.
2. '...shipments towards the interior of the Peninsula are difficult... it is the first market closed to us...', see Crisis Agrícola y Pecuaria (Madrid, 1887), vi, p. 312, (hereafter, Crisis).
3. See Appendix D to Chapter 2, p. 111.
4. S.C. on ... (P.P. 1852, XVII), Q. 2342.
5. 'Since 1850... muleteers and carters who arrived in Southern Andalusia with general merchandise brought wine from la Mancha, always under the name of Valdepeñas...', see F. Gonzalez y Alvarez, Apuntes sobre los vinos españoles (Madrid, 1878), p. 8. Huetz also refers to this barter trade, see op. cit., i, pp. 283, 327, 340, 401.
6. See Huetz, op. cit., p. 458.

The progress of the wine trade between 1855 and 1865 can be perceived in the statistics of exports of non-fortified wines.¹ Exports grew at an annual rate of growth of 20 per cent in 1855/57. For that year, exports to France accounted for 60 per cent of the increase in total exports. Trade with France accounted in fact for two thirds of the wine sent to the rest of the world. Exports to France had grown rapidly from a mere 1,000 tons in 1852 to 44,000 tons at their peak in 1857. Exports to the rest of the world revealed the penetration of Spanish wines in American markets in the presence of sluggish French and German trade.

This upsurge in Spanish exports after 1850 was favoured by a reduction in French duties on Spanish wines after:

'... the disastrous effects of the vine disease in France which have reduced the production of wine to one fifth, and has contrained her for the first time in the history of the world to become herself an importer of wine from the Península'.²

This disease, the Oidium, was little felt in Spanish vineyards. The districts of the periphery were afflicted in 1852-53, but it was not before 1854-55 that it spread into the interior. But, except for Barcelona and Tarragona, where the vintage fell to about one tenth of the average crop, the disease hardly affected wine output in other areas.³ Despite the loss of the local crop, the export trade through Barcelona contined to grow and was described by the English Consul as active:

'... the exportation by land must be very trifling; that by sea to France, Sardinia and Tuscany has been very extensive; but the great markets for the best and the strongest Catalonian wines have lately been the Spanish colonies'.⁴

1. See Chart 1, p. 213.
2. Report by Vicount Chelsea on the Past History and Present State of the Wine Trade in France (Parl. Papers, 1859, XXX), p. 287.
3. Report on the Oidium Disease in Spain (Parl. Papers, 1859, XXX), p. 211, (hereafter, Oidium). For example, in Valencia the decrease in production was less than five per cent, see op.cit., pp. 210-1.
4. Oidium, p. 215.

'A vast quantity of wine has been purchased from Aragon, Navare and Valencia.'¹ In 1857, half of the total coastal trade in common wine passed through Barcelona where it was prepared for the long journey by sea.²

In the Northern districts of Navarre, Rioja and Aragon, the response to external demand was weaker because internal transport was costly and difficult and because distances either to the French border or to the sea were longer. Although Aragon and Navarre were hardly affected by the Oidium, the wine output was greatly diminished in Rioja where it fell by a factor of five in the period 1850-58.³ At the same time, the districts of the interior (Zamora, the Ribera de Duero and the Mancha), too far from the sea to export their surplus wine, managed to increase their sales to other wine growing districts. But British wine traders remained sceptical about the potentialities of these districts and one stated that:

'... if there was a great demand for the Valdepeñas and other wines produced in districts equally distant from the sea.... (capitalists) would experience a very considerable difficulty in getting any large portion of wine (to the ports of shipment). The expense of the transit is ten times more that the value of the wine. I can purchase a butt of wine in Valdepeñas for three to four pounds and the transit expense to Puerto Santa María will be upwards of 14 pounds by "galera".'⁴

Although Spanish foreign trade statistics do not reveal the origin of the wines exported to France, other evidence suggests that the additional supplies came mainly from districts along the Mediterranean sea board. One third of imports into France entered the country through the Southern sea port of Cette. The Mediterranean wine

1. Ibidem

2. In 1857, 25,200 tons of wine were shipped into Barcelona out of a total for Spain of 50,685 tons. All this trade originated in seaports of the Mediterranean, see Estadística del Comercio de Cabotaje for 1857, pp. XVIII and 22.

3. Huetz, op. cit., p. 521.

4. S.C. on ... (P.P. 1852, XVII), Q 5769.

districts also enjoyed strong locational advantaged in supplying French troops engaged in the Crimean war. Exports from Valencia rose from 5,000 pipes in 1854 to 20,000 two years later. Exports of Benicarlo wines had increased by one third, and over 21,000 pipes were shipped from Alicante.¹ The whole of this exporting trade had been created by French demand.

Thus, the volume of marketed wine increased in 1855/65. For three reasons: first, because world prices went up as supplies outside Spain fell prey to vine disease and Spanish viticulture could compete despite high transport costs. Secondly, because external demand absorbed the excess production of Spanish vineyards.² Over-production occurred every time the vintage was good and a bumper crop could boost wine output by as much as a third of normal output. Thirdly, increased foreign demand for Spanish wines stimulated price increases throughout Spain. Prices trebled in Alicante, Cadiz, Rioja, Tarragona, Valencia and Zamora and went up by nearly eight fold in Barcelona.³ Supplies were inelastic and part of Spanish output and normal consumption was diverted towards foreign demand.⁴

To sum up, in the pre-rail age, interregional flows of wine were limited in volume. Markets were supplied by local growers, while some districts in the periphery benefited from a prosperous export trade. The Oidium crisis of 1855-65 marks the beginnings of

1. Oidium, pp. 212-3.

2. Excess production amounted to nearly one third of production, see Junta Consultiva Agronómica in Crisis, iv, p. 606.

3. Oidium, pp. 211, 213-5. Also in J. Hildago de Tablada, "Los Vinos Españoles en Francia", Los Vinos y los Aceites (1878), pp. 1-2.

4. This fact was foreseen by an English wine trader when asked if Spanish supply could match easily an increase in English consumption: '... There could not be a rapid increase. First, there would be a great increase in prices and then they would settle down', see S.C. on ... (P.P. 1852, XVII), Q. 822.

increased regional exchanges within Spain. Its long run effects were positive according to foreign observers:

'The present condition and prospects of the wine trade are much more favourable than previous to the disease. The demand for good wines has increased, the exportation is much greater, the traders have much improved their knowledge of the matter and a great deal of additional care is now successfully bestowed upon the production and preparation of the wines.'¹

Furthermore, railway construction had started and contemporaries pinned their hopes upon improvements in transport, as an English diplomat saw it:

'Large is the extent of country in Aragon and Navarre cultivated with vineyards, it is small in comparison with what it might be if the demand for the wines of those provinces should continue, and what it certainly would be when the railroads now in the course of construction are completed to the French border, as well as to Bilbao and Barcelona, which lines will be of equal benefit to the vineyards of Old and New Castile, many of which like those of Aragon, have been as little known to the rest of Spain as they are to the rest of Europe.'²

B.2. The Impact of Phylloxera, 1865-1913:

The absence of output statistics for the decades before the 1890's can be obviated by using railway data on wine shipments to mark the evolution of the trade. A comparison of railway traffic in wine and exports of common wine shows that after 1865 both curves fluctuated together until 1898.³ The peaks (1869, 1873, 1881/83, 1891 and 1895/98) and troughs (1870, 1876, 1885/6 and 1893) coincided and this supports the view that the external demand for Spanish non-fortified wines accounts for most of the progress of the wine industry after 1865. Moreover, when total exports are disaggregated between exports to France and to the rest of the world, the relative stability of the latter suggests that French demand was acting as the main force.

1. Oidium, p. 215.

2. Ibidem, p. 229 (Note: Underlining does not appear in the original source.)

3. See Chart 1, p. 213.

Fluctuations in French output in wine and Spanish exports to France matched each other.

The evolution of wine production and trade went through four phases:

(a) First, a period of moderate growth from 1865 to 1876 with exports rising at 5.5 per cent annually and with two peaks in 1869 and 1873. Exports to France accounted for only 17 per cent of total exports and peaked in 1873 when around one quarter of exports were shipped to France. The volume of wine carried by Norte increased at a similar rate and fluctuated, together with exports to France. MZA's traffic in wines showed a lower rate of growth and the fluctuations of the wine carried coincided more with exports to the rest of the world than to France.

(b) Second, a period of spectacular growth in exports to France, 1876-83; with very high rates of increase in the early years followed by a short slump between 1883-86 and a strong recovery after 1891. The volume of wine exported to France trebled between 1877 and 1878, doubled the following year and doubled again in 1880. The overall rate of growth between 1878 and 1883 was 42 per cent, whilst exports to the rest of the world remained fairly stable. Exports to France accounted for 3/4 of exports and at their peak in 1883 the French share had increased to 82 per cent. Norte carried the larger share, with a rate of growth of 33 per cent in its wine shipments compared to a 23 percent growth rate for MZA. In 1882, France and Spain signed a commercial treaty which reduced duties on Spanish wines. Although the immediate effects of the treaty were minor.¹ Exports declined after 1881 as French output recovered.² Nevertheless,

1. See in particular Report on the Trade of Spain (Parl. Papers, 1883, LXXI), p. 641. On the Commercial Treaty of 1882, see T. Carnero, Expansión Vinícola y Atrazo Agrario (Madrid, 1980), pp. 86-101.
2. Spanish output declined by the spread of a new disease the 'mildew' which damaged in particular the vineyards of the Northwest, see Huetz, op. cit., p. 528.

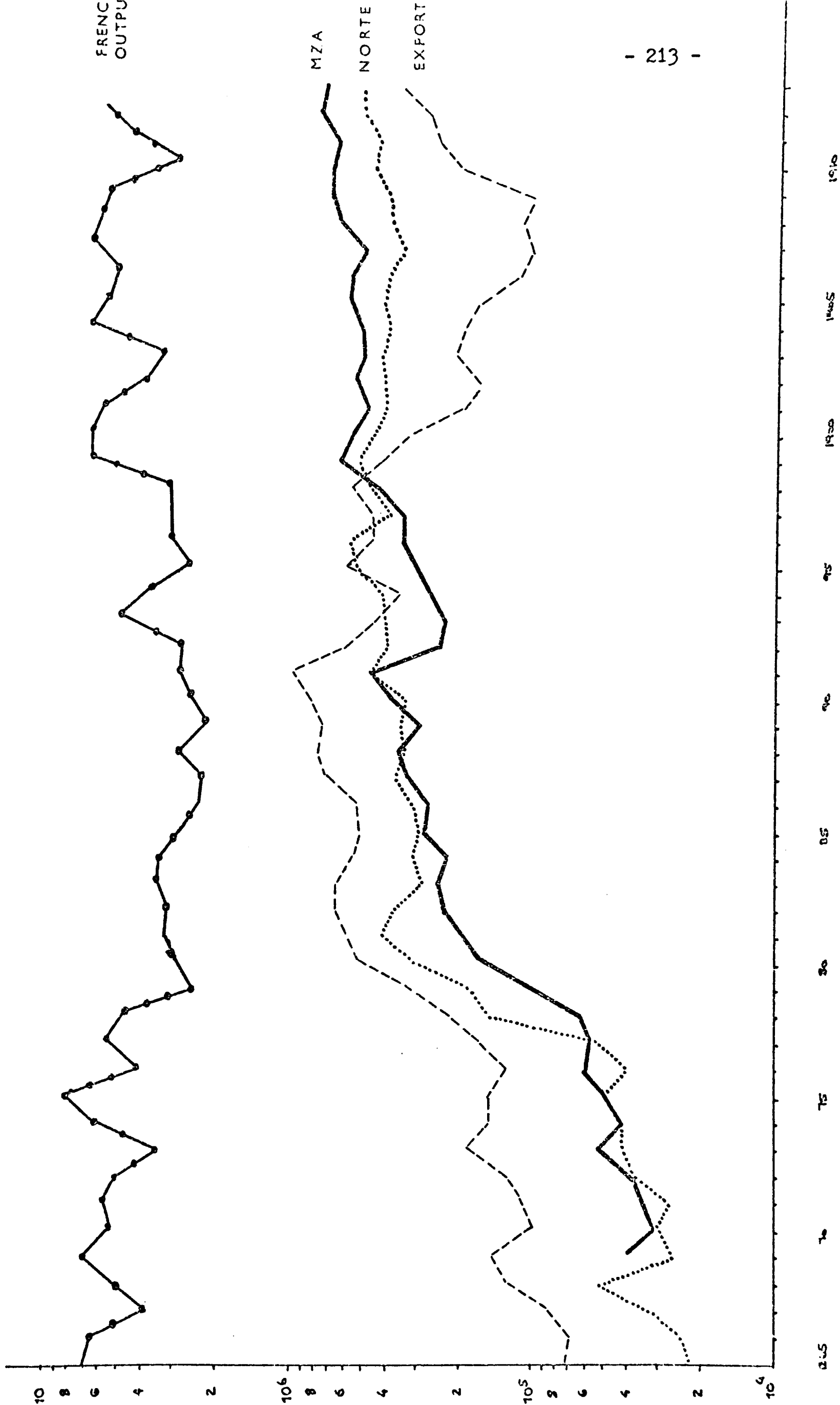


Chart 1: Railways and Wine Exports.

Notes and Sources: (Chart 1).

- Norte : Memorias, 1865-1907 and from 1907 onwards, Datos Estadísticos, 1908-13.
 MZA : Memorias, 1869-1913.
 Export: Red wine exports as given in Estadística del Comercio Exterior, 1865-1913.
 France: French output of wine, see B.R. Mitchell, European Historical Statistics, 1750-1970 (1978).

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the aggregate railway traffic in wine for four leading railway companies rose.¹ And the recovery after 1886 was originated in the long recession of the French wine industry between 1884 and 1892. Exports to France peaked in 1891 at over 11 million hectolitres. This new upward trend in exports was reflected in the traffic of the railway companies.²

(c) Third, a period of falling exports starting in 1892 when the commercial treaty between France and Spain expired. Exports dropped by 2/3 in three years but recovered slightly in 1895 after a series of disastrous harvests in France. Railway companies felt the depression in the wine trade although wine remained the staple commodity in railway traffic. Norte's traffic decreased 14 per cent in 1892 while MZA lost half of its wine shipments: a contrast which indicates that Phylloxera had attacked the wine districts served by MZA while the Rioja was spared and could supply most of the wine for export.

(d) Fourthly, after 1898 exports of common wine fell sharply from 6.3 to 1.1 million hectolitres in the course of a decade. The export trade resumed partially after 1909 and attained 65 per cent of its 1898 level. This drop in exports followed upon a series of good

1. As a result of a 20 per cent increase in the wine hauled by TBF, see TBF, Memorias for 1882 and 1885.
2. Although the wine tonnage of TBF dropped after 1888 because the Catalan vineyards served by TBF were damaged by the Phylloxera, see T. Carnero, op. cit., pp. 111-67.

vintages in France where production had surmounted the effects of the Phylloxera. French demand for foreign wines shifted towards Algerian wines. After 1900, French demand ceased to be the driving force behind the prosperity of the wine trade in Spain and the share of exports to France fell to 38 per cent by 1902. Looking at the graph, the high inverse correlation between the evolution of French output and Spanish exports to France shows now that Spanish wine traders failed to grasp the opportunities to replace French exporters in foreign markets. Rather Spanish wine helped the French wine trade to maintain its stronghold on foreign markets by supplementing French domestic demand in an era of falling supplies.

Falling exports were accompanied by falling domestic production as vineyards were damaged by the spread of the Phylloxera.¹ Output was reduced by a factor of three between 1900 and 1902 and continued to fall over the first decade of the 20th century.² At the peak of the export trade in 1890, half of Spain's wine output was exported but only 13 per cent was sent abroad in the period 1900-09 and a quarter thereafter. These figures suggest that increasing volumes of wine were being consumed domestically.³

It seems that the railways were not depressed by the decline in exports because while exports declined at an annual rate of 12.5 per cent in the period 1900-09, the volume of wine moved by Norte decreased at only 2 per cent. While MZA carried larger quantities of wine.⁴

1. See Junta Consultiva Agronómica, La Invasión Filoxérica en España y Estado en 1909 de la Reconstitución del Viñedo (Madrid, 1911). On the spread of the disease in the Northwest, see Huetz, op. cit., ii, pp. 551 and following.
2. See Table 3, p. 226.
3. See Section C.2. below, pp. 225-32.
4. See Columns 1 and 2 in Table 3, p. 226.

C). Railways and the Wine Industry, 1865-1913:

Did railways alter the direction and volume of the trade in wine? After 1865, the wine trade was very responsive to external demand. In volume terms, exports increased 15 times between the Oidium and Phylloxera crises. But, in contrast with the 1850's, price increases during the years of Phylloxera were rather moderate which suggests that the supply curve was more elastic after 1870.¹ Increased supply originated in an expansion of the acreage under vines, an improvement into the quality of wines and their marketing, and finally in the availability of railways.²

During the Oidium crisis when prices rose rapidly, the cultivation of vines had been extended to areas formerly under wheat and legumes. For example, in Navarre vineyards occupied 30 per cent more land in the 1880's compared to the 1850's, and in Albacete the increase had been four-fold.³

Producers had also improved the quality of their wines. In the Rioja, new methods were copied from Bordeaux.⁴ French traders became established in Spain and toured the wine districts in order to buy new vintages. Storage facilities were also improved. The directors of Norte observing that the availability of casks depressed production, instituted a policy of loans to wine producers in an effort

1. Except for Alicante, Barcelona, Logrono and Tarragona, see N. Sanchez Alborno (ed.), Los Precios del Vino en España (Madrid, forthcoming).
2. Sanchez Alborno has suggested in a recent paper that incremental exports were achieved through a decline in internal consumption, see N. Sanchez Alborno, "El Mercado de Productos Agrarios en España", unpublished paper delivered to the Conference on Railways and Market Integration (Madrid, 1980).
3. Crisis, ii, p. 223.
4. Huetz, op. cit., ii, p. 530.

to solve this particular bottleneck.¹

Railway construction had a double effect on the wine trade. First, cost reductions in transportation brought new districts into the wine trade. Secondly, railways made possible the haulage of huge volumes of wine to the ports and to the growing urban markets in far less time than it took by road. Section C.1. compares the pattern of wine flows in the 1880's when external demand was active with the pattern after 1900 when internal demand had substituted for external demand. Section C.2. deals with the effects of railways on the marketing of wine, both abroad and at home.

C.1. The Pattern of Domestic Trade:

(1) Wine Flows in the 1880's:

The geographical distribution of wine exports in the 1880's denotes a higher concentration of exports from the north than from Mediterranean ports. Overland exports through the Basque border increased steadily until 1882. Over 25 per cent of Spanish exports of red wine were shipped from the Basque province of Guipuzcoa and Irun became the main exporting centre. Along the Mediterranean, the rise of Alicante and Valencia culminated in 1886 with a third of exports passing through these ports. Successful competition from the overland route across the Catalan border led to a fall in exports through Barcelona from 30 per cent in 1878 to 13 per cent in 1883/4. Although exports from Barcelona to the rest of the world, excluding France, remained stable. This shift to the overland route in the trade with France suggests that railways were replacing shipping.

1. '...proposition de prêter sans intérêt 50,000 francs... pour donner de l'impulsion au commerce de vins en Castille... Mr. V. s'engage a établir des dépôts à Burgos, Valladolid, Reinosa et Santander', see Norte, Procès, 6 June 1863. A further 10,000 francs were spent in casks, see Norte, Procès, 18 February 1863.

In 1882, for example, a third of total red wine exports from Spain followed the overland route.

During the 1880's, exports from the Mediterranean ports continued to rise. But the share exported from the North increased from 19.2 per cent in 1880 to 23.5 per cent in 1882.¹ The contrasts between two periods of expansion, the 1850's and the 1880's, consists in the pronounced shift of trade to the direct overland route by rail to France and the higher share of northwest wine in total exports.

Railway data will now be presented in order to study the direction of trade. Interregional flows of wine among provinces served by Andaluces, MZA and Norte have been presented in Table 1. The data help us to distinguish the deficit periphery and surplus core regions (the two Castiles, Rioja and Aragon).

TABLE 1.

Interregional Wine Flows, 1878-1886 (000' T).

	1878	1882	1886
MADRID (Norte)	- 0.4	+ 5.6	+ 2.5
(MZA)	-	-21.1	-24.4
Total	- 0.4	-16.3	-21.9
Basque Country	-24.8	-59.7	-62.2
Santander	-12.4	-13.1	- 9.5
Total	-37.2	-72.8	-71.7
LEVANTE	-	-28.9	-20.0
NORTHWEST			+ 9.0
ANDALUCIA (MZA)		-13.0	+11.1
(Andaluces)		- 2.7	- 1.6
Total		-15.7	+ 9.5
CATALUNA	- 2.8	+23.8	+30.9
OLD CASTILE	+ 8.5	+11.3	+ 5.6
NEW CASTILE		+75.1	+53.7
RIOJA	+49.4	+107.0	+33.1
ARAGON (Norte)	+26.7	+80.5	+46.2
(MZA)		+25.8	+22.6
Total	+26.7	+106.3	+68.8
<u>Trade Balance:</u>	+44.2	+189.8	+79.0

1. North includes Irun, Pasajes, Bilbao and Santander.

Notes and Sources: (Table 1).

- A negative sign means a net inflow into a province.
 A positive sign means a net outflow out of a province.
 The Trade Balance refers to the overall trade for three railway networks, Andaluces, MZA and Norte. A positive sign means that in the aggregate wine outflows are larger than the inflows, that is there is a net export to other railway networks.
- Row (1) : Madrid and its province.
 Row (2) : Basque Country includes the three Basque provinces and Santander includes its province.
 Row (3) : Levante refers to the provinces of Alicante and Murcia traversed by MZA.
 Row (4) : Northwest refers to Leon, Oviedo, Lugo, Orense and Coruña all traversed by Norte.
 Row (5) : Andalucía refers for MZA to Córdoba, Huelva, Jaen and Seville. It has also been made extensive to Badajoz. For Andaluces, it includes the provinces of Cadiz, Córdoba Granada, Jaen, Málaga and Sevilla.
 Row (6) : Cataluña includes Lérida and Barcelona.
 Row (7) : Old Castile includes the provinces of Avila, Burgos, Palencia, Segovia (for 1886 only) and Valladolid, all served by Norte.
 Row (8) : New Castile includes Ciudad Real, Guadalajara and Toledo. It has been made extensive to Albacete. All four provinces are served by MZA.
 Row (9) : Rioja refers to the provinces of Logrono and Navarra, both traversed by Norte.
 Row (10): Aragon includes the provinces of Huesca and Zaragoza.
- Norte : Datos Estadísticos, 1878-86.
 MZA : Crisis, VII, pp. 123 -31.
 Andaluces: Crisis, VII, pp. 270-8.

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In the periphery, the small deficit of Alicante (Levante) contrasts with the fact that in 1882 over half of the wine hauled by MZA was hauled within its boundaries. Alicante was a major wine grower and almost self-sufficient. The surplus for Cataluña conceals, however, a persistent deficit in Barcelona. Within the Andalousian region, part of the wine produced in Huelva was shipped to foreign countries, but increasing volumes were forwarded by rail to Seville.¹ In the provinces served by Andaluces Company, sherry prevailed over other wines amounting to two thirds of the wine hauled by the

1. See MZA in Crisis, vii, pp. 132-3

company.¹ Within the Northern region, the Basque country and Santander were supplied with wine from the Rioja and Aragon.² Wine from Old Castile was hauled by Norte towards the Northwest, Galicia and Asturias.³

The relatively small TBF Company contributed greatly to the development of the wine trade and in 1885 it carried as much as 44 per cent of the joint wine tonnage of Norte and MZA. Most of its along the south-north route and 70 per cent of it came from the area between Tarragona and Villafranca.⁴

The AVT Company played its part in the haulage of wine from la Mancha to the Catalan market. In the early 1880's, two thirds of the wine carried by this company travelled along the Valencia-Tarragona lines and moved in a northbound direction.⁵

To sum up: the wine trade conformed in the 1880's to the pattern of trade which had developed before the spread of railways. The reduction in transport costs brought about by railways had, however, a positive effect on the creation of large wine producing areas in Central Spain such as the Valdepeñas district which supplied Madrid and other markets in the north of Spain. Railways made it possible to realise the potentialities of vineyards in the centre of Spain. An English wine trader when asked if some wine consumed in England in the late 1870's was unknown before 1860 replied:

1. Half of it travelled through the 'sherry ports' of Torcadero and Puerto Santa María and the remainder originating in the Montilla district was shipped via Málaga, see Andaluces, in Crisis, vii, pp. 270-1 and 274.
2. See Norte in Crisis, vii, p. 223.
3. Ibidem, p. 308.
4. Two thirds of these wine flows were carried to France and the remainder supplied to Barcelona, see TBF in Crisis, vii, pp. 360-7.
5. The volume of wine on transit to the TBF Company increased from eight per cent of the wine hauled by AVT in 1882 to 30 per cent in 1886, see Crisis, vii, p. 320.

'Yes... there is a much larger quantity to come if it could be brought in at a fair duty... railways are being made so that you can bring it from almost any part of Spain.'¹

Railways not only connected ports to the wine districts. They also carried wine into the interior, though in smaller quantities. The wine supplied to Madrid and the provinces of Old Castile by Norte amounted to only 10 per cent of the wine hauled by this company.² In contrast with Norte, 20 per cent of the wine hauled by MZA was supplied to the interior.³ Thus, approximately 90 per cent of the wine hauled by Norte was carried to the periphery. In particular, Guipuzcoa was supplied with half of the wine hauled by Norte.⁴ In these years, railways served external rather than internal demand. Assuming that all the wine which travelled by rail to ports and to the French border was exported, not less than two thirds of the wine hauled by Norte and MZA was exported.⁵

(2) Wine Flows in the 1900's:

The period which started about 1900 witnessed demand and supply conditions very different from those of the 1880's. The Phylloxera invaded Spain's vineyards and internal demand was substituted for external demand. Growing urban markets in Spain's manufacturing and mining districts demanded more wine. While former wine surplus areas became net importers of wine after a series of disastrous vintages. The effect of these new conditions altered the pattern of wine flows described in the previous section. First, I will focus on the modifications displayed by foreign trade figures and will then analyse the new channels of internal trade.

The distinctive feature of the export trade in common wines

1. Select Committee on Import Duties on Wine (Parl. Papers, 1878-9), QQ. 3421-5.
2. Calculations from the information contained in Norte, Datos Estadísticos 1878-86.
3. Calculations made using information contained in MZA in Crisis, vii, pp. 123-37.
4. Same source as footnote 2 above.
5. This percentage is an upper bound because some of the exported wine was probably carried by carts.

in the early 20th century was that foreign markets were supplied mainly by Mediterranean vineyards. Once demand from the rest of the world replaced French demand, the Mediterranean districts regained their traditional dominance. But the fall in exports to France also meant the end of the overland route by rail across the border. For example, wine exported through Port Bou on the Catalan side which amounted to 15 per cent of all exports in the 1880's did not exceed half per cent after 1900. Moreover, exports from the three Northern centres (Pasajes, Bilbao and Santander) amounted to 15 per cent of exports at their peak in 1907/9. Wine exports once again concentrated around two areas of the Mediterranean sea board: Barcelona, and Tarragona with 39 per cent of exports and Valencia and Alicante with 35 per cent of exports. These percentages conceal, however, the growing importance of Valencia, which in 1913 supplied over one quarter of Spain's exports.¹

Railways became less orientated towards external demand. This follows from the disappearance of exports by rail and can be deduced from the evidence on railway flows along Norte's network. Unfortunately, there are no data on wine flows for Andaluces and MZA after 1900.

TABLE 2.

Interregional Flows of Wine, 1901-13 (000' T).

	<u>(for the Norte network)</u>			
	1901	1905	1909	1913
MADRID	+ 1.6	+ 3.2	- 0.1	+ 13.1
OLD CASTILE	- 5.2	- 19.9	- 45.2	- 42.6
Basque Country	- 96.8	- 80.9	- 34.0	- 61.0
Santander	- 24.9	- 21.7	- 13.2	- 10.2
Total:	-121.7	-102.6	- 47.2	- 71.2

(continued on following page...)

1. Estadística del Comercio Exterior for 1913.

(Table 2 contd...)

TABLE 2.

Interregional Flows of Wine, 1901-13 (000' T).

(for the Norte network)

	1901	1905	1909	1913
NORTHWEST	- 39.4	- 50.0	- 51.2	- 48.4
LEVANTE	- 0.1	- 1.5	- 2.7	- 17.8
CATALUNA	- 15.8	- 4.0	- 4.3	+ 2.9
ARAGON	+ 32.8	+ 7.3	- 0.4	+ 7.8
RIOJA	+ 73.4	+ 20.1	- 23.7	+ 6.9
Trade Balance:	- 74.4	-147.4	-174.8	-149.3

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Notes and Sources:

Calculated from the information provided by Norte, Datos Estadísticos, 1901-13.

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Compared to Table 1, the new flows present some interesting changes. First, the territory served by Norte increasingly became dependent on wine imports from districts served by other railway companies.¹ For example, former wine surplus areas such as Old Castile became net importers. This tendency to import was intensified in 1909 when all the provinces served by Norte displayed negative signs.

Secondly, the negative signs reflect the advance of Phylloxera and railway data indicate the date of recovery from the disease. Phylloxera was felt for the first time in the Zaragoza district around 1900, and by 1909, it had destroyed 94 per cent of the vineyards. Wine surpluses were ten times less in 1905 than they were in 1882. When the disease spread to Lérida in 1904, the wine surplus fell ten per cent of its 1901 level. In the Rioja, Navarre was invaded in 1892 and Logroño in 1899. By 1909, the whole vineyard had been destroyed.

1. Imports from regions outside Norte's network are translated into a negative 'trade balance' in Table 2.

In Navarre and Alava, output dropped by a factor of five between 1903 and 1907.¹

Outside Norte's network, existing channels of trade were not radically altered by the disease. Wine from La Mancha was carried northwards to feed the export trade through Cataluña or for coupage with local wines. For example, wine surplus from the Valdepeñas districts continued to be carried to Madrid either for local consumption or to be re-exported to Northern markets.² In 1913, the former TBF network, by then part of MZA, hauled 266,000 tons of wine or 58 per cent of MZA's tonnage of wine. The bulk of these flows concentrated on the Barcelona-Tarragona line.³

The volume of wine shipped towards Central Spain increased its share of total wine flows. Over one third of the wine carried by Norte in the period 1900-13 was supplied to the core, whereas in the 1880's, this percentage was ten per cent. Domestic consumption grew as wine sent by rail to the market towns of the periphery exceeded exports from these same towns. For example, in 1901-02, Santander and Bilbao exported only 6,000 tons of wine to foreign countries but were supplied with 84,000 tons by rail. While Valencia, which in 1913 absorbed 28 per cent of the wine carried by Norte, re-exported by sea two thirds of the wine which arrived by rail.⁴ Assuming that the wine exported to foreign countries from the seaports

1. Junta Consultiva Agronómica, op. cit. Also Junta Consultiva Agronómica, Estadística de las Producciones de Mosto y Olivarera en 1903 (Madrid, 1904) and Report on the Trade and Commerce of Spain, (Parl. Papers, 1909, CXVIII), p. 203.
2. Wine flows carried to Madrid amounted to 40 per cent of the wine surplus. A further 10 per cent were shipped to Zaragoza and 35 per cent were hauled southwards to Andalousia, see MZA, Tráfico de Vinos de Valdepeñas, 1913 (Archive MZA).
3. MZA, Corrientes principales de Tráfico con su tonelaje, 1913 (Archive MZA).
4. Norte, Datos Estadísticos for 1913 and Estadística del Comercio Exterior for 1913.

served by Norte and MZA had been previously carried by rail, it can be deduced that in 1913, 28 per cent of Norte's and MZA's wine tonnage was exported.¹

After 1900, the pattern of railway flows altered and demonstrates that railways catered far more for the home market than for external demand. These shifts must be attributed to the spread of the Phylloxera, which turned traditionally wine surplus districts into net importers, and to the revival of the wine industry in France.

C.2. The Impact of Railways on the Market of Wine, 1882-1913:

The data presented in Table 3 relate the tonnage of wine carried by rail to Spain's output and domestic consumption of wine. The volume of wine supplied by rail fluctuated within narrow margins between 1882 and 1909. In 1913, however, it increased by 32 per cent, compared to the average tonnage for 1882/1909. Since the output of wine was declining because Spanish vineyards were ravaged by the vine disease, the share of wine marketed by rail rose from 34 per cent in 1886 to 73 per cent in 1909.² This was achieved chiefly through the expansion of the network and to a lesser extent through a shift to railway transportation from other means of transport.

TABLE 3.

Railway Traffic and the Output of Wine, 1882-1913.

(see following page...)

1. Wine exports from seaports served by Norte and MZA amounted to 306,000 tons in 1913, see Estadística del Comercio Exterior for 1913. Combined tonnage of wine hauled by MZA and Norte from Column 5 in Table 3.
2. See Column 7 in Table 3. These percentages are, however, slightly over-rated because railway data on wine flows include vinegar and spirits.

TABLE 3.

Railway Traffic and the Output of Wine, 1882-1913.

Year	(1) Norte	(2) MZA	(3) Other	(4) Transit Trade	(5) Total
1882	381	237	329	81	866
1886	320	283	373	118	858
1901	428	506	-	106	828
1905	428	593	102	172	951
1909	409	706	91	214	922
1913	542	767	84	204	1189

Year	(6) Wine Output	(7) 5 / 6	(8) $\frac{5 - X}{6 - X}$	(9) Inter-provincial Trade (Norte).
1882	-			0.62
1886	2530	0.34	0.10	0.44
1901	2060	0.40	0.33	0.51
1905	1630	0.58	0.52	0.47
1909	1354	0.73	0.69	0.45
1913	1574	0.75	0.65	0.36

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Notes and Sources:

Column (1): Wine, vinegar and spirits carried by Norte in thousand tons, from Datos Estadísticos, 1882-1913.

Column (2): Wine, spirits and mineral water carried by MZA in thousand tons from Memorias, 1878-1913.

Column (3): In 1878, wine carried by TBF. In 1882 and 1886, it includes also Andaluces and AVT. From 1905, only Andaluces. AVT and TBF were amalgamated to Norte and MZA in 1891 and 1898 respectively. For Andaluces, see Crisis, vii, p. 278; AVT, Crisis, vii, p. 322 and TBF, Memorias, 1878-1886.

Column (4): Transit Trade refers to wine exchanged among railway companies. Norte and MZA at the following railway junctions: Atocha, Valladolid, Casetas, Zaragoza, Barcelona, Reus, Tarragona, La Encina. Norte with TBF at Barcelona, and Tarragona; with AVT at Tarragona, source Norte, Datos Estadísticos, 1878-1913. MZA with AVT at La Encina until 1886 and with Andaluces at Espeluy, Sevilla, Córdoba and Belmez, see Crisis, vii, pp. 126-37.

Column (5): Wine tonnage carried by Norte, MZA and Other as:
(1) + (2) + (3) - (4) in thousand tons.

Column (6): Wine Output in thousand tons. The 1886 figure is based on a contemporary estimate, see Junta Consultiva Agronómica, in Crisis, iv, p. 606. From 1901, see B.R. Mitchell, European Historical Statistics 1750-1970 (1978), p. 141. Hls. were transformed into tons applying a 0.092 coefficient

Column (7): Railway wine tonnage as a share of wine output.

Notes and Sources contd. (Table 3).

Column (8): Railway wine flows for internal consumption as a share of internal consumption. I assumed that exports had been carried to the shipping points by rail. Foreexports, see Estadística del Comercio Exterior 1878-1913. It includes wine of all classes.

Column (9): Interprovincial rail flows for Norte refer to the wine carried across the boundaries of the provinces served by Norte. They include wine exchanges with companies outside Norte's network. Calculations made from the data in Norte, Datos Estadísticos 1882-1913.

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The volume of wine marketed by rail for domestic consumption rose rapidly between 1886 and 1913. While railways were serving external demand, only 10 per cent of the wine consumed by Spaniards was supplied by rail. This is an indicator of how little integrated was the home market in the 1880's. When internal demand replaced external demand after 1900, two thirds of the wine consumed in Spain was supplied by rail.

The integration of the home market was accompanied, however, by declining interprovincial flows of wine. For Norte, for example, interprovincial flows dropped from 62 per cent in 1882 to 36 per cent of Norte's wine tonnage in 1913. In contrast to Norte, interprovincial flows of wine amounted to a smaller share of MZA's wine tonnage: 44 per cent in 1882. This marked difference between Norte and MZA is explained by the fact that the vineyards served by MZA were located nearer the sea than the wine producing regions served by Norte.

The decreasing trend of interprovincial flows of wine in terms of the wine tonnage carried by rail are explained by the absence of surplus wine after the Phylloxera damaged Spain's vineyards. Indeed, imports of wine from regions outside Norte's network accounted for most of Norte's interprovincial traffic. For example, the volume of wine trans-shipped between Norte and MZA doubled in the period 1901/13.¹

1. See Column 4 of Table 3.

Therefore, railways had a positive impact on the volume of wine supplied to the home market. I will proceed to analyse to what extent railways affected the price of wine paid by French importers and Spanish consumers. I will calculate the social saving of railways on wine flows in the 1880's.

The profits that railway companies derived from the transportation of wine in the 1880's varied. For MZA, wine never represented more than 15 per cent of its traffic, for TBF about 25 per cent. For Norte, wine flows fluctuated from 10 per cent in 1878 up to 23 per cent in 1881 and decreased thereafter. Expressed in tons, the picture can be misleading and revenue from the transport of wine amounted to nearly 30 per cent of TBF's total receipts contrasting with 24 per cent as a share of tonnage. This fact implies that the haul for wine flows was longer than the average haul or that the freight charged for wine flows was higher than average. Since one third of TBF's wine was carried northwards along the whole network, wine receipts were surely boosted by the longer haul. But for MZA, wine receipts amounted to only 12 per cent of total revenue in 1885, and was diminished by short haul traffic. On average, wine was hauled by MZA at a distance of 110 kilometres.¹ But 78 per cent of the wine was carried at a distance shorter than 60 kilometres because the wine districts served by MZA were close to the coast. Indeed, the Alicante district, which in 1886 supplied 42 per cent of the wine hauled by MZA, is located within 70 kilometres from the sea. I estimated that MZA's output of wine amounted to 31.1 million ton-kms. or 6.7 per cent of MZA's total output, whereas wine expressed in tons was 15 per cent of MZA's tonnage. When wine flows for this company are

1. MZA in Crisis, vii, p. 125.

disaggregated between wine for export and wine flows for home consumption, I found that the former travelled, on average, slightly over 50 kilometres and the latter 310 kilometres.¹

Wine was, therefore, a relatively unimportant commodity for railway companies servicing markets in the neighbourhood of vineyards. This fits the Andaluces Company with a wine output of 3.1 million ton-kms. in 1886 and an average haul of 55 kilometres.² In contrast, with Andaluces or MZA, wine was an important source of revenue for TBF, in spite of the proximity of the vineyards it served to the sea. The wine this company exported to France was hauled by rail in a successful competition with a sea borne route. I estimated that the wine output for TBF was 29.5 million ton-kms. in 1886 with an average haul of 135 kilometres.³

Similar calculations for Norte disclose that in 1878 output was 28.2 million ton-kms. or 10.4 per cent of Norte's total output.⁴ I estimated that the wine output in 1886 had increased to 77.5 million ton-kms. or 20 per cent of aggregate output.⁵ The average haul for

1. Ibidem.

2. This output is based upon the assumption of a constant haul of 55 kilometres for the period 1882/6. This haul was deduced from an estimated wine output of 2.9 million ton-kms. for 1882 as a result of applying a weighted rate to the wine receipts in 1882. This rate was calculated on the basis of the cost of transport along the Jerez-Trocadero line (which accounted for 72 per cent of total traffic) and on the rest of the network. For rates on the Jerez line, see Andaluces, "Tarifa Especial num. 15", in Crisis, vii, p. 287.

3. This wine output is the result of dividing the wine receipts by an average wine rate of 0.0666 pesetas per ton-km. Wine receipts as given in TBF, Memoria for 1886 and the average rate is the mean of the rates charged by TBF on the following journeys: Barcelona-Port Bou, Barcelona-Tarragona and Tarragona-Port Bou as given in TBF in Crisis, vii, p. 335.

4. This output was calculated from the information provided by Norte, Datos Estadísticos for 1878 on each individual wine flow between every two stations on Norte's network. For railway distances, I used Renfe, Distancias Kilométricas (Madrid, 1944).

5. I assumed that the average rate charged for wine freight in 1878 varied as Norte's general rate index.

Norte was more than double the haul by MZA because the wine districts served by Norte were located at a greater distance from their markets. For example, wine from Aragon had to travel over 400 kilometres to the French border.

In 1886, railways supplied 141.2 million ton-kms. of wine output at a cost of 12.9 million pesetas.¹ The social saving on these wine flows can be estimated at 69 million pesetas or 25 per cent of the value of wine exports during that year.² Since railways were servicing external demand rather than home market over the 1880's, it is necessary to express the share of social savings exported to consumers abroad. I estimated that 62 per cent of railways wine output was exported.³ Therefore, social savings on wine flows supplied to sea ports amounted to 42.8 million pesetas or 15 per cent of the value of wine exports. Accordingly, social savings on internal flow amounted to 26.2 million pesetas. My estimates show that in the event of a railway closure, counterfactual prices facing the French consumer would have been 15 per cent higher. Assuming an elasticity of one, for example, exports would have been 15 per cent lower, which would have entailed a loss of four per cent of Spain's wine output.

1. This is the 'financial' cost rather than the actual cost, see discussion in section B.3. of Chapter 2. Wine receipts for each railway company from their respective Memorias for 1886.
2. This social saving is based on the calculations of Table 3 in Chapter 2. Overland output comes to 120 million ton-kms. at a cost of 81.9 million pesetas or 0.6827 pesetas per ton-km. adjusting for price changes by way of the Sarda price index.
3. This estimate is based upon the assumption that the surplus wine regions supplying Norte's seaports remained unaltered after 1878. Thus, from the information contained in Datos Estadísticos for 1878, I was able to calculate that the average haul for the wine flows supplying exports was 234 kilometres compared to 124 kilometres for the home market. Applying this average haul to the exports from ports served by Norte, I estimated that Norte's output for export was 42.5 million ton-kms. MZA's output for export amounted to 12.3 million ton-kms., see MZA in Crisis, vii, pp. 124-5. Finally, I assumed that Andaluces and TBF were servicing only the export trade.

Therefore, these results show that the impact of rising external demand if Spain had not constructed a railway network would have been unaltered. If transport costs had remained constant at pre-rail levels, would the wine districts of Central Spain have been able to export their surplus wine to France? Wine exports to France depend on the costs of producing wine in Spanish vineyards plus the costs of transporting wine to France compared to local prices in France. Thus, if the costs of transporting wine in the absence of railways are at least equal to the railway cost, Spanish wine will be sold in France.

The most distant wine exporting region served by Norte was Huesca. Since wine from Huesca was exported to France, it means that its cost in France was below or equal to the market price of wine in France. In 1878, this rail cost was 29 pesetas per ton.¹ In a non-rail economy, the boundaries of wine exporting areas will be set by carting rates. A transport mark-up of 29 pesetas allows for hauling wine within 50 kilometres.² But the main wine growing areas of the Mediterranean were located within this distance from the sea. It implies that in the absence of railways and assuming that Spanish wine exporters could not affect the price level of wine in France, Mediterranean wine would have been exported. In contrast, none of the vineyards in north-central Spain were that close to the border or sea. Given that these districts contributed 12 per cent of wine exports in 1886, the present results support the view that the contribution of railways to the export trade of wine was relatively minor.

1. The wine freight rate charged by Norte on wine flows from Huesca to Irun was 0.07041 pesetas per ton-km. in 1878. Calculations made from the information provided by Datos Estadísticos for 1878. This rate was applied to the distance between these two towns.
2. It is the result of dividing 29 pesetas by the carting rate used in Chapter 2, see Appendix D, pp. 111-2.

The contribution of railways to the long run development of the wine industry should not be under-estimated. While external demand was active and absorbed most of Spain's surplus wine, the pattern of wine flows in the domestic market remained practically unchanged, although railways were already opening up new channels to the wine trade in Central Spain. But the response to favourable external conditions came mainly from peripheral vineyards. When external demand disappeared after 1900, railways made it possible for wine producers to commercialise an ever increasing volume of wine for domestic consumption. As the production of wine started to decline in several regions under the effect of Phylloxera, wine was supplied from distant vineyards.

I have shown that in the event of a railway closure, Spain's wine exports would have been little affected. This fact was explained by the location of vineyards near the sea which accounted for export wine being little transport intensive. For example, wine hauled by MZA for the home market travelled along distances 5.5 times longer than the average haul of export wine. Thereby, railways contributed far more to the development of the home market than to export trade. However, the relevant counterfactual would have been Spain without railways and without Phylloxera as compared to Spain with railways but without Phylloxera. Railways and vine diseases first in France and then in Spain made it possible to commercialise the wine industry so that more and more vineyards supplied other than purely local markets. In so far as commercialisation leads to efficiency and higher productivity, this pushed the industry onto a new production possibility curve.

CHAPTER SEVEN.

RAILWAYS AND THE TRADE IN MINERALS.

A). Railways and the Coal Industry:

While Spain's mineral wealth was praised by contemporaries, Spain was poorly endowed with coal deposits. Spanish coal was scarce, costly to produce and of poor quality compared to British coal. The Spanish economy relied heavily upon imported coal: in 1885/94, foreign coal accounted for 53 per cent of domestic consumption. In this section, I will consider the impact of railways on the long run development of the coal industry in Spain. I will then proceed to analyse the transportation of imported and domestic coal.

Table 1 shows that the share of coal marketed by rail trebled between 1865/74 and 1905/13.¹ But as late as 1913, about two thirds of the coal consumed in Spain were not moved by rail because markets along the periphery were supplied by sea. In terms of domestic production, however, the tonnage of coal carried by railways went up from 26 per cent in 1865/74 to 90 per cent in 1905/13.² Of course,

1. See Column 8 in Table 1. The Table, however, suffers from poor statistical records for the major colliery railway lines: the Langreo Company and the Robla-Valmaseda Company. In 1879, the Langreo railway hauled nearly one third of the coal mined in Spain. But, when the coalfields of Central Spain were mined, the leading railway companies regained their share of the market. For example, in 1904 Norte and MZA carried a volume of coal equal to two thirds of the coal mined in Spain, whereas the Langreo and Robla lines carried about 22 per cent. For Norte and MZA, Memorias for 1904. For Langreo and Robla, it was assumed that all their traffic was coal, see Dirección General de Obras Públicas, Memorias.
2. These percentages are upper bounds because the coal tonnage carried by rail includes some imported coal.

part of this increase was due to the expansion of the network, but given that railways serviced coalfields quite early, most of the increase was owed to the widening of the market.¹ Railways created new sources of demand for coal in the interior of Spain and the distance travelled by coal increased.² Railway companies demanded large quantities of coal and the leading railway companies prompted the development of new coalfields in Central Spain.³

TABLE 1.

Railways, Coal Production and the Coal Trade, 1865-1913.

(annual averages, 000' T and %)

Year	(1) Norte	(2) MZA	(3) Andaluces	(4) Total	(5) Coal Output	(6) Domestic Consumption
1865/74	81	37	-	118	570	1032
1875/84	152	151	105	405	852	1798
1885/94	422	360	-	782	1125	2757
1895/04	1065	590	-	1605	2376	4348
1905/13	1542	782	203	2368	3500	5940

Year	(7) 4 / 5	(8) 4 / 6	(9) 4/(non rail 6)	(10) 4/(5 - rwy. consumption)
1865/74	20.7	11.4	13.8	26.1
1875/84	47.5	22.5	28.3	66.7
1885/94	69.5	28.4	33.8	94.3
1895/04	67.5	36.9	43.5	82.8
1905/13	67.6	39.9	46.3	89.0

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Notes and Sources:

Column 1: Norte, Datos Estadísticos 1874-86 and 1901-13. For the remaining years, Memorias. Norte's records include under 'coal': coal, coke, charcoal and firewood. Between 1874-86 and 1901-13, I excluded charcoal and firewood by deducting from the total coal tonnage the out-going traffic from the following stations: Villalba to Sanchidrian,

1. Coal tonnage per kilometre of track multiplied five times between 1865/74 and 1905/13.
2. The average lead of the coal carried by Norte increased by 60 per cent between 1878 and 1901, Calculations based on Datos Estadísticos, 1878 and 1901.
3. See Chapter 4.

Notes and Sources contd. (Table 1).

(Column 1 contd) ... incoming traffic from the Medina-Salamanca line, Manzanos to Tolosa, Poves to Amurrio and Bacaicoa to Pamplona. All these stations traded in charcoal and wood according to Datos Estadísticos for 1878.

Column 2: MZA, Memorias 1869-1913 and TBF, Memorias, 1878-97. MZA records include under 'coal': coal, coke and 'briquettes'.

Column 3: Andaluces, Memorias, 1879-82 and 1905-13. Andaluces' records include under 'coal': coal and coke.

Column 4: Total Coal tonnage as the sum of Norte plus MZA plus Andaluces minus coal trans-shipments between Norte and MZA. Transit trade was calculated from the information provided by Datos Estadísticos between 1874-86 and 1901-13.

Column 5: Spanish production of coal, see Nadal, Fracaso, Appendix 5.

Column 6: Spanish domestic consumption as production plus imports. Imports include coke. For import data, see Nadal, Fracaso, Appendix 5.

Column 7: Coal tonnage carried by rail as a share of coal output.

Column 8: Coal tonnage carried by rail as a share of domestic consumption of coal.

Column 9: Coal tonnage carried by rail as a share of the non-rail consumption of coal, that is domestic consumption minus the derived demand for coal from railways. See Table 1 in Chapter 4.

Column 10: Coal tonnage carried by rail as a share of coal production after deducting domestic coal consumed by railways. It was assumed that foreign coal met one third of fuel requirements of railways. For coefficient, see Chapter 4, p. 172.

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Coal was increasingly commercialised by railways. But the share of Norte's traffic exchanged between provinces fell. At its peak in 1882, 62 per cent of the coal carried by Norte traversed provincial boundaries. Thereafter, the trend was downward and in 1909, only one fifth of Norte traffic was interprovincial. The decline of inter-regional flows was explained by the amalgamation of Norte to the Noroeste Company which opened to Asturian coal an outlet to the markets of Central Spain. Although the output of these coalfields contributed heavily to Norte's traffic, 58 per cent of the coal flows originating there were intraprovincial.¹

Although coal flows included imported coal, evidence suggests

1. Approximately 90 per cent of the interregional flows consisted of Asturian coal, see Table 3, p. 239.

that railways were more important for domestic coal than for imported coal.¹ However, Norte supplied just as many ton-kms. of imported coal than of domestic coal in 1878.² But, on the whole, imported coal travelled on average less than domestic coal.

B). The Traffic in Coal, 1878-1913:

Railway records on coal flows outside Norte's network are scarce. Most of the evidence presented in this section describes the pattern of coal flows between the regions served by Norte. But Norte carried more coal than any other railway company and served Spain's major coalfields.³

The flows of coal carried by Norte in 1878 have been tabulated in Table 2. Out of the five major surplus areas, only the province of Palencia is inland.⁴ The remaining four are coastal towns: Bilbao, Pasajes, Santander and Barcelona. Over half of the coal hauled by Norte in 1878 was sea borne coal which had travelled along the coast or had been imported from abroad. The Table indicates that imported coal was landed at the port nearest to the point of consumption.

TABLE 2.

Major Coal Flows in the Area served by Norte in 1878 (000' T).

FROM:	TO:					
	MADRID	OLD CASTILE	BASQUE COUNTRY	RIOJA ZARAGOZA	BARCELONA	OTHER
PALENCIA:	31.1	21.6	-	-	-	-
Santander:	18.3	1.5	-	-	-	0.5
Bilbao	-	-	5.3	12.6	-	2.6
Pasajes:	-	-	15.1	1.2	-	3.4
Barcelona:	-	-	-	-	20.7	2.3

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1. See below page 237.
2. These calculations are based on data on coal flows contained in Datos Estadísticos for 1878.
3. See Table 2.
4. Coal flows from these five areas accounted for 90 per cent of the coal carried by Norte in 1878.

Notes and Sources: (Table 2).

All capital letter words refer to provinces.

Coal flows include coke but exclude charcoal and firewood.

Row 1: Palencia includes coal inflows from the Noroeste Company.

Column 2: Old Castile includes the provinces of Valladolid, Palencia Santander and coal in transit to the Noroeste Company, the Medina-Salamanca and Medina-Zamora lines.

All calculations based upon the information provided by Norte, Datos Estadísticos for 1878.

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Coal traffic which originated in Pasajes or Barcelona ended within provincial boundaries and in both cases, coal travelled on average less than 70 kilometres. One quarter of the coal landed at Bilbao was consumed locally. The rest was delivered to the neighbouring Navarre and Zaragoza and the average lead was 188 kilometres while coal landed at Santander travelled 480 kilometres to Madrid.¹

The share of imported coal in the total tonnage hauled by Norte decreased after a direct link had been established in 1886 between the Asturian coalfields and the Castilian markets. It fell from 58 per cent in 1878 to 37 per cent in 1886 and by 1901, when Asturian coal amounted to two thirds of Norte's traffic, to 18 per cent.²

Data on coal carried by the other companies is scarce but, given that the main consumption centres (either for urban households or for the mining and smelting of mineral ores) were located within a short distance from the sea and given that the modest demand for coal from the interior of Spain could be matched quite easily by the coalfields of the interior of Spain (Villanueva del Río, Belmez ,

1. These calculations are based on the data presented in Table 1. Foreign coal landed at Bilbao in 1878 amounted to 7,400 tons and coastwise flows to 1,800 tons, Estadística del Comercio Exterior for 1878 and Estadística del Comercio de Cabotaje for 1878.
2. In 1886, coal flows originating in Pasajes, Bilbao, Santander, Barcelona and Tarragona totalled 110,000 tons or 37 per cent of Norte tonnage. For 1901, ports include also Valencia, Vinaroz and Ripa. Calculations based on Datos Estadísticos for 1886 and 1901.

Puertollano and Peñarroya), imported coal was probably moved over very short leads. For example, in 1913, under eight per cent of MZA's traffic originated in coastal towns.¹

Flows have been arranged in Table 3 to represent the trade balance serviced by Norte. No dramatic changes had occurred in the coal trade between the 1880's and the 1901-13 period. Asturias became a prominent supplier of Spanish coal to the markets of the interior, and over 90 per cent of the interregional trade consisted of Asturian coal. Asturian coal accounted for two thirds of the coal hauled by Norte. But the coal carried by Norte towards the interior of Spain amounted to half of the volume of Asturian coal exported by sea to other markets of the periphery.² The remaining share of the coal mined in Asturias was consumed locally.³

Leon also emerged as a major supplier. Earlier in the 19th century, Leon failed to increase production because of transport costs and because of competition from Asturian and Palencian coal.⁴ Output went up rapidly in the 1890's after the construction of a direct rail link between the Eastern coalfields at Sabero and the Bilbao market.⁵ Prosperity spread to the Northern coalfields served by Norte and by 1901, eight per cent of Norte's coal traffic originated in these fields.⁶

1. MZA, Corrientes principales de Tráfico con y su Tonelaje, 1913.
2. See A. Navarrete, El Carbon Nacional y su Transporte (Madrid, 1909), p. 37.
3. See Estadística Minera of 1905.
4. See the answers of the Sociedad Palentino Leonesa to the
- 7 Interrogatorio sobre el Derecho Diferencial de Bandera (Madrid, 1867), iii, pp. 81-5.
5. Output increased five-fold. See also T. Cortizo Alvarez, "Las Cuenas Mineras Leonesas (Leon, 1977), pp. 23-9.
6. Norte, Datos Estadísticos, 1905.

TABLE 3.

Interregional Flows of Coal carried by Norte, 1878-1913 (000' T).

	1878	1882	1886	1901	1905	1909	1913
MADRID :	-52.3	-57.9	- 82.6	-156	-134	-138.5	-200
OLD CASTILE :	-17.6	-19.4	- 28.7	- 82.3	- 75	- 64.5	-126.6
BASQUE and SANTANDER and							
PALENCIA :	+74.2	+96.0	+101.8	- 2.5	- 23	- 25.3	- 28
CATALONIA :	-	-16.0	- 16.0	- 19.0	- 12.8	- 56.0	- 49.8
ARAGON :	- 8.2	-14.6	- 17.7	- 53.5	- 32.0	- 51.8	-102.3
NORTHWEST :				- 0.2	- 4.1	- 3.5	- 4.5
LEVANTE :				+ 16.6	+ 4.0	+ 1.0	+ 6.4
ASTURIAS and LEON :			+ 36.3	+410.6	+338.6	+328.6	+545.2
Balance of Trade :	- 4.0	-12.0	- 7.0	+114.0	+ 71.7	- 10.0	+ 4.0

Notes and Sources:

A (-) sign means a coal deficit.

A (+) sign means a coal surplus.

The Balance of Trade measures coal flows of the territory served by Norte with the rest of Spain.

Row 1 : The province of Madrid served by Norte.

Row 2 : Old Castile includes Avila, Segovia, Valladolid, Burgos, Logroño and Navarre.

Row 3 : Basque provinces (Alava, Guipuzcoa and Vizcaya) plus Santander and Palencia.

Row 4 : Catalonia includes Barcelona, Gerona, Lérida and Tarragona.

Row 5 : Aragon includes only Huesca and Zaragoza.

Row 6 : Northwest includes Lugo, Orense and Coruña.

Row 7 : Levante includes Castellon and Valencia.

All calculations are based on the information provided by Norte, Datos Estadísticos for the corresponding years.

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Coal continued to originate in coastal towns. Guipuzcoa continued to depend on imported coal.¹ Coal landed at Bilbao was hauled southbound to Zaragoza for the milling and beetroot industries. But the railways carried only a very small share of the coal landed at Bilbao.²

1. Coal imports landed at Pasajes reached a peak of 65,000 tons in 1901 and decreased thereafter.

2. For example, in 1913, the share of coal imports carried by rail was 13 per cent, Estadística del Comercio Exterior and Datos Estadísticos for 1913.

Finally, the 'Balance of Trade' shows that except for 1901 and 1905, the territory served by Norte was more or less self sufficient in coal. But in 1901 and 1905, it exported large volumes of coal to the rest of Spain.¹

The development of the main coalfields in Central Spain was closely related to the construction of railway lines. Before railways were laid across the Córdoba district in 1865, Belmez coal could not be 'conveyed at any great distance as the country is rough and hilly and no regular road which could carry winter traffic has yet been made'.² Coal was consumed locally by lead and copper foundries in a volume not exceeding a thousand tons and it rarely travelled more than a hundred kilometres from the mine.³ After the opening of a railway link by the Madrid-Badajoz Company in 1868, coal output multiplied three times in one year.⁴ Overnight, the railway created a new demand for Belmez coal in Madrid (500 kilometres away) and in the Linares mining district where it replaced English coal.⁵ Coal mining in the Puertollano district was also fostered by the construction of a direct railway line to Madrid in the 1880's. By 1913, Puertollano had grown into the main coal surplus area within the MZA network.⁶ In that year, trains carried 285,000 tons of coal or three quarters of total coal mined.

My attempt to reconstruct coal traffic suggests that railways had a double effect on the coal trade. First, they prompted the development of internal coalfields such as Leon, Belmez and Puertollano by widening the market. Secondly, railways fostered an import substit-

1. See Table 3.

2. Report on the Consular District of Cadiz (Parl. Papers, 1866, LXX), p. 332.

3. See answers given by the Belmez coalfields to Interrogatorio (Madrid, 1867), III, p. 93.

4. See Nadal, Fracaso, p. 149.

5. Report for the Consular District of Málaga (Parl. Papers, 1882, LXXI), p. 1312.

6. MZA, Corrientes principales de Tráfico, 1913.

ution process in Central Spain. But, the data also show that domestic coal failed to penetrate the markets of the periphery where foreign coal continued to be preferred over sea borne Spanish coal.

It would be interesting to explain the success of the import substitution in the interior of Spain and its failure at the periphery.

(a) Coal supplied for central markets:

In 1885, a railway line between Castile and Asturias was finally opened. Before that time, central markets were supplied with both foreign and domestic coal. Norte hauled foreign coal at the same rate per ton-km. as domestic coal from Palencia, though the Spanish coalfields were located closer to the local markets.¹ At the same time, the development of the Leon coalfields was frustrated by a differential rate in favour of Palencia.² The opening of a railway line to Belmez in 1868 meant that Belmez coal could be delivered to Madrid at more competitive prices because it travelled a shorter distance and this provoked Norte to cut freight rates.³ At the pithead, Belmez coal cost roughly the same as English coal at Santander.⁴ Adjusting for different qualities, in Madrid, Belmez coal was six per cent more expensive than English coal and was cheaper in

1. Contract with the Gaz Company in Madrid for the haulage of imported coal from Pasajes and Santander at a cost of 18 pesetas per ton of coal, or 0.035 pesetas per ton-km., Norte, Procès 17 Nov. 1869. For the haulage of Barruelo coal at a cost of 14 pesetas per ton or 0.035 pesetas per ton-km., Norte, Procès 9 Feb. 1870. In 1881, Palencian coal was hauled to Madrid at a cost of 20 pesetas or 0.05 pesetas per ton-km., Norte, Procès 25 June 1881.
2. Although the rate per ton-km. of coal was similar for Barruelo and Leon, the distance from Leon was longer. Norte, Procès Paris, 13 Jan. 1864.
3. In 1868, Norte cut its coal rate to favour the sale of Orbó's coal in Madrid after the opening of a railway to Belmez, see Norte, Procès 18 March 1868. In 1885, MZA's coal rate was reduced to enable coal from Puertollano and Peñarroya to sustain competition with Asturian coal in Madrid, see MZA, Procès 11 Dec. 1885.
4. The price of Belmez coal at the pithead was 17s per ton or 21.25 pesetas in 1882 whereas the cif price of English coal at Santander was 21.87 pesetas per ton. For Belmez coal, see Report for the Consular District of Málaga, (Parl. Papers 1882, LXXL) p.1312. For English coal, see Nadal, Fracaso Table 2, p. 142.

Linares.¹

The reaction of MZA to the opening of the Asturian railway was to cut freight rates for the haulage of coal from Belmez and Puertollano in an attempt to safeguard the Madrid market from Northern coal carried by Norte.² Then the expansion in the size of the market for Asturian coal facilitated mining on a larger scale and resulted in cost reductions at the pithead.³ By 1895, the combined effects of higher tariffs and the fall in the exchange rate made Asturian coal 30 per cent cheaper than English coal at Bilbao.⁴ This differential together with the proximity of Spanish coalfields to the markets of the interior pushed forward the process of import substitution.

The substitution of Spanish for English coal had its origins in a 'rate war' between Norte and MZA. Cheap and all-year-round transportation enabled larger volumes of coal from Belmez-Peñarroya and Puertollano to be delivered to the interior. The railways began a process which was carried forward by the fall of the peseta and protection in the 1890's.

(b) Coal supplies to the Periphery:

The peripheral market was much larger than the internal market. And in 1905, that market accounted for two thirds of total domestic

1. Belmez coal in Madrid could be sold at 41.25 pesetas per ton, the cost of haulage being 20 pesetas per ton, MZA, Procès 2 Dec. 1881. English coal could be sold at 45.8 pesetas per ton, the cost of haulage being 23.9 pesetas per ton or 0.0464 pesetas per ton-km., Norte, Datos Estadísticos, 1878. For different quality, see Chapter 4.
2. Rates per ton-km. of Belmez coal were reduced from 0.0505 pesetas to 0.04663 pesetas per ton-km., MZA, Procès, 11 December 1885.
3. The price of Asturian coal on board at Gijon decreased from 20 pesetas per ton in 1882 to 15 pesetas in 1887, see F. Gascué, "La Crisis Carbonera en Asturias" Revista Minera, XXXVIII (1887), p. 41.
4. See below footnote number 5, page 243.

consumption.¹ Domestic coal supplied 15 per cent of it. In that year, 30 per cent of total imports passed through Barcelona and a further 24 per cent was landed at Bilbao.² I will analyse why Asturian coal could not compete with English coal, despite its locational advantages.

The development of an export trade in minerals to Europe led to a fall in freight on ships crossing from England to Spain to pick up minerals. In the 1880's, English coal was cheaper than Asturian sea borne coal at all the coastal towns of Spain.³ At Gijon, the price of domestic coal (fob) was already too high to compete along the Northern sea shore. Railways were not, in any case, a viable alternative to the cheaper sea borne coastal traffic.

But under the more favourable conditions of the 1890's, the price differential narrowed in favour of Asturian coal.⁴ By 1896, screened coal was 28 per cent cheaper on waggon at the pithead than Newcastle coal at Bilbao and almost half the price of English coal at Barcelona.⁵ However, Asturian coal could not compete with English coal in either of these towns when carried by rail, even at a very low freight rate.⁶ If the import substitution was to succeed it had

1. It was assumed that coal consumption in the periphery included all coal and coke imports, coal consumption in Asturias and sea borne Asturian coal. For import figures, Estadística del Comercio Exterior 1905, for Asturian consumption as a difference of Asturian output minus coal sent on coastal trade, see A. Navarrete, op. cit., p.37 and for Norte, see Table 3.
2. See Estadística del Comercio Exterior 1905.
3. See Table 4 in Chapter 4.
4. J.G.H., "La Cercana Nivelación del Precio del Carbon en Gran Bretaña y Asturias", Revista Minera XL (1889) pp. 74-6.
5. Liga General de los Intereses Hulleros de España, Exposición presentada al Excmo Sr Presidente del Consejo de Ministros (Madrid, 1896), p. 9 and Appendices 11 and 12.
6. Norte favoured the haulage of Asturian coal from Mieres to Bilbao and Barcelona by charging a reduced rate of 0.02 pesetas per ton-km. of coal, see "Una Tarifa Notable de Transporte", Revista Minera XLI (1890) pp. 52-3. Mieres-Bilbao involved a long detour via Palencia and Miranda but avoided the trans-shipment costs of the shorter route via the narrow gauge railway of La Robla-Valmaseda.

to rely on the sea route. By 1897, Asturian coal was cheaper than English coal at Cadiz.¹

Price differentials in favour of domestic coal at the pithead continued to narrow after the turn of the century. The 'coal interest' claimed that railway freight rates were excessive and asked for subsidised transport.² They argued that production costs could not be cut unless the market for Spanish coal was previously enlarged.

In 1905, domestic coal at the pithead in Asturias was still over 50 per cent cheaper than English coal cif at Bilbao or Barcelona.³ But in that year both by sea or rail, this price differential was large enough to allow Asturian coal to compete with English coal at Bilbao. In Barcelona, however, Asturian coal was 36 per cent more expensive than English coal when hauled by rail and roughly equal in price when carried by sea.⁴

It is not possible to blame railways for the failure of an import substitution in peripheral markets. Spain's coal mines were protected by distance and the price of domestic coal was regulated by the price of English coal plus a transport mark-up. Perhaps a more direct railway routing between coalfields and the major markets of the periphery could have made substantial changes. Indeed, the length of the three railway lines laid between Asturias and Bilbao implied

1. Asturias sea borne coal was in 1897 10 per cent cheaper than English coal, see Report for the Consular district of Cadiz, (Parl. Papers, 1904, CI Pt I), p. 340.
2. A. Navarrete, op. cit., pp. 41-8, proposed a whole system of new railway tariffs subsidised by the State through higher customs duties. In this line, the 'Liga Marítima Española' asked for a 50 per cent reduction in rail rates from coalfields to coastal towns, see 'Informe y Proposiciones de la Liga Marítima Española a la Conferencia sobre Transportes por Ferrocarril' in A. Navarrete, op. cit., p. 53. and Hullera Nacional, 'Comunicación Dirigida al Excmo Sr Ministro de Fomento' in A. Navarrete, op. cit., p. 56.
3. J. Revilla, op. cit., pp. 189-90.
4. Both figures include differences in quality. For freight from Gijon to Barcelona, (Parl. Papers, 1906, CXXVIII), 574.

a 30 % saving in kilometres in contrast with the extremely roundabout Norte line. If the short railway link had been laid down before, Asturian coal could have been sold 11 per cent cheaper than English coal.¹

C). Railways and Non-Coal Minerals:

Spain's mineral ore deposits (iron, copper and lead) were attractive to English industrialists because they were rich in metallic content, could be easily mined and were located near the sea.²

In his economic history of Spain, Nadal saw railways as a partner of foreign capital in 'exploiting' the mineral wealth of Spain for the benefit of foreigners. He argued: 'export to the service of which the Spanish railway system was subjugated was mainly concerned with the products of mining'.³ In this section, I will argue for an alternative view, namely:

(a) that the massive export of mineral ores which started in the 1870's was promoted basically by the extremely favourable terms of the mineral concessions granted rather than by the construction of railways.

1. This alternative routing included 3 narrow gauge railway companies: The Compañía de los Ferrocarriles Económicos Asturianos, the Compañía del Ferrocarril Cantábrico and the Compañía de los Ferrocarriles de Santander a Bilbao. The argument assumes that there would have been only one company in order to avoid costly transshipments and that the rate charged was 0.02 pesetas per ton-km. of coal, see footnote number 6, page 243.
2. The main iron ore deposits were located within a short distance of the Bilbao river. For a good description, see W. Gill, "The Iron Ore District of Bilbao" JISI 1882, p. 63 and following. The main copper deposits were in Huelva, see S.G. Checkland, The Mines of Tharsis, Roman French and British Enterprises in Spain, (London, 1967). For lead, I will refer mainly to the districts of Almería and Cartagena in the Southeast, and Córdoba and Linares in South-central Spain.
3. Nadal, Fracaso, p. 48.

(b) that Nadal's prime example of lead mining in the Linares district is one of the few instances where distance from the coast made railways relevant to the argument.

(c) That the haulage of minerals accounted for only a small share in the output of the major railway companies and by no means all minerals carried by rail were exported.

The lack of cheap transportation was not a long standing obstacle to the development of the Spanish industry and mining progressed despite the absence of railways. The export trade in iron ore from Bilbao demonstrates that prosperity could be induced by changes in external demand.¹ High prices on the London market compensated easily for transportation charges which were in any case reduced by the short distances from the mines to the sea. In Bilbao, Huelva or Almeria, the best deposits were located close to the ports. But the transport costs were not unimportant and only the richer of Bilbao, Huelva or Almeria deposits or those closest to the sea were mined.² For example, in Huelva, transport costs amounted to 46 per cent of the value of magnesium ore, (fob).³ The haulage of the ore required large numbers of animals and carts and 'about one thousand donkeys are daily employed in carrying lead ore from the mines to the smelting works of Adra'.⁴ Ores at a greater distance from the sea were not exploited and it is clear that, without a sharp decrease in transport costs, the exploitation of the inland deposits of Badajoz, Córdoba or Linares was unreasonable. Thus, before the railway line was laid down between Córdoba and Jaen, mining in the rich lead district of Linares was in

1. See in particular M.W. Flinn, "British Steel and Spanish Ore: 1871-1914" Econ. Hist. Rev., 2nd. ser. VIII (1955), 84-90.
2. A mining report for Huelva stated for instance that within 7 leagues the metallic content of ores had to be exceptional and beyond that distance mining was impossible, see Estadística Minera for 1865, pp.72-3.
3. Ibidem.
4. Report for the Vice Consular District of Adra (Parl. Papers 1864, LXI), p. 346.

embryo.¹ With the coming of railways, large volumes of lead ore could be hauled to Córdoba, Cartagena or even to the more distant Rentería in the Basque country and coal could be supplied at low cost from the neighbouring Belmez coalfields.²

Mining was restricted by transport costs and the price of minerals on world markets. Within these limits, the low costs of raising Spanish ore compensated for high transport charges. The price of transportation became more important when mineral prices fell with the discovery of new deposits both in Spain and in other countries, or as Spain's most accessible deposits were depleted.

But in assessing the role of railways in the development of the minerals industry, a clear distinction should be made among the railway companies. On the one hand, there were the large railway companies with diversified services and output. On the other, were those small and highly specialised lines, often subsidiaries of mining concerns. These lines were laid down after the promulgation of the 1868 Mining Law which sought to attract capital from abroad by offering foreigners the rights to own Spanish mines.³ Of course, such lines carried large volumes of mineral ores to the ports. The output of the Tharsis mines was reported to increase rapidly after the construction of its railway line.⁴ And in 1875, the opening of a rail link from the Río Tinto mines caused a fall in the price of copper pyrites by nearly 50 per cent.⁵ Mineral lines were laid around Bilbao. By 1882, the five mile long Triano company moved a tonnage of iron ore amounting to 90 per cent of Norte's traffic in that year.⁶ But Triano supplied

1. See Estadística Minera for 1863, p. 22.

2. See Estadística Minera for 1869, p. 61.

3. For the implications of the 1868 Mining Law, see Nadal, Fracaso, pp. 90-5.

4. See Estadística Minera for 1869, p. 57.

5. See Estadística Minera for 1875, p. 56.

6. See P. de Alzola, "Ferrocarriles de vía ancha y vía estrecha", Revista de Obras Públicas (1884), p. 340.

11.5 million ton-kms. to the minerals sector, an output equivalent to a mere 3 per cent of Norte's total output for the same year.

Among the large nationwide railway companies, Norte supplied 7.5 million ton-kms. of non-coal mineral flows in 1878 or 2.8 per cent of its total output.¹ These minerals were carried at an average distance of 101 kilometres. The average haul was, however, boosted by the long distance flows of lead ore from the Linares district to the smelting works in Renteria. Excluding that flow, minerals travelled 31 kilometres around Norte's network. Non-coal minerals were never a high share of Norte's traffic. At their peak in 1906, mineral ores amounted to 6.6 per cent of the total tonnage and 2.2 per cent of output.²

While the distribution of these flows for 1878 reveals that only minerals hauled in the province of Santander wererexported. The rest were carried from Bilbao to the ironworks of Alava and Guipuzcoa. Moreover, Norte's records show that the haulage of non-coal minerals persisted as a local trade. Secondly, that only small volumes of minerals were exchanged interregionally. Indeed, the major districts (Guipuzcoa, Santander and Asturias) were self sufficient.³ Finally, Norte did not promote the development of mining districts unknown before the construction of railway lines. Outside Norte's network, the transportation of minerals was also a minor source of railway revenue.⁴ Minerals amounted to 6.3 per cent of the tonnage moved by MZA in 1878. In 1913, their share raised to 11.5 per cent but accounted for a mere five per cent of MZA receipts.⁵

1. Calculations based upon the information provided by Datos Estadísticos for 1878.
2. Output was calculated by assuming that the 1878 rate for non-coal minerals fluctuated according to Norte's freight rate index. The average haul for 1906 is 55 kms.
3. Self sufficient applies here only to railway traffic. Oviedo was, for instance, a net importer of seaborne Biscayan iron ore.
4. TBF, AVT, MZOV and Medina-Salamanca, Memorias.
5. MZA, Memorias, 1878 and 1913.

The connection between railways and the exploitation of Spanish minerals for the benefit of foreign interests has been over-emphasised because minerals would have been exported without railways. Spanish minerals were favourably located and were little transport intensive. However, as the best deposits were depleted, mining called for an improvement in transportation. Before that stage was reached, transport costs were not the only factor in the quantity exported. Given the level of transport costs, the volume exported depended on the world price. The expansion of world demand for mineral ores fostered the development of the Spanish mining industry.

The major networks were not responsible for bringing minerals to the coast. Minerals were carried by small lines constructed for that purpose by mining companies. Lumping railways together is to exaggerate the role of the major networks. For them, minerals were unimportant.

APPENDIX.

A Note on Railway Records.

A). Commodity Flows:

In Part III, I have made an extensive use of Norte's Datos Estadísticos to estimate commodity flows in the territory served by Norte, in order to describe interregional trade. This unpublished source of material displays the outgoing and ingoing shipments for every station along Norte's network over two periods of time: 1874-86 and 1901-30.¹ From 1882 to 1886, a similar set of data is available for Andaluces and MZA, though only for agricultural commodities.²

Since every railway company is a closed system, ingoing and outgoing traffic will be equal in volume:

$$\sum O_i + \sum W_i = \sum t_i + \sum \theta_i \quad \dots (i)$$

(i = 1, 2 ... n stations)

where O_i and W_i are outgoing shipments from non junction and junction stations respectively, and t_i and θ_i are ingoing shipments into non junction and junction stations. (i) can be written alternatively:-

$$\sum_{i=1}^n (O_i - t_i) = \sum_{i=1}^n (\theta_i - W_i) \quad \dots (ii)$$

and if railway stations are grouped in each province as:-

$$\sum_j \sum_i (O_{ij} - t_{ij}) = \sum_j \sum_i (\theta_{ij} - W_{ij}) \quad \dots (iii)$$

(j = 1, 2 ... p provinces)

1. Commodity traffic is classified in twenty groups.
2. See "Datos Estadísticos facilitados por la Compañía de Ferrocarriles Andaluces (MZA)", in Crisis, VII.

$\sum_{ij} (o_{ij} - t_{ij})$ reflects the balance of commodity trade for province j. The sum of these terms for all provinces is the 'balance of trade' of the territory served by Norte with the rest of Spain.

When the balance is positive, it implies that:-

$$\sum_i \sum_j o_{ij} > \sum_i \sum_j w_{ij}$$

that is, ingoing shipments at junctions exceed outgoing shipments and there is a net export of goods.

If the 'balance of trade' is positive (negative), I will define 'interregional trade' as the sum of all surplus (deficit) provincial flows.¹ The ratio of interregional trade to aggregate tonnage indicates the degree of commodity exchanges between provinces.

B). Estimates of Commodity Output:

Datos Estadísticos for the year 1878 provide a complete statement of the traffic flows among the 187 stations on Norte's network.² By multiplying the volume of the goods exchanged among trade partners by the rail distance between them, I was able to estimate the output in ton-kms. for some commodities. Some of these output estimates have been used in Part III.

1. In the event that outgoing traffic were totally consumed outside a province while ingoing traffic in a similar volume were imported from other provinces, 'interregional trade' would then fail to reflect the true interregional trade. This situation is, however, very unlikely to happen.
2. There are 187 matrices of 187 rows (one for each railway station) and 20 columns (one for each commodity group), totalling 700,000 entries.

TABLE 1.

Rail Output Estimates for the Major Commodities hauled by Norte in 1878.

	Tonnage	%	Output	%	Receipts	%	Average
	(000' T)		(10 ⁶ Tkm)		(10 ⁶ ptas)		Haul. (kms.)
1. Grain	274.6	18.9	57.7	21.2	5.44	19.5	210
2. Flour	167.2	11.5	33.1	12.2	3.74	13.4	198
3. Wine	142.3	9.8	28.2	10.4	2.84	10.1	198
4. Vinegar, Spirits	11.6	0.8	2.3	0.8			198
5. Coal	144.8	10.0	32.1	11.8	2.0	7.1	221
6. Charcoal	22.6	1.5	1.8	0.6			79
7. Minerals	74.4	5.1	7.5	2.8	0.4	1.5	101
8. Metals	74.9	5.2	20.6	7.6	1.9	6.7	275
9. Building materials	95.8	6.6	5.8	2.1	0.5	1.9	61
10. Textiles	40.2	2.8	10.2	3.7	1.8	6.4	254
11. Total Norte	1450.4		271.4		27.9		187

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Notes and Sources:

See text.

Calculations made from the evidence provided by Datos Estadísticos for 1878.

Rail distances as given in Renfe, Distancias Kilométricas (Madrid, 1944).

CONCLUSIONS.

The active encouragement of railway construction by Spanish governments in the mid 19th century has attracted a great deal of critical attention from economic historians. They argued that a higher rate of economic development could have been attained if industry had been supported by the state in the way that it helped railways. Improvements in transportation, so the argument runs, would have followed industrial expansion because modern industry called for a cheap and continuous flow of transport services. But, by building ahead of demand and attracting scarce capital funds into social overhead capital, the state probably hindered the development of agriculture and industry. Moreover, the construction of railways in advance of demand could not stimulate industrial growth because the country was too backward to grasp the potential benefits from railways. Several economic historians of Spain share the view that gains from railways were extremely limited because the railway companies were permitted to import all the material they required free from customs duties.

My estimates on the derived demand for railroad iron and coal show, however, that domestic output of pig iron should have increased by 120 per cent over the first construction boom in order to have matched demand for iron from railways. Similarly, coal output in the Asturian district, where the iron industry would presumably have located itself, had to increase by 129 per cent between 1855 and 1864. Furthermore, on their premises, in order to sustain the rate of railway construction, capacity in the iron industry had to be enlarged 12-fold

in just ten years. But Spain's iron industry was too small in 1855 and its production and techniques too backward to allow for such an expansion of capacity on that scale. My calculations support the view that protection of the local iron industry could have severely delayed the extension of the railway network. Traditional transport could no longer cope with the expansion in demand for its services. That type of transport depended upon the release of labour and animals from agriculture. Its seasonality and high costs simply could not serve the requirements of more rapid development. The bottleneck in transport was serious because the supply of other forms of transport (internal waterways and improved highways) was restricted by a hostile topography.

I set out to ascertain the importance of railways by estimating the costs involved by not constructing the network. Social savings seemed to be the appropriate methodology to grasp the benefits derived from railroad operation; although some of the assumptions involved are strong and perhaps restrictive. By multiplying volume of transport services by the difference in unit transport costs for alternative means of transport, social savings measures the loss to the economy from the shutdown of railways for one year. In Spain, freight traffic would have been mainly re-allocated onto the roads, and only a small share would have been taken over by coastal trade and canals. The monetary cost reduction effected by railways was one to nine compared to overland transportation, but using the railway companies internal freight rate as a proxy for marginal costs, it was found that the real cost reduction was overwhelming, about one to 36.

The shutdown of the railway network for one year in 1878 could, on this methodology, have entailed losses for the economy amounting

to 12 per cent of Spain's national income. An alternative estimate indicated that railways made possible the re-allocation of up to 43 per cent of arable land to the cultivation of bread grains. At a time of demographic pressure, and when increase in agricultural output emanated from the expansion of the margin of cultivation rather than from productivity gains, the contribution of railways seems impressive.

Compared to other social savings estimates, railways were very important in Spain: resource saving from American railroads in 1859 amounted to four per cent of gross national product and to 4.7 per cent by 1890; benefits accruing from English railways accounted for four per cent of national income in 1865. In Germany, Fremdling suggested that direct benefits stemming from railway operation might exceed five per cent of gross national product at the end of the 19th century. And the freight social savings on Tsarist railways accounted for 4.6 per cent in 1907.¹ On the other hand, Coatsworth put savings from railways at around 38 per cent of Mexico's gross national product in 1910.² This last estimate is comparable to my own for 1912 which amounts to 18.5 to 23 per cent of Spain's national income for that year.

How can we explain such national differences? Railways were important in Mexico and Spain because the two countries lacked cheap

1. For social savings from American railways in 1859 see A. Fishlow, American Railroads and the Transformation of the Ante-Bellum Economy (Cambridge, Mass., 1965), p. 52; for 1890, see R.W. Fogel, Railroads and American Economic Growth (Baltimore, 1964), p. 223; for England, see G.R. Hawke, Railways and Economic Growth in England and Wales, 1840-1870 (Oxford, 1970), p. 196; for Tsarist railways, see J. Metzger, "Railroads in Tsarist Russia: Direct Gains and Implications", Explorations in Economic History (1976), 96.
2. J.H. Coatsworth, "Indispensable Railroads in a Backward economy: the case of Mexico", JEH XXXIX (1979), 948.

waterways as alternatives to road transport. Whereas in England, Germany, Russia and the U.S.A., rivers and developments in canal construction had already generated important cost reductions from the close of the 18th century. In these countries, railways came at the end of a long process initiated by improved inland navigation. In Spain and Mexico, that intermediate stage between inefficient road transportation and railways did not occur.

However, is it possible to reconcile such high social savings with low rates of economic growth? The explanation for this paradox seems to lie in the fact that in Spain factors of production might have been underemployed to a larger extent than elsewhere. Social savings reflect a loss in social output only when all factors of production are fully employed. If some factors are otherwise idle, the shutdown of the railway network may result in a loss of leisure time and will not affect production. Beasts of burden and men were indeed underemployed in Spain for at least four months of each year. Because their primary occupations were in agriculture, their employment in transport provided only a secondary source of income, but their fixed costs of transportation were, under this system, shared with agriculture. If part-time cultivators decided to engage in transportation, their 'real' costs would include the extra feed required by animals while working instead of resting. I decided, therefore, to investigate alternatives to the original definitions of social savings and they have been set out in Table 1.

TABLE 1.

Social Savings from Spanish Railways, 1878 (10^6 pesetas and %).

	(1) Social Saving	(2) % national Y
Real Cost Reduction	516.4	11.8
Monetary Cost Reduction	459.6	10.5
Intermediate Solution	326.0	7.5
Inventory Solution	40.0	1.0

Notes and Sources: (Table 1.)

- Row 1 : Social savings using an internal rate for railway transport from Table 3, row 3, p. 69.
Row 2 : Social savings using railways average freight rate from Table 3, row 2, p. 69.
Row 3 : See p. 89.
Row 4 : See p. 88.

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The difference between the 'intermediate' and 'inventory' solution is that the former posits that the freight traffic hypothetically re-allocated onto the roads would have been taken over by part-time hauliers for four months each year, while professional carriers would have supplied transportation services for the rest of the time. And peasants would charge marginally lower rates for their services than professional carriers.

The 'inventory' solution was rejected on grounds that no modern economy could operate with such seasonality in the organisation of transport. The indirect costs in the form of fixed capital tied up in stocks would exceed the low costs of a peasant transport system. I attempted to measure the number of days when draught animals and men were underemployed in agriculture but this estimate is a very inadequate indicator of the actual or potential volume of transport supplied by peasants. When the railways substituted for road transport, they prompted an increase in the demand for transport to move goods to and from railway stations. If underemployed peasants had failed to provide sufficient services to meet the additional demand, producers would have faced increasing marginal costs. In this case, the 'inventory' estimate in Table 1 becomes a lower bound.

The 'intermediate' solution (which is in fact a mix of professional carters and peasant hauliers) seemed to be more plausible because the assumptions of this solution did not require the holding by producers and consumers of large stocks of raw materials and final

products.

But, despite the presence in Spain of large numbers of seasonally underemployed peasants and beasts of burden, there can be no presumption that even if they had been used in some combination with professional carters, the overall price of traditional transport would have declined by a significant percentage because during the growing season peasants would have charged their full opportunity costs. Thus, the 'inventory' solution seems to be an entirely implausible estimate and the real social saving derivable from the use of traditional resources was probably closer to 7.5 per cent.

Finally, the contribution of railways should be modified taking into account the interest paid by railway companies to foreign creditors. In 1878, the two leading railway companies paid up to 50 million pesetas interest. In that same year, they carried 72 per cent of the freight output carried by Spanish railways. It is, therefore, possible to conclude that foreign investment boosted Spain's national income by no less than 6.8 per cent.¹ Thus, the gains which accrued to the Spanish economy from foreign investment in railways were far higher than the price she paid to foreigners for financing their construction. As some historians suggest, foreigners did not 'exploit' Spain by investing in the country's railways.

The protectionist model of Spanish economic development supported by Nadal and other economic historians would have delayed railway construction. Given the backwardness of the Spanish economy, the expansion of the iron industry would not have generated extensive

1. In the 1870's, 60 per cent of the capital of railway companies was held by foreigners, see P. Tedde, "Las Compañías Ferroviarias en España (1855-1935)", loc. cit., II, pp. 38-43. Thus, transfers to France totalled 30 million pesetas. Gains from railways accruing to Spaniards amounted to a lower bound of 296 million pesetas or 6.8 per cent of national income.

externalities for the rest of Spanish industry. Instead, it seems to me more likely that the iron industry could have been saddled with an excess capacity of up to 60 per cent after 1865.

Fremdling has shown that at the start of railway construction in the 1830's, the German iron industry was also relatively backward. None the less, in 1837 its pig iron output was seven times higher than Spanish production in 1855. Between 1837 and 1865, railway expansion in Germany was accompanied by an eight-fold increase in the capacity of her iron industry. The notion that Spain could have created a modern iron industry in less time than Germany seems quite implausible.

The shares of iron and steel output delivered to railways certainly increased after protection had been instituted in the 1890's. But only 4.3 per cent of pig iron output and 9.5 per cent of steel output went into rail manufacture (compared with Germany where, in the 1840's, railways absorbed 30 per cent of pig iron output).¹ Neither in Spain nor elsewhere did the derived demand from railways support linkages posited by Rostow between railways and the growth of the modern iron industry. In Spain, the influence of railways on the initial growth of the steel industry was weaker than in Germany. Though important, railways were just one more sector. And to place the feedbacks from railways in a proper perspective, we need research on the feedbacks from shipbuilding and urban construction to the iron industry. Meanwhile, my estimates seem to qualify the exaggerated claims for the so called 'lost opportunity' to develop a modern iron industry in the 1850's. Although Spain was well endowed with iron

1. R. Fremdling, "Railroads and German Economic Growth: A leading sector analysis with a comparison to the United States and Great Britain", JEH XXVII (1977), Table 3, p. 590.

deposits, the economy was deficient in coal of good quality for the manufacture of coke and lacked technical expertise. Furthermore, while the success of the import substitution policy of the 1890's was only partial, perhaps something could have been done to follow the German example and foster the development of the bar iron industry. For example, while the British iron industry enjoyed a strong comparative advantage based on cheap and good quality coke, it may well have paid Spain to liberalize the import trade of coke pig iron while protecting its rolling mills. As the market for iron products expanded and fuel requirements in iron manufacturing declined, a gradual protection of the local iron industry in the first stages of iron production might well have promoted its steady growth in the long run. In any case, the railways did a lot to stimulate the growth of the Spanish coal industry.

My research also investigated the impact of railways on the widening of the market and patterns of internal trade. For this exercise, I faced serious data problems. Evidence on the commercial exchanges before the advent of railways is slim and railway records (which could add to our knowledge of the markets), although extremely good for Norte, are scanty for the remaining companies.

By cutting transportation costs by a factor of nine and releasing internal communications from the restraint of seasonality, railways afforded Spanish producers greater opportunities to market their surpluses. They led to an integration of the home market. My research has shown that railways increased the commercialisation of trades in coal, flour, wheat and wine, that the radial shape of the network matched the requirements of internal trade and finally that railways exerted only slight influence on the initial spurt in wine and mineral ore exports.

Table 2 which amalgamates the tabulation of chapters five, six and seven shows how the share of domestic consumption of grain, wine and coal carried on trains increased over the period 1882-1913. In all cases, the process was accompanied by long distance shipments from the surplus areas of the interior of Spain to the deficit areas of the periphery. For example, railways opened up new coalfields, extended the margin of cultivation and the area under vineyards in Central Spain. New trade was created for the mines of Central Spain to supply local markets with coal as a substitute for charcoal and imported coal. The process was even more spectacular for the case of wine where railways assisted internal demand to provide the necessary substitution for foreign demand when the French vineyards were restored to their pre-Phylloxera levels of output. The table shows how the commercialisation of the grain, flour and coal markets developed rapidly under the impact of protection in the 1890's.

TABLE 2.

The Commercialisation of Grain, Flour, Wine and Coal by Rail, 1882-1913.

Year	Grain	Flour	Wine	Coal	Year
1882	25	16		13.8	1865/74
1886	22	16	10	28.5	1875/84
1901	24	18	33	33.8	1885/94
1905	32	32	52	43.5	1895/04
1909	31	28	69	46.3	1905/13
1913	47	34	65		

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Notes and Sources:

- Column 1: The share of the domestic consumption of wheat carried by railways, see Table 1A, p.187.
Column 2: The share of the domestic consumption of flour carried by railways, see Table 1B, p.189.
Column 3: The share of the domestic consumption of wine carried by railways, see Table 3, p.226.
Column 4: The share of the domestic consumption of coal carried by railways, see Table 1, p.234.

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In the 1880's, domestic coal and grain were uncompetitive at the periphery because production costs at the core were too high. In these conditions, railways made little difference. But when tariffs were levied in the 1890's, railways contributed to the process of import substitution by hauling large volumes of coal and grain from Central Spain at costs well below those obtainable by road. Without established railways, a much higher protection of the domestic grain would have been required to allow domestic grain to be sold at the periphery. The 'success' of import substitution (if indeed it can be seen as a success) depended critically on the railways.

The analysis of internal trade flows suggest that railways met the requirements of the Spanish economy although the lines have been criticised in the textbooks as being too 'roundabout'. But technical as well as economic reasons determined the routes taken by these lines.¹ The theory that foreign railways served as an instrument for the exploitation of Spanish mineral wealth seems not to be valid. Evidence on commodity flows suggest that minerals accounted for only a small share of railway traffic and the cost reduction effects on the haulage of mineral ores was probably insignificant. Even on the unrealistic assumption that all the ores carried by rail were for export rather than for internal consumption, only a tiny proportion of my estimated social savings from railways was exported in the form of ores, thus accruing gains to foreigners rather than Spaniards.

1. Nevertheless, there is a point to this argument because a direct line between the Asturian coalfields and Bilbao would have prompted coal import substitution before it actually happened.

The export statistics show that mineral ores and wines were exported before the advent of railways. The original spurt in these exports was caused by an expansion in world demand which boosted world prices and compensated for high transport costs in Spain. The export of ores and wine probably would have proceeded later in the century without the assistance of railways because the major vineyards and mineral ore deposits were located at short distances from the coast.

My thesis has concentrated on those aspects of railway development which seemed particularly relevant in the light of recent research on the role of railways in economic growth. There are, however, many other aspects where railways made undoubted contributions to economic growth which still need to be investigated. For example, they created employment for large numbers of unskilled workers in the course of their construction. And their expenditures boosted consumption which gave rise to the familiar multiplier effects on the trade and cycles of the Spanish economy. Their relationship with government and the development of the capital market has been well investigated.¹ Another important factor which still requires attention is the pricing policy of railways and its effect on location patterns, regional specialisation and the commercialisation of agriculture and industry.

While the central hypothesis of my thesis is that railways were important for the growth of the Spanish economy in the period 1855 to the Great War, in no way does it contradict the view that industrialisation proceeded all too slowly in 19th century Spain. Railways were but one ingredient in a long chain of factors which affect economic growth.

1. See P. Tedde, op. cit.,

But the level of economic development attained by the Spanish economy and the incomes of its people at the close of the century would have been definitely lower had railways not been laid down in 1855.

APPENDIX.

Carting Prices.

Province: Alava.

From	To	Kms.	Price	Rate	Class
La Puebla de labarca	Fuenmayor	3	.06 ^P /a	1.3284	1
Elciego87	Cenicero	4	.12 ^P /a	1.9926	1
Oyon	Logrono	6	.70 ^P /d	1.2681	2
Labastida	Haro	8	.75 ^P /d	1.0910	2
Amurrio	Railway	9	1.12 ^P /d	1.3526	2
Banos de Ebro	San Asensio	10	1.50 ^P /d	1.63044	2
Moreda	Logrono	10	1.12 ^P /d	1.2174	2
Navaridas	Railway	10	.78 ^P /d	0.8478	2
Laguardia	Cenicero	12	1.00 ^P /d	0.9158	2
Leza	Cenicero	12	.12 ^P /a	0.6919	2
Samaniego	Briones	12	1.14 ^P /d	1.0326	2
Barriobusto	Logrono	15	.75 ^P /a	3.3209	1
Villabuena	Briones	15	1.50 ^P /d	1.0869	2
Elvillar	Logrono	16	.25 ^P /a	1.0378	1
Lanciego	Logrono	16	1.50 ^P /d	1.0190	2
Oguendo	Areta	16	3.00 ^P /d	2.0380	2
Paganos	Railway	18	.75 ^P /d	0.4529	2
Banos de Ebro	San Vicente	20	2.25 ^P /d	1.2228	2

Source: Información Vinícola, file no. 79, 79-2.

Province: Albacete.

Fuensanta	La Roda	9	.12 ^P /c	0.9435	2
Villagordo del Jucar	La Roda	16	.13 ^P /c	0.5520	2
Valdeganga	Albacete	23	1.00 ^P /d	0.4726	2
Tarazona	La Gineta	23	2.00 ^P /d	0.9452	2
Carcelen	Alpera	26	2.25 ^P /d	0.9406	2
Motilleja	La Gineta	31	2.25 ^P /d	0.7889	2
Mahora	La Gineta	34	1.80 ^P /d	0.5754	2
Madrigueras	La Gineta	37	.37 ^P /c	0.6885	2
Alcala	Alpera	39	5.15 ^P /d	1.4353	2

From	To	Kms.	Price	Rate	Class
Navas de Jorquera	Albacete	39	2.00 ^P /d	0.5574	2
Fuente Albilla	Albacete	42	3.1 ^P /d	0.8023	2
Jorquera	Albacete	47	3.5 ^P /d	0.8094	2
La Recueja	Railway	47	.25 ^P /d	0.3613	2
Villaniolia	Albacete	49	.50 ^P /c	0.6932	2
Casas de Ves	Albacete	60	.62 ^P /c	0.7020	2

Source: op. cit., file no. 79.

Province: Almeria.

Adra	Almeria	59	.75 ^P /c	0.8635	1
Adra	Almeria	59	.50 ^P /c	0.5757	2
Alcolea	Almeria	79	2.00 ^P /d	0.2752	1

Source: op. cit., file no. 80-2.

Province: Avila.

Cebreros	La Canada	21	2.50 ^P /d	1.2940	2

Source: op. cit., file no. 80-3.

Province: Badajoz.

Guarena	Railway	4	.50 ^P /d	1.3587	2
Villalba	Railway	14	.13 ^P /f	1.0093	2
Jerez de los Cab.	Zafra	38	.50 ^P /e	0.8939	2
Siruela	Railway	40	.37 ^P /g	0.8409	2

Source: op. cit., file no. 81-2.

Province: Burgos.

Valcavado de Roa	Valladolid	64	.50 ^P /a	0.6022	2
Roa	Venta de Banos	65	.50 ^P /a	0.593	2
Sotillo de Ribera	Burgos	66	.90 ^P /a	1.0512	1
Fuentelizando	Valladolid	70	.50 ^P /a	0.5506	2
Horra	Valladolid	71	3.75 ^P /d	0.5741	2

From	To	Kms	Price	Rate	Class
<u>(Province: Burgos contd...)</u>					
Valdezote	Valladolid	74	.50 ^P /a	0.5209	2
Fuentecen	Valladolid	75	.50 ^P /a	0.5139	2
Adrada de Haza	Valladolid	80	.75 ^P /b	0.6317	2
Aranda	Burgos	80	3.00 ^P /d	0.4076	2

Source: op. cit., file no. 81-4.

Province: Cáceres.

Casas de Millan	Canaveral	5	.50 ^P /d	1.0869	2
Berrocalejo	La Calzada	11	2.00 ^P /d	1.9763	1
Valdelocasa	Navalmoral	18	.75 ^P /d	0.4529	2
Posaron	Railway	18	.50 ^P /a	1.9375	1
Morcilla	Mirabel	18	.50 ^P /a	1.9375	1
Torrejoncillo	Canaveral	18	.30 ^P /e	1.1988	1
Tormo	Malpartida	22	.50 ^P /a	1.4531	1
Montanchez	Railway	23	.62 ^P /e	1.8313	1
Torremenga	Railway	25	.59 ^P /a	1.5089	1
Miajadas	Railway	32	.25 ^P /c	0.5307	2
Valdestillas	Railway	33	5.00 ^P /h	1.3724	1
Cabrero	Railway	33	5.00 ^P /h	1.3724	1
Cabezuela	Plasencia	33	6.00 ^P /d	1.9762	1
Piornal	Railway	37	4.50 ^P /h	1.1016	1
Jerte	Piedrahita	52	.75 ^P /a	0.9222	1
Perales	Canaveral	53	.50 ^P /d	0.6032	1
Cilleras		59	6.00 ^P /d	1.1054	1
Navalvillar	Navalmoral	60	1.00 ^P /b	1.0694	1
Cadalso	Canaveral	78	5.00 ^P /d	0.6967	2

Source: op. cit., file no. 82.

Province: Cádiz.

San Lucar	Railway	2	.62 ^P /i	0.6583	2
Chiclana	Partibas	2	1.50 ^P /i	2.1065	2
Chipriona	San Lucar	8	5.00 ^P /i	1.3165	2
Chiclana	San Fernando	10	6.25 ^P /i	1.3165	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Cádiz contd...)</u>					
Chiclana	Cádiz		10.00 ^P /i	1.5922	2
Rota	Jerez	27	7.50 ^P /i	0.5851	2
Villamartin	Jerez	54	.50 ^P /e	0.6290	2

Source: op. cit., file no. 82-2.

Province: Castellon.

Peñiscola	Benicarló	8	.10 ^P /f	1.3587	2
Pavias	Candiel	12	.12 ^P /f	1.0869	1
San Jorge	Vinaroz	14	.06 ^P /f	0.4658	2
Cervera	Benicarlo	16	.10 ^P /f	0.6793	2
Ayodar	Onda	16	.25 ^P /b	1.0615	2
Lucena	Castellon	33	.25 ^P /c	0.5105	2
Torralba	Villareal	35	3.75 ^P /d	1.1646	1
Toras	Valencia	75	.50 ^P /b	0.6274	2

Source: op. cit., file no. 83-2.

Province: Córdoba.

Montilla	Railway	3	1.25 ^P /6d	0.7548	2
Villanueva rio	Belmez	10	.25 ^P /c	1.6661	1
Villaviciosa	Alhondiguilla	12	1.25 ^P /d	1.1322	2
Monturque	Aguilar	13	.12 ^P /c	0.6408	2
Lucena	Aguilar	25	.19 ^P /c	0.5065	2
Baena	Montilla	35	.25 ^P /c	0.4760	2
Zuheras	Aguilar	39	.75 ^P /c	1.2816	1

Source: op. cit., file no. 83-4.

Province: Ciudad Real.

Valdepeñas	Railway	3	.06 ^P /2f	1.0869	2
Miguelturra	Railway	3	.40 ^P /d	1.4493	2
Tomelloso	Argasilla	9	4.50 ^P /6d	0.8361	2
Piedrabuena	Poblete	24	.20 ^P /c	0.5907	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Ciudad Real contd...)</u>					
Daimiel	Almagro	24	.07 ^P /f	0.3397	2
Villanueva	Valdepeñas	29	.25 ^P /c	0.5856	2
<u>Source: op. cit., file no. 83-3.</u>					
<u>Province: Granada.</u>					
Padul	Granada	18	.13 ^P /c	0.4781	2
Pinos del Rey	Granada	42	.75 ^P /c	1.1821	1
<u>Source: op. cit., file no. 83-8.</u>					
<u>Province: Guadalajara.</u>					
Horche	Guadalajara	16	.25 ^P /c	1.0343	2
Romanoncos	Guadalajara	30	.50 ^P /c	1.1033	2
Pastrana	Guadalajara	49	.60 ^P /c	0.8106	2
Sacedon	Guadalajara	66	.87 ^P /c	0.8776	2
<u>Source: op. cit., file no. 84-1.</u>					
<u>Province: Huelva.</u>					
La Palma	Railway	2	.25 ^P /d	1.3587	2
Paterna	Railway	3	2.00 ^P /i	1.4043	2
Chicena	Escacena	4	2.50 ^P /i	1.3165	1
Moguer	San Luceni	4	.75 ^P /d	1.8115	1
Boluellas	La Palma	5	3.00 ^P /i	1.1490	2
Bonares	Niebla	5	2.50 ^P /i	1.0719	2
Villalba de Alcor	Railway	7	1.00 ^P /i	0.3105	2
Trigueros	Railway	7	1.50 ^P /j	0.2143	2
Rociana	Railway	9	1.00 ^P /d	1.2077	1
Lucena	Railway	9	1.00 ^P /d	1.2077	1
Palos	Railway	9	1.00 ^P /d	1.2077	1
Gibraleon	Huelva	14	.75 ^P /k	0.5357	2
Almonte	Boluellas	15	7.5 ^P /i	1.0532	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Huelva contd...)</u>					
Zalamea		26	.19 ^P /c	0.4899	1
Villanueva	Cartaya	29	.50 ^P /c	1.1713	2
Villanueva	Huelva	45	.75 ^P /c	1.1322	2
La Palma	Huelva	46	1.75 ^P /d	0.4125	2
Rosal de la Front.	Tharsis	48	.75 ^P /c	1.0615	1

Source: op. cit., file no. 84-3.

Province: Huesca.

El Tomillo	Railway	4	1.00 ^P /l	1.6983	1
Lastanosa	Railway	8	2.00 ^P /l	1.6983	1
Peralta de Alcolea	Railway	13	2.50 ^P /l	1.3064	1
Alcubierre	Grañen	18	1.25 ^P /d	0.7548	2
Angues	Huesca	23	2.50 ^P /l	0.7384	2
Estadilla	Barbastro	25	1.50 ^P /d		
Almudevar	Huesca	28	2.00 ^P /l	0.4852	2
Ayerbe	Huesca	29	1.75 ^P /d	0.6559	2
Adalmesca	Huesca	38	5.00 ^P /d	1.4302	1
Alquezar	Railway	41	6.00 ^P /d	1.5907	1
Castejon	Barbastro	52	.37 ^P /c	0.4834	2
Abizanda	Barbastro	56	5.00 ^P /d	0.97	1
Boltana	Barbastro	72	.75 ^P /c	0.7076	2

Source: op. cit., file no. 84-4.

Province: Jaen.

Ubeda	Baeza	20	.15 ^P /c	0.5095	2
Torreperagil	Baeza	31	.50 ^P /c	0.9739	2
Valdepeñas	Jaen	35	.34 ^P /c	0.5866	2
Santiesteban	Vilches	36	.25 ^P /c	0.4193	2
Villacarrillo	Baeza	53	.50 ^P /c	0.5697	2
Villanueva	Baeza	63	.37 ^P /k	0.5873	2
Cazorla	Baeza	76	.80 ^P /c	0.7133	2

Source: op. cit., file no. 84-5.

From	To	Kms.	Price	Rate	Class
<u>Province: Madrid.</u>					
Colmenar de Oreja	Aranjuez	23	.25 ^P /c	0.7248	2
Colmenar de Oreja	Madrid	40	.25 ^P /c	0.4168	2
Carabana	Vallecas	44	3.00 ^P /d	0.7411	2

Source: op. cit., file no. 85-3.

Province: Murcia.

Moratalla	Calasparra	23	.15 ^P /c	0.4544	2
Fuentealamo	Cartagena	30	.50 ^P /c	1.1613	1
Caravaca	Calasparra	32	.25 ^P /c	0.5443	2
Jumilla	Railway	33	.40 ^P /c	0.8445	2

Source: op. cit., file no. 85-5.

Province: Navarra.

Murchante	Tudela	7	.42 ^P /d	0.6522	2
Funes	Marcilla	7	.85 ^P /d	1.32	1
Anorbe	Biurrun	7	1.02 ^P /d	1.5838	1
Peralta	Marcilla	8	.51 ^P /d	0.6929	2
Brunuel	Ribaforada	9	.42 ^P /d	0.5072	2
Cascante	Tudela	9	1.02 ^P /d	1.2319	2
Corella	Alfaro	10	1.02 ^P /d	1.1087	2
Falces	Marcilla	10	.85 ^P /d	0.9239	2
San Martin		10	1.02 ^P /d	1.1087	2
Viana	Logrono	11	1.53 ^P /d	1.5118	1
Ablitas	Tudela	11	.85 ^P /d	0.84 ^P /d	2
Cintruenigo	Alfaro	13	1.02 ^P /d	0.8528	2
Obanos	Biurrun	13	1.02 ^P /d	0.8528	2
Artajona	Tafalla	15	1.27 ^P /d	0.9208	2
Artazu		15	1.02 ^P /d	0.7391	2
Puente de la Reina	Biurrun	15	1.02 ^P /d	0.7391	2
Lerin	Lodosa	18	1.75 ^P /d	1.0567	2
Medigorria		19	1.10 ^P /d	0.6293	2
Fitero	Tudela	21	1.02 ^P /d	0.5279	2
Dicastillo	Lodosa	25	2.12 ^P /d	0.9217	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Navarra contd....)</u>					
Allo	Lodosa	28	1.27 ^P /d	0.493	2
Ciraqui	Pamplona	30	2.12 ^P /d	0.7681	2
Estella	Lodosa	38	2.92 ^P /d	0.8352	2

Source: op. cit., file no. 85-6.

Province: Orense.

Cortegada	Filqueira		9.00 ^P /m		
Orense	Railway	4	.75 ^P /n	1.5798	2
Beade	Rivadavia	5	7.00 ^P /m ³	1.5217	2
Castelo de Mino	Railway	5	7.00 ^P /m	1.6847	2
Leiro	Santiago	88	35.00 ^P /n	1.6756	1

Source: op. cit., file no. 85-7.

Province: Oviedo.

Cangas	Trubia	80	8.00 ^P /d	1.0869	2
Cangas	Luarca	83	6.00 ^P /d	0.7857	2

Source: op. cit., file no. 85-8.

Province: Pontevedra.

La Caniza	Railway	9	6.00 ^P /5d7	1.4493	2
Puenteareas	Salvatierra	11	5.00 ^P /m	0.9575	2
Caldas	Pontevedra	20	4.00 ^P /k7	0.	2

Source: op. cit., file no. 85-10.

Province: Sevilla.

Paradas	Osuna	4	1,25 ^P /i	0.6583	2
Pilas	Analcazar	5	2.50 ^P /i	1.0532	2
Cantillana	Tocina	11	.25 ^P /c	1.5775	1
Espartinas	Sevilla	13	1.00 ^P /d	0.8361	2
Villanueva	Sevilla	14	1.75 ^P /d	1.3587	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Sevilla contd...)</u>					
Villafranca	Dos Hermanas	15	1.50 ^P /d	1.0869	2
Umbreta	Sevilla	16	1.00 ^P /d	0.6793	2
Montellano	Utrera	31	3.00 ^P /d	1.0518	2
Navas	Cazalla	34	1.00 ^P /c	2.04	1

Source: op. cit., file no. 85-14.

Province: Teruel.

Baguena	Calatayud	47	3.00 ^P /d	0.6938	2
Burbaguena	Calatayud	50	2.50 ^P /d	0.5435	2
Alcorisa	Azaila	54	1.25 ^P /b	1.1478	1
Sarrion	Sagunto	85	5.00 ^P /d	0.6394	2
Sarrion	Sagunto	110	2.00 ^P /d	0.1976	2
San Martin	Valencia	110	3.50 ^P /d	0.3458	2
Sarrion	Calatayud	164	6.00 ^P /d	0.3977	2

Source: op. cit., file no. 86-3.

Province: Toledo.

Orgaz	Mora	7	.12 ^P /c	0.8715	2
Mora	Railway	3	.37 ^P /d	1.3405	2
Sonseca	Mascaraque	13	.84 ^P /d	0.7023	2
Villafranca	Alcazar	14	.14 ^P /e	0.6793	2
Quintanar	Villacanas	26	.25 ^P /e	0.6532	2
Madridejos	Tembleque	26	.25 ^P /c	0.6532	2
Villanueva	Villacañas	40	.25 ^P /c	0.4246	2

Source: op. cit., file no. 86-4.

Province: Valladolid.

Rodilana	Railway	3	.05 ^P /b	0.8809	2
Cisterniga	Valladolid	6	.75 ^P /d	1.3587	2
Arroyo	Valladolid	7	1.00 ^P /d	1.5528	2

From	To	Kms.	Price	Rate	Class
<u>(Province: Valladolid contd...)</u>					
La Seca	Pozaldez	8	.12 ^P /a	1.0425	2
Fuensaldana	Valladolid	9	.10 ^P /b	0.7567	2
7 Iglesias	Venta de Pollos	14	.80 ^P /d	0.6211	2
Villanueva	Valdestillas	15	.75 ^P /d	0.5435	2
Tardehumos	Rioseco	12	.10 ^P /a	0.5791	2
Rueda	Medina	13	.25 ^P /e	1.3064	2
Villavieja	Venta	17	.12 ^P /b	0.4807	2
Geria	Valladolid	18	.12 ^P /b	0.4540	2
Tiedra	Toro	18	.12 ^P /c	0.4492	2
Pina	Valladolid	22	.25 ^P /b	0.7739	2
Mota	Toro	25	3.00 ^P /d	1.3043	2
Villalba	Valladolid	27	4.00 ^P /d	1.6103	1
Sardon	Valladolid	27	1.00 ^P /d	0.4026	2
Quintanilla	Valladolid	35	.25 ^P /c	0.4813	2
Quintanilla abajo	Valladolid	47	1.55 ^P /d	0.3585	2
Bociles	Railway	50	3.00 ^P /d	0.6522	2
Palacios	Palencia	58	.50 ^P /b	0.5871	2
Peñafiel	Valladolid	65	.37 ^P /5b	0.7753	2

Source: op. cit., file no. 87-44, 87.

Province: Zaragoza.

Purroy	Moras	3	1.00 ^P /o	3.0193	1
Mallen	Cortes	33	2.00 ^P /T	1.000	2
Pleitas	Railway	4			
Pinseque	La Joyosa	6	1.25 ^P /d	2.2645	1
Olves	Calatayud	6	1.50 ^P /d	2.7174	1
Vallones	Terrer	5	.75 ^P /d	1.6304	1
Carinena	Railway	8	.50 ^P /d	0.6793	2
Maluenda	Calatayud	8	1.00 ^P /o	0.8832	2
Tauste	Gallur	8	1.00 ^P /o	0.8832	2
Villalba	Calatayud	8	1.50 ^P /d	2.038	1
Moros	Ateca	11	1.25 ^P /o	1.0293	1
Villamayor	Zaragoza	11	1.00 ^P /1.5d	0.6587	2
Malon	Tudela	12	1.00 ^P /d	0.9057	2
San Martin	Tarazona	12	1.30 ^P /d	1.1775	1

From	To	Kms.	Price	Rate	Class
<u>(Province: Zaragoza contd...)</u>					
Peñaflor	Zuera	13	1.20 ^P /d	1.000	1
Mora	Calatayud	15	1.50 ^P /d	1.0869	1
Novallos	Tudela	18	1.00 ^P /d	0.6038	2
Embid	Ariza	18	3.70 ^P /d	2.2343	1
Miedes	Calatayud	19	.75 ^P /d	0.429	2
Malegon	Gallur	20	1.25 ^P /d	0.6793	2
Oreja	Railway	20	2.50 ^P /o	1.1322	1
Ruesca	Calatayud	20	2.00 ^P /d	1.0869	2
Torrijo	Ateca	20	2.63 ^P /d	1.4293	1
Tarazona	Tudela	22	25.00 ^P /30d	0.4117	2
Tarazona	Tudela	22	1.00 ^P /d	0.4941	2
Tobed	Morata	22	2.00 ^P /d	0.9881	1
Monterde	Ateca	25	2.50 ^P /d	1.0869	1
Paniza	Zaragoza	43	2.65 ^P /o	0.5582	2
Orcajo	Calatayud	48	3.00 ^P /d	1.472	1
Villanueva	Calatayud	46	2.00 ^P /d	0.4726	2
Sadaba	Gallur	58	3.70 ^P /d	0.6934	2
Sos	Gallur	86	.50 ^P /c	0.3918	2
Villanueva	Zaragoza	92	4.00 ^P /d	0.4726	2

Source: op. cit., file no. 88-2, 88-3, 89.

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Notes and Sources:

Class (1) refers to Beasts of Burden.
Class (2) refers to Waggon.

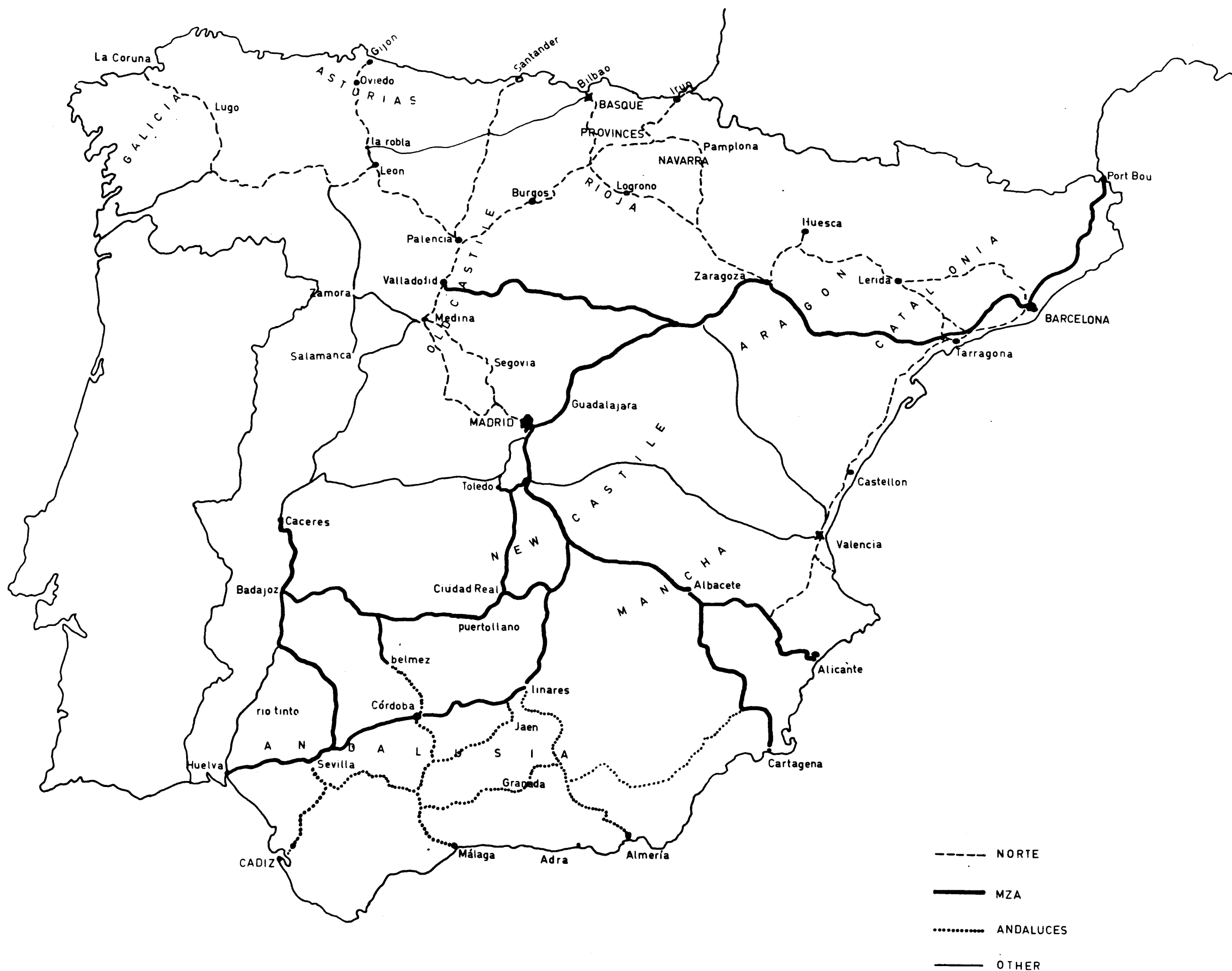
Measures:

a. Cántara	i. Bota = 516 litres.
b. Cántaro	j. Ton
c. Arroba	k. Quintal
d. Hl.	l. Nietro = 160 litres.
e. 16 litres.	m. Pipa = 3.5 Moyos.
f. 10 litres.	n. Moyo = 129 litres.
g. 11 kg.	o Alquer = 120 litres.
h, Carga = 120 litres.	

Regional variations as given in M. Martín, Pesos y Medinas, (Madrid, 1852), pp. 131-134.

Density of wine = 0.92.

Distances were measured on a modern road map confronted to the road network opened to traffic in the 1880's.



MAP: SPANISH RAILWAYS

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81-4	85-4	88-3
82	85-5	89
82-2	85-6	
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