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THE REGIONAL DISTRIBUTION OF SPANISH TRANSPORT INFRASTRUCTURE (1860-1930)

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ABSTRACT: The origin of Spanish regional economic divergence can be traced back at least until the seventeenth century, although its full definition took place during industrialisation. Historians have often included uneven regional infrastructure endowments among the factors that explain Spanish regional divergence. In that context, this paper has two objectives. Firstly, it offers a description of the regional distribution of the main Spanish transport infrastructure between the middle of the nineteenth century and the Civil War. And, secondly, it estimates a panel data model to search into the main reasons that explain the differences among the Spanish regional endowments of railways and roads during that period. The conclusions of the paper indicate that institutional factors and the physical characteristics of each area had a strong influence on the final distribution of transport infrastructure among the Spanish regions.

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1. Introduction.

The Spanish economy is nowadays characterised by huge differences in income per capita among regions. Although the origin of those striking differences has been traced back to the second half of the seventeenth century,[1] the development of the modern Spanish regional economic structure was not completed until the nineteenth and early twentieth centuries, in which the process of regional divergence substantially accelerated.[2]

As a result of that divergence process, two different areas might be distinguished in the country. Since the beginning of the twentieth century, regional figures of income per capita, regional percentages of industrial active population, or the available estimates of the "physical index of quality of life" (which summarise information on literacy, infant mortality and life expectancy) reflect a division of the country between a rich "North" (made up by most Northern and Mediterranean regions and Madrid), which has enjoyed an intense development process during the nineteenth and twentieth centuries, and a poor "South" (Andalusia, Extremadura, Castile-La Mancha, Murcia and the Canary Islands), which has remained relatively stagnant or has experienced a gradual economic decline in relative terms. Some regions are of course difficult to incorporate in that division, as is the case with the largest and most heterogeneous ones (such as Castile-Leon, Andalusia or Aragon), or with Galicia and Asturias, which during the second half of the nineteenth century had high indices of quality of life and low levels of income per capita in relative terms. However, in spite of that complexity, the existence of a fundamental geographical dualism in the Spanish economy in Late Modern times is broadly confirmed by the available information.[3]

The reasons for that regional divergence are complex. To start with, the literature on Early Modern Spain has stressed the importance of the differences in population density that resulted from the Christian conquest of each region in the Middle Ages.[4] The most sparsely-populated areas of the interior initiated in the mid-seventeenth century a process of purely extensive agrarian growth without productivity increases, based on the colonisation of empty lands. By contrast, at the same time, some densely populated

[1] Llopis Agelán (2001), p. 523.
[2] Carreras (1990), pp. 14-15.
[3] The main regional economic variables for nineteenth and twentieth century Spain may be seen in Zapata Blanco (2001).
[4] According to Llopis Agelán (2001), pp. 514-515, the main reasons for the differences in regional population density in the eighteenth century were the timing of the Christian conquest and the control that the upper classes exerted on the colonisation process in each region after the conquest.

peripheral regions, especially on the Mediterranean coast, started a process of expansion of intensive agrarian products, with a much greater impact on productivity.[5]

Those differences, which arouse in Early Modern times, tended to be reinforced later on, in a typical accumulative process based on the opportunities to exploit agglomeration and scale economies that were opened up to the regions with high population density and high productivity. However, historians have often insisted that, from the early-nineteenth century onwards, a number of additional factors, such as technological change, the State's economic policy, the integration of the national market or changes in the external relations of the Spanish economy might have altered some of the previous regional advantages that were associated with population density.[6] Among those aspects, the geographical pattern of Spanish infrastructure has often been mentioned as a potential factor of regional divergence during the nineteenth and early twentieth centuries.

Interpretations on this issue might be divided into two large areas. Firstly, some historians have stressed that the uneven distribution of infrastructure among the Spanish regions may have produced situation of shortage of transport networks in some regions, whose local development might have been hindered as a result. For instance, in Asturias, the scarcity of infrastructure has been blamed for the take-over of the local iron industry by the Basque one during the second half of the nineteenth century,[7] and, in Galicia or the Pyrenees, the lack of connections with the national transport network might have constituted a major obstacle to industrialisation.[8] Other authors have insisted on the privilege that some "Northern" regions, such as the Basque Country, Madrid, Cantabria or some provinces of Castile-Leon, received from the public sector regarding infrastructure investment. Actually, Cantabria and the three Castilian provinces of Valladolid, Palencia and Burgos appear to have been a privileged area since Early Modern times, when the Canal of Castile and the road that connected it with the sea were constructed to allow the commercialisation of Castilian production.[9]

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[5] See Llopis Agelán (2001), pp. 516-522, who indicates that other factors such as institutions, the geographic situation of each region, and the previous existence of market traditions were also relevant in the process of regional economic divergence that started around 1650.

[6] Ibidem, p. 523.

[7] Ojeda (2001), p. 52.

[8] On Galicia, see some contemporaries' opinions in Veiga Alonso (1999). On the Pyrenees see, for instance, Vidal Raich (1994), p. 181.

[9] For the Basque Country, see González Portilla et al (1995), p. 77; for Madrid, see García Delgado and Carrera Troyano (2001), pp. 230-233; for Cantabria, Domínguez Martín and Pérez González (2001) and, for Castile-Leon, Moreno Lázaro (2001), p. 188-189 and 206.

Secondly, the geographical structure of the national transport and communication networks has been said to have been inefficient and mainly inspired by political criteria. The radial character of the Spanish road, railway and telegraph systems, which adapted to the previous structure of postal services, and also imitated the design of the French networks, might have been inadequate for the Spanish needs and made connections between production and consumption centres expensive.[10] In addition, the political decision-making process was blamed at the time for being a vehicle used by individual members of parliament to win votes, giving rise to the construction of "parliamentary" roads and railways which were not justified on economic grounds.[11]

This paper aims at analysing the main determinants of the regional distribution of Spanish railways and roads between the mid-nineteenth century and the Civil War. That study may help to understand if, in the global context of the long-term Spanish regional divergence, some areas could have enjoyed situations of relative advantage or disadvantage regarding infrastructure, which could have improved or worsened their growth prospects. Therefore, this analysis is intended to throw some additional light on the reason for the contemporary divergence among the Spanish regional economies. The networks of railways and roads have been chosen as the object of study, since they constituted the core of the Spanish infrastructure during the period before the Civil War, amounting to between 65 and 90 per cent of the total stock.[12]

The paper is organised as follows. Firstly, Section 2 offers a short description of the geographical distribution of the networks of railways and roads during the period under study. Secondly, in Section 3 an econometric exercise is carried out that tries to identify the main determinants of the spatial distribution of those two networks. Section 4 summarises the major conclusions of the paper.

2. The geographical distribution of Spanish railways and roads.

The comparison among the infrastructure endowment of different regions is not an easy task, as it requires an appropriate index of the actual service capacity of each type of

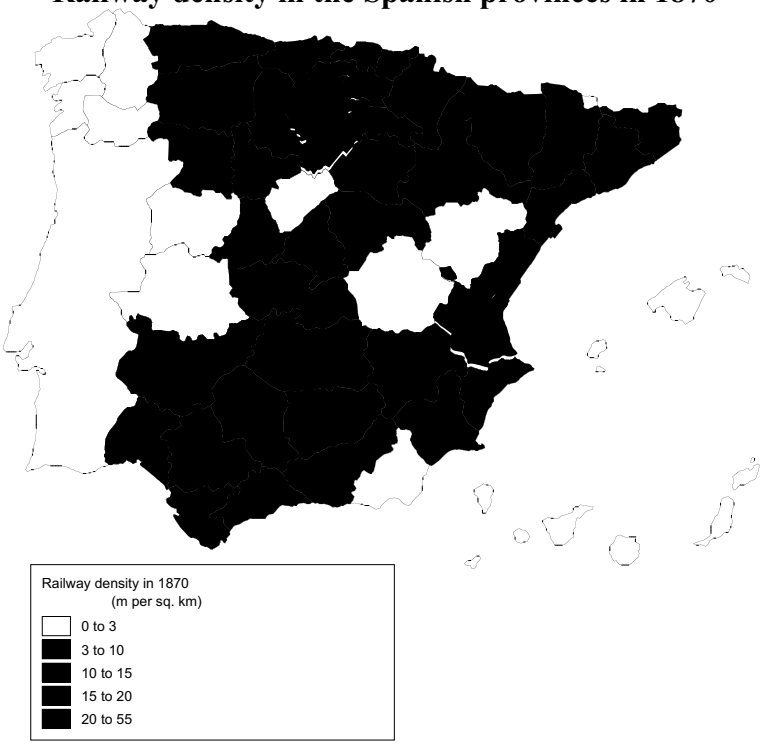
[10] See, for instance, Nadal Oller (1975), pp. 48-50.
[11] On "parliamentary" roads, see Alzola y Minondo (1979), pp. 437-438; Calvo Calvo (2001) has recently detected similar situations in the case of the telegraph system.
[12] See Herranz Loncán (2004), p. 110. The concept "infrastructure" refers here to the so-called "economic" infrastructure, i.e. transport and communication networks, energy distribution structures and hydraulic works.

infrastructure in each regional context. In the case of large-scale transport and communication infrastructure, which can be characterised as "space-serving" assets, network density (i.e. the ratio between the length of the network and the surface of the service area) would probably constitute the best available measure of service capacity. Increases in the density of a network are the most direct way to reduce transport and communication costs, through reductions in the average distance from each production or consumption point to the network, as well as decreases in the average detour of paths through the network.

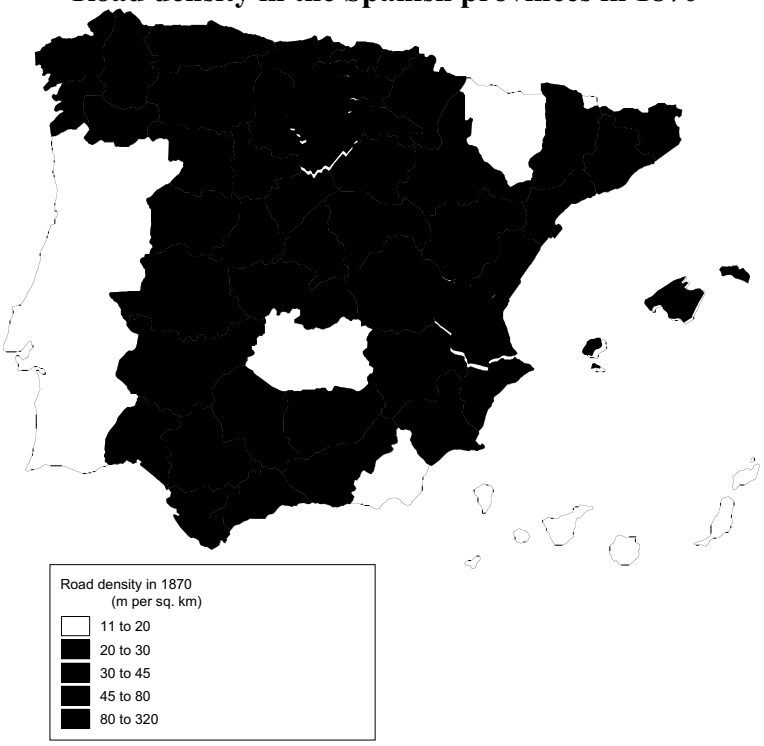
Maps 1 to 6 show the density of the railway and road networks in each of the Spanish provinces in the years 1870, 1900 and 1930. All of them present a rather similar picture. Firstly, both in the cases of railways and roads, infrastructure distribution among the Spanish provinces was very uneven, reflecting much higher regional disparities than in other European countries at the time.[13] Secondly, in all cases it is possible to observe the high density of the transport networks both in the coastal provinces of Catalonia and Valencia and in a cluster of provinces situated in the central-Northern area of Spain: the Basque Country, Navarre, La Rioja, Cantabria, Asturias, Madrid and the central provinces of Castile-Leon. At the other end of the range, the inland and sparsely-populated regions of Extremadura, Aragon and most provinces of both Castiles, as well as the South-East corner of Spain and the Canary Islands, were quite poorly endowed during the whole period under study. Finally, as happens with most regional economic variables, Western Andalusia and Galicia are difficult to integrate in that framework, since they were well endowed with one type of infrastructure (railways in Andalusia and roads in Galicia) but poorly endowed with the other.

[13] For instance, in France, a country that is comparable to Spain in size, the coefficient of variation of the railway density of the *départements* was 40% in 1907, whereas among the Spanish provinces it was 71% at that time. Data on France in Price (1983), pp. 222-223; the *département* of Seine (i.e. the city of Paris) has been excluded from the calculation to keep the coefficients comparable.

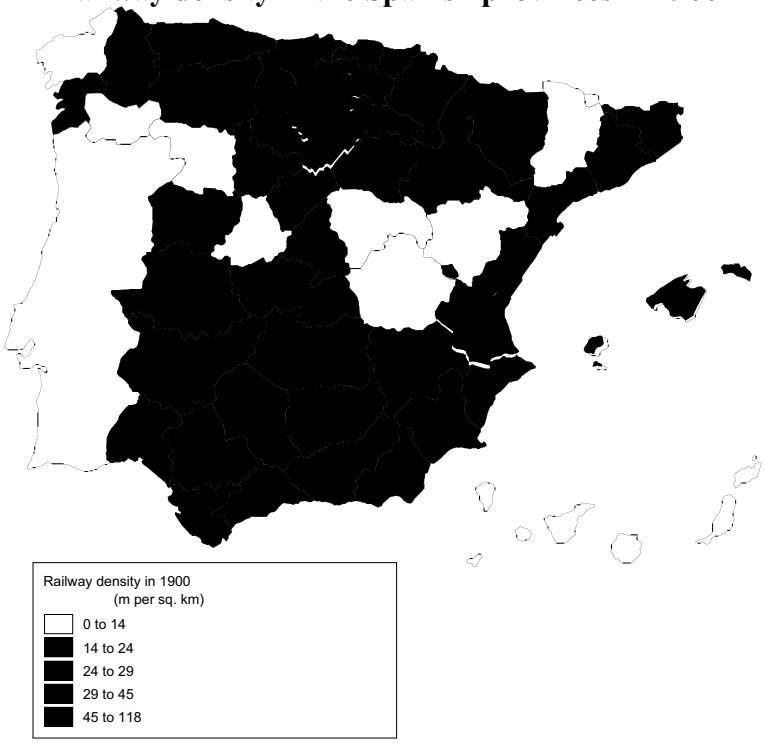
Map 1
Railway density in the Spanish provinces in 1870



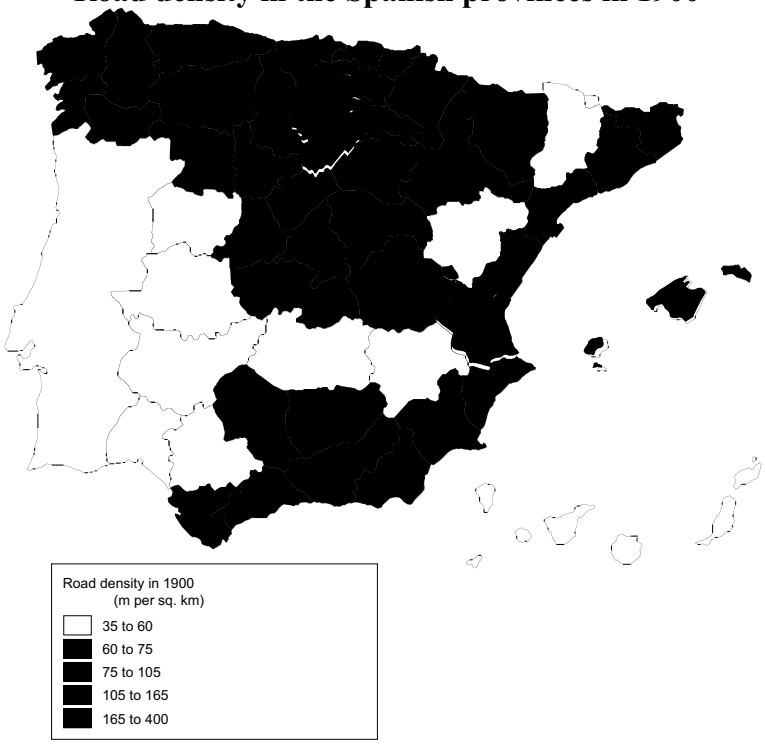
Map 2
Road density in the Spanish provinces in 1870



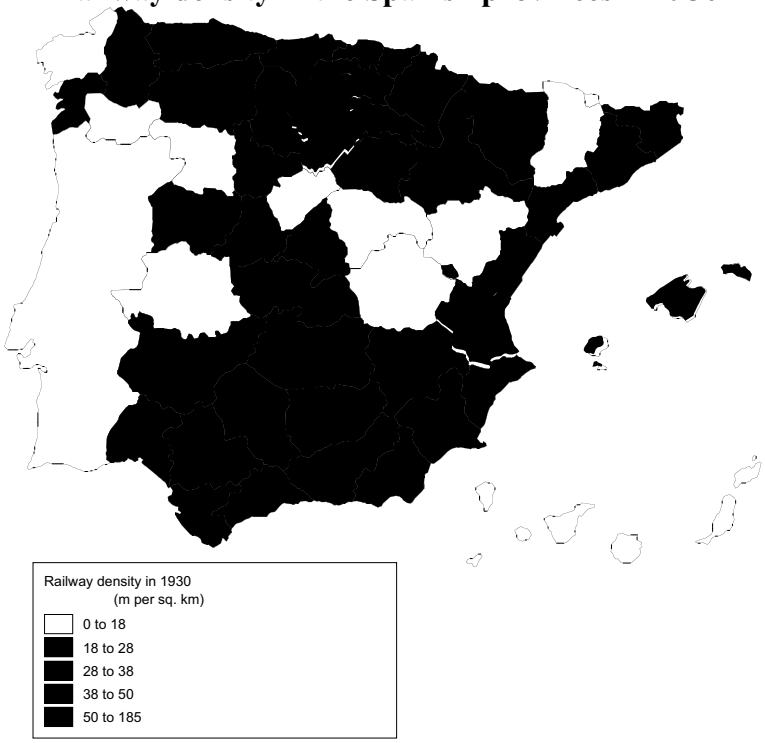
Map 3
Railway density in the Spanish provinces in 1900



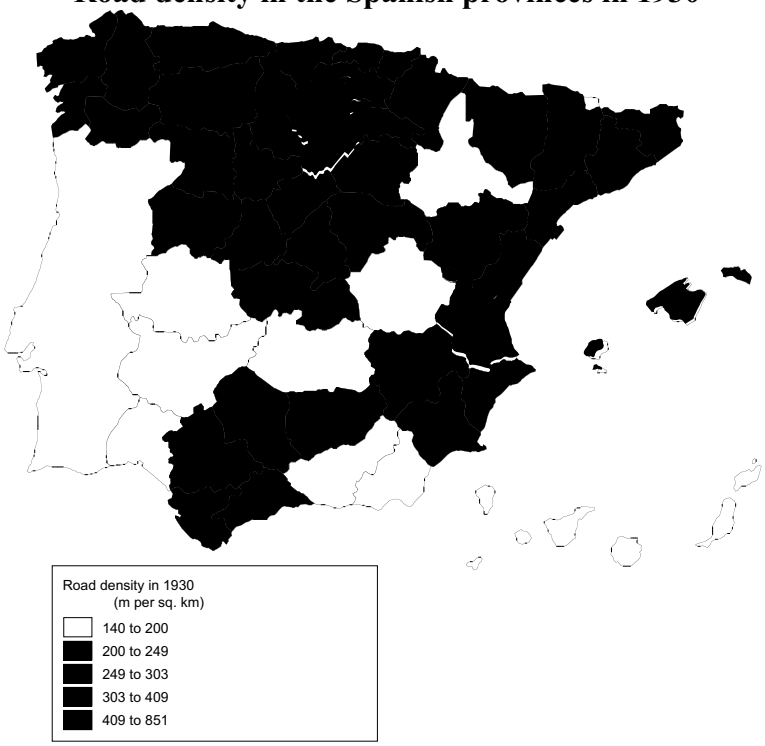
Map 4
Road density in the Spanish provinces in 1900



Map 5
Railway density in the Spanish provinces in 1930



Map 6
Road density in the Spanish provinces in 1930

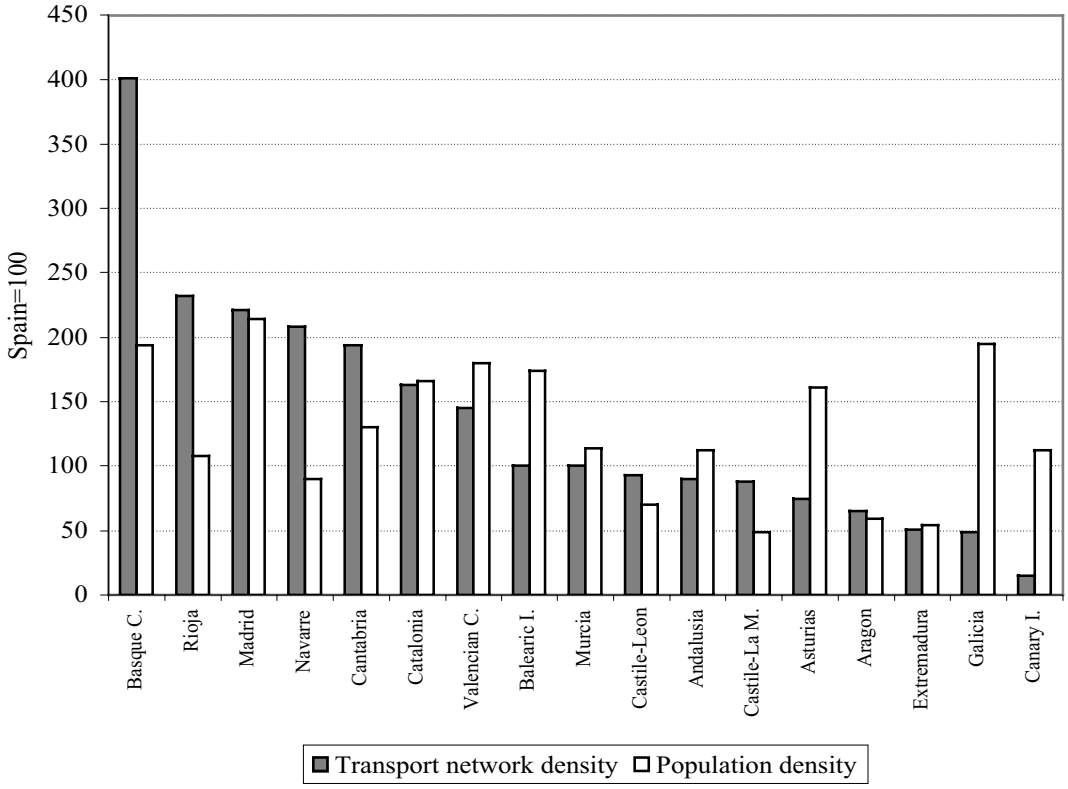


Sources to maps 1 to 6: Railway density from *Memoria(s), Anuario(s)* and *Estadística(s) de Obras Públicas* (from now on, MAEOP) and *Anuario de Ferrocarriles de D. Enrique de la Torre*; road density from MAEOP and Ministerio de Obras Públicas (1940), Vol. 1, pp. 200-201.
Note: For the first decades of the period under study, figures on provincial and local roads are not completely reliable, due to the lack of homogeneity in the statistical criteria that were followed in different provinces.

Obviously, in order to draw conclusions about each region's relative infrastructure shortage, its density figures must be compared with its needs for infrastructure. A very rough indicator of those regional needs is given by population density. Graph 1 compares, for each of the Spanish regions, a weighted (normalised) average of the railway and road network density figures and the regional population density.[14]

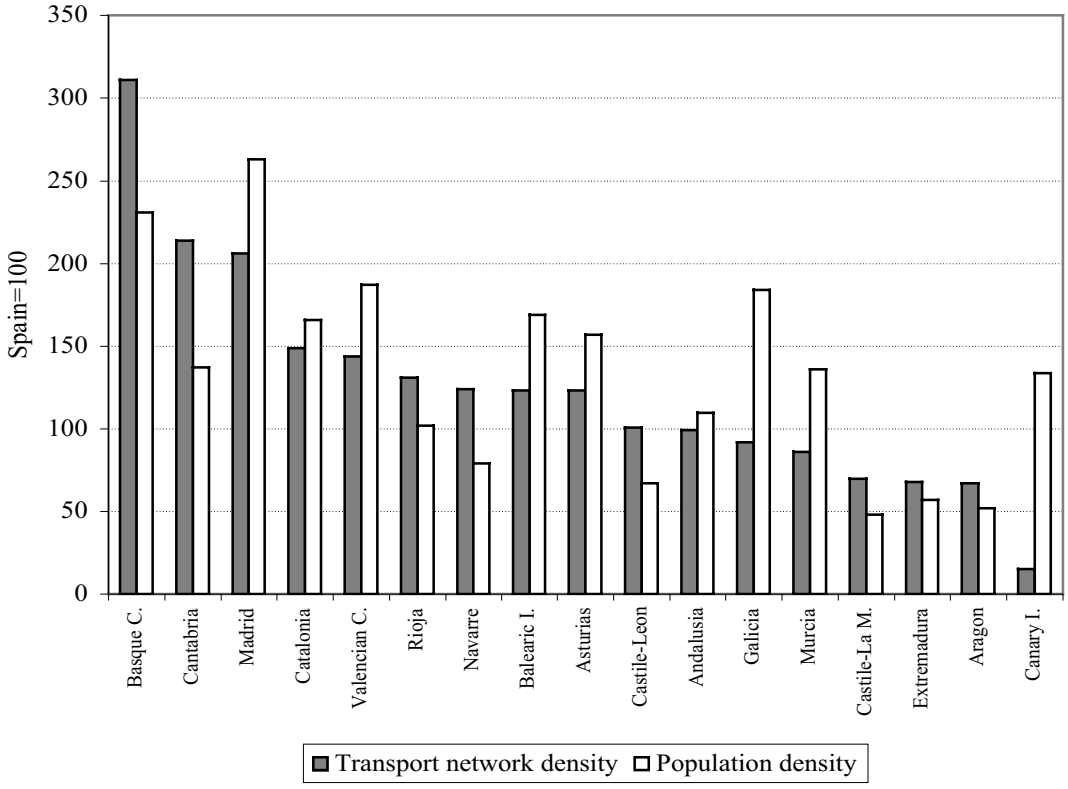
Graph 1
Transport networks and population density in the Spanish regions

A) 1870

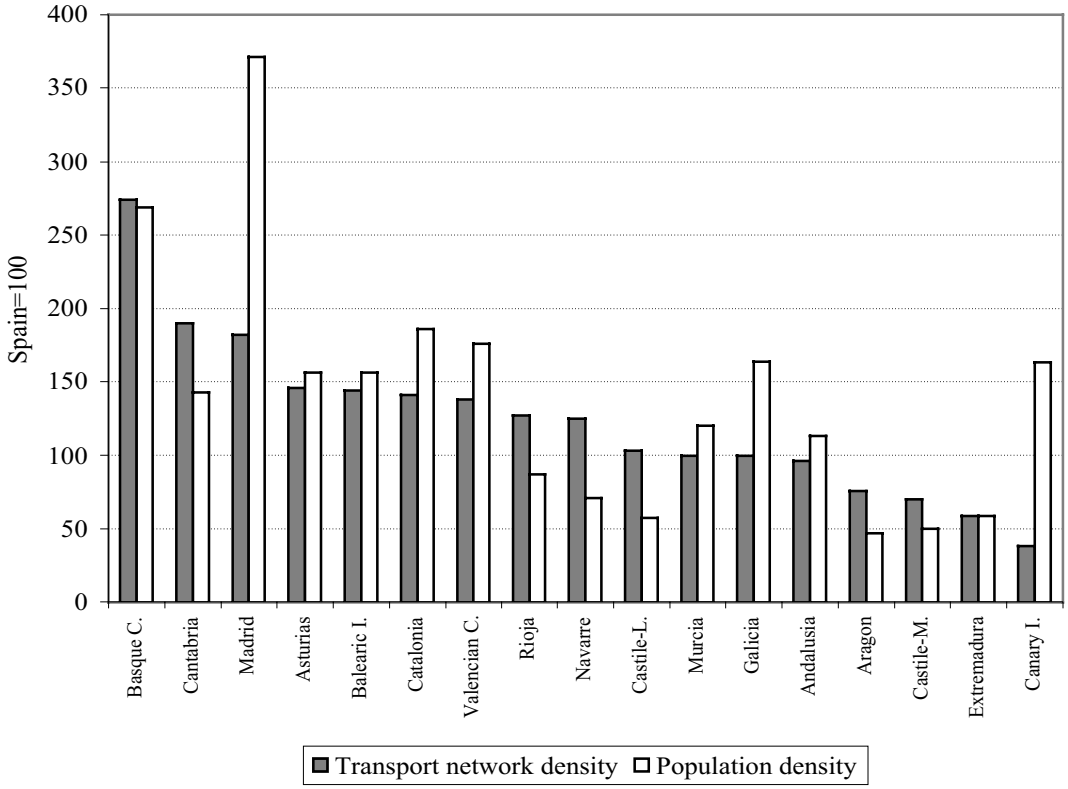


[14] The weights that have been used to calculate the average transport network density are the relative importance of railways and roads within Spanish total capital stock in each date.

B) 1900


350
300
250
200
150
100
50
0
Spain=100
Basque C.
Cantabria
Madrid
Catalonia
Valencian C.
Rioja
Navarre
Balearic I.
Asturias
Castile-Leon
Andalusia
Galicia
Murcia
Castile-La M.
Extremadura
Aragon
Canary I.
Transport network density
Population density

C) 1930


400
350
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100
50
0
Spain=100
Basque C.
Cantabria
Madrid
Asturias
Balearic I.
Catalonia
Valencian C.
Rioja
Navarre
Castile-L.
Murcia
Galicia
Andalusia
Aragon
Castile-M.
Extremadura
Canary I.
Transport network density
Population density

The graphs show a relatively high agreement between both magnitudes through the period, correlation coefficients being 0.45, 0.64 and 0,65 in 1870, 1900 and 1930 respectively. However, they also allow observing the numerous potential situations of relative infrastructure shortage or "excess" that might have existed during those decades. Concretely, the graphs seem to be consistent with the considerations of historians and contemporaries on the privileged situations of some Northern areas, such as Cantabria, Navarre or Castile-Leon, and on the disadvantage of other regions, such as Galicia and Asturias. However, situations of shortage do not seem to have been confined to those areas. Indeed, they appear to have also affected other regions, such as the Canary Islands, the Valencian Community and, in the first decades of the twentieth century, Madrid, although in this case the extremely high spatial concentration of the population of the region makes the comparison with other areas difficult.

These examples seem to indicate that the regional distribution of infrastructure was not just a reflection of the long-term differences among the Spanish regional economies. It instead appears to have responded to other factors and, therefore, to have been in itself a potential factor of regional divergence in the Spanish economy, as the historiography has often indicated. In that context, the next section analyses the main determinants of the actual provincial distribution of the railways and roads during the late nineteenth and early twentieth centuries. By doing so, it tries to shed some light on the explanation of the inequality in factor endowments among the Spanish regions and, therefore, to help explaining the process of regional divergence.

3. An explanatory model for the provincial distribution of Spanish railways and roads.

3.1. The model.

This section is based on previous research by Rietveld and Boonstra (1995) and Rietveld and Wintershoven (1998) on the factors that explain the present distribution of railways and highways among the EU regions. These authors' main interest was the study of the potential shortage of infrastructure in the border regions of the EU due to the influence of institutional "barrier effects". They, however, find these to be unimportant in the actual geographical pattern of the European transport networks. This section includes a

similar estimation exercise for the Spanish railway and road network during the period 1860-1930, although the paucity of quantitative information has made some adjustments necessary.

For the sake of clarity, those authors divide the determinants of the regional endowment of transport infrastructure into "demand" and "supply" factors. On the one hand, from the demand point of view, construction of infrastructure is said to respond to the perceived need for infrastructure services or, in other words, to the *ex ante* expected level of use of the networks. A region's need for transport infrastructure would depend on several variables. The most obvious one is population density since, in sparsely-populated areas, the low expected level of traffic may not justify building certain infrastructure, especially if its construction is expensive, because it would entail a waste of resources and a very high opportunity cost. Transport infrastructure endowment is expected, therefore, to grow with population density although at a decreasing rate, for two reasons. On the one hand, beyond a certain saturation point, increases in the density of transport networks may no longer be functional.[15] And, on the other hand, the indivisible character of most large-scale transport infrastructure necessarily produces some excess endowment in sparsely-populated areas.[16]

Secondly, the structure of the system of population centres also affects the level of expected traffic of a future transport link. If population is highly concentrated in a small number of large cities, traffic may also be expected to be concentrated on a few routes. On the contrary, if the same amount of population is distributed throughout a large number of small villages, traffic will also be diverted to many different links. In that context, for a given level of population density, the construction of expensive transport infrastructure may be justified in the former case but not in the latter.

And, thirdly, income per capita and the structure of production also determine a region's need for transport services. On the one hand, the growth of income per capita raises the demand for transport in several ways, e.g. by increasing the share of market-orientated activities, the specialisation and concentration of production, or the purchasing power of individuals (which increases the demand for passenger transport services). On the other hand, some activities use transport services more intensively than others and, as a

[15] Laffut (1983), p. 206.
[16] Rietveld and Wintershoven (1998), p. 266.

consequence, the demand for transport in an economy also depends on the share of each sector within total output.

In addition, the expected use of infrastructure not only depends on the level of regional demand but also on the interregional need for transport. Some routes may cross an area just to connect two foreign regions, without meeting any internal need. In that context, international borders and the sea may reduce the demand for infrastructure in a region, because they diminish the potential number of interregional links that might cross the area. Obviously, the importance of interregional demand is higher in the case of longest haul transport infrastructure. Accordingly, in the context of the late nineteenth and early twentieth century, it would be expected to be much more significant in the case of railways than in the case of roads.

From the point of view of the supply of infrastructure, there are also a number of factors that have a strong influence on the final level of investment. Firstly, the unit cost of infrastructure construction may show wide variations among regions, depending on the geographical characteristics of each area (i.e. its topographical difficulty), and also on the regional differences in prices of immobile resources.

Secondly, the final level of investment also depends on the financial capacity of the potential investors. In the case of a purely private investment, capital mobility across regions may partially eliminate the constraints associated with this factor. On the contrary, in the case of public or subsidised investment, the financial capacity of the public institutions which are in charge of either the investment or the subsidy may set a budget constraint on the process of construction. As a consequence, broad differences in the investment capacity of different regions may arise due to such factors as the institutional framework or the level of income per capita of each region (which would affect the level of regional tax returns).

The aforementioned authors also include, among the supply factors, the possibility of the objective function of the public sector to include goals other than efficiency. Usually, those non-efficiency objectives are related to equity considerations (such as achieving a similar infrastructure endowment in all regions), a better political control of the territory, or short-term goals (i.e. stimulating stagnant regional economies through public work construction expenses). In addition, the public decision-making process may also be influenced by particular interests and rent-seeking strategies, or by regional differences in

the socio-political structure and in the prevailing relationships between voters and politicians.

3.2. The data.

In the case of the Spanish economy before 1936, it is not easy to find indicators of all the variables that have just been described. To start with, regarding the provincial demand for transport, information has been collected on population density and the degree of urbanisation and industrialisation in each province. As no provincial estimates of income per capita are available,[17] urbanisation and industrialisation rates have been taken here as second-best indicators of the Spanish provinces' level of development. However, the interpretation of these two variables is difficult, because the rate of urban population is also an indirect indicator of the size and structure of population centres, and the level of provincial industrialisation may also affect the demand for transport services because different sectors use transport with different intensity.

Information on population density and urbanisation rates at the provincial level for the first year of each decade between 1860 and 1930 has been obtained from the official Spanish population censuses.[18] In a first approach, population has been considered urban in the case of municipalities 10,000 or larger. However, urbanisation rates calculated in this way may be misleading for some provinces, due to the fact that Spanish municipalities were usually made up of a main population centre and some subordinated small hamlets. As a consequence, in some cases (especially in the Northern regions), large municipalities might contain no urban centre but only a great number of small villages. In order to make up for this problem, those municipalities with more than 10,000 population, but which lacked a significant number of high (i.e. 3 or more floors) buildings, or which included

[17] Álvarez Llano (1986) offers estimates on the share of each region within Spanish GDP in 1802, 1849, 1860, 1901, 1921, 1930, 1940 and 1950, which would allow the calculation of figures of regional GDP per capita. Álvarez Llano's estimates, however, are described by the author himself as very rough, and other historians have been very reluctant to use them. Carreras, for instance, has indicated that, despite not being in conflict with the available evidence on the period, Álvarez Llano's figures can only be taken as mere suggestions, due to the lack of information on the estimation methods and the bizarre behaviour of certain regions; see Carreras (1990), pp. 6-8, and also Zapata Blanco (2001), p. 562. Álvarez Llano's figures are included in Table 1 below to offer a more complete picture of the economic characteristics of the Spanish regions, but they have not been used in the estimation of the model.

[18] Data from the 1860, 1877, 1887, 1900, 1910, 1920 and 1930 censuses has been used. For 1880 and 1890, data comes from the 1877 and 1887 censuses, respectively, and, for 1870, a geometric interpolation of the 1860 and 1877 figures has been calculated.

more than ten population centres, or whose main centre was smaller than 5,000 people, have not been considered as urban.[19]

Provincial industrialisation is not so easy to approach as the share of urban population, since no industrial censuses were carried out in Spain during the period under study, and no historical estimates of industrial output are available at the provincial level. As a second-best option, two alternative indirect approaches to the provincial degree of industrialisation are possible. Firstly, most population censuses tried to classify active population among sectors of activity. Those attempts, of course, were not free from serious conceptual problems. Apart from the fact that aggregation criteria widely varied among different censuses, the sector of activity was not properly identified for numerous wage labourers and, especially, for women, for whom census data have been said to be totally meaningless.[20] Nevertheless, keeping in mind the shortcomings of those data, the percentage of industrial workers within total population has been calculated for the censuses that were carried out between 1877 and 1930.[21]

A second approach to the level and structure of industrialisation is available from data on the main industrial tax (the industrial section of the *Contribución Industrial y de Comercio*). The collection of that tax was based on each company's holdings of a representative asset, so that the amount collected reflected the value added produced by the company. Unfortunately, the *Contribución Industrial* was not applied in the Basque Country and Navarre during the period of study, and this absence substantially reduces the usefulness of the indicator. In addition, data for the remaining provinces must be used carefully because there is not enough guarantee that the coefficients applied to the companies' assets properly reflected their relative productive capacity. That problem may cause the importance of certain sectors and regions within the Spanish industry to be different from their contribution to the tax returns.[22] Besides, fraud and exemptions could

[19] All this information is available in Luna Rodrigo (1988). As this author warns, urbanisation rates calculated in this way are not completely free from shortcomings, mainly due to the technical problems of the Spanish censuses. However, with these three corrections, the most serious distortions are avoided.

[20] One of the main reasons for these problems was the fact that, very often, rural workers were simultaneously involved in several different sectors of activity in nineteenth and early-twentieth century Spain. On the shortcomings of Spanish census figures, see Nicolau (1989) or Pérez Moreda (1999), pp. 54-56.

[21] This would be equivalent to estimating the percentage of manufacture workers within active population because, as Pérez Moreda (1999), p. 53, indicates, the importance of the "active age cohorts" within total population did not change during the period under study.

[22] Differences could increase gradually as time went by, due to the high inflexibility of the Spanish fiscal system, which was to a large extent based on the administrative determination of the amounts to be collected (the so-called *cupos*), with very little consideration of statistical information. However, from Sudrià's point

also increase the biases in regional figures.[23] Finally, from 1910 onwards, the largest industrial (joint-stock) companies were burdened with a different tax (the *Contribución de Utilidades*), which had the additional problem that the firms' fiscal address did not always coincide with the location of their factories.[24] Keeping all these problems in mind, provincial data on the returns of the *Contribución Industrial* up to 1905, and Betrán's estimates of the joint returns of the *Contribución Industrial* and the *Contribución de Utilidades* in 1913 and 1929 have been gathered to proxy the geographical structure of Spanish industry between 1860 and 1930.[25]

Regarding supply factors, provincial differences in the cost of infrastructure construction may be approached through the information on road construction costs in each province that was published in the *Memoria(s)*, *Anuario(s)*, and *Estadística(s) de Obras Públicas* for most years between 1873 and 1924.[26] Unfortunately, these figures again exclude Navarre and the Basque Country, where the main road networks were not constructed by the State but by the Provincial *Diputaciones*.

Other supply variables are more difficult to approach than construction costs. Regarding the financial capacity of local investors, information on provincial and local

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of view, the influence of this problem on the picture of the Spanish industrial structure resulting from the *Contribución Industrial* data would not be very serious, because "*it is plausible that calculation mistakes tended to be distributed in a random way*"; see Sudrià Triay (1997), p. 405.

[23] Some local studies, however, have found quite a low level of fraud in the statements of the firms' assets, which can be explained for two reasons. On the one hand, statements were signed by Local Councils. And, on the other hand, the fiscal weight of the *Contribución Industrial* was always lower than the share of the industrial sector on Spanish GDP, which may be considered an indication of the relatively low importance of the *Contribución Industrial* for producers; see Comín Comín (1996), p. 117. Insofar as exemptions are concerned, according to Sudrià Triay (1997), pp. 405-406, the most important ones were tobacco production (which was a public monopoly during the period under study) and some cotton firms, which were classified as agrarian due to their rural location. However, Carreras (1983), pp. 55-56, has indicated that the second of these two problems seems to have been irrelevant.

[24] On the other hand, the *Contribución de Utilidades* had the advantage that it was also applied in the Basque Country and Navarre.

[25] See Betrán Pérez (1997). This author's estimates are the result of exhaustive research into the actual location of the companies that were affected by the *Contribución de Utilidades* in 1913 and 1929. Betrán's data has been used as representative for the structure and level of provincial industry in 1910 and 1930, respectively. For 1860, 1880 and 1890, the returns of the *Contribución Industrial* in 1856, 1878/1879 and 1889/1890, have been used. For 1870 and 1900 geometrical interpolations of the returns of 1863 and 1878/1879, and 1895/96 and 1905, respectively, have been calculated. All this data comes from the *Estadística Administrativa de la Contribución Industrial*.

[26] Only cost figures for "third category" roads have been used, due to the scarce construction activity in other categories during the time sample. They cannot be directly aggregated by provinces throughout the whole period under study, due to price changes and the heterogeneity among cost figures for different years (as expropriation is included only in some cases). Therefore, for each year, provincial unit costs have been normalised by the Spanish figure and a weighted average of all normalised yearly values has been obtained for each province, in which weights are based on the number of km that were constructed each year. Differences among provinces in construction costs have been assumed to be the same in railways and in

public institutions' budgets is only available for the period before 1886 and for a few years between 1917 and 1927.[27] For the whole period under study, it has only been possible to take into account the particular fiscal situation of the Basque provinces and Navarre. Those four provinces benefited from a great fiscal autonomy, as they were responsible for the management of the whole tax system. The Spanish State only took part in the process as a passive recipient of a previously established yearly amount of money. According to the available data and some contemporary opinions, that system enormously improved the financial situation of the provincial and local public institutions of those four provinces, compared with the rest of the country.[28]

Finally, still from the "supply" point of view, in an aggregate analysis it is virtually impossible to measure deviations of public policy from geographically optimal investment criteria and, as a consequence, some unexplained residual of the provincial distribution of investment would be related to a hypothetical uneven distribution of those deviations among the Spanish provinces.

Table 1 compares the regional relative endowment of railways and roads with the main characteristics of each region at three points of time. Regions are arranged according to their average transport network density, and the correlation coefficients between each variable and the endowment of railways and roads are presented in the last two rows of the table. According to those figures, there was quite a high correlation between the railway endowment of each region and its main economic characteristics during the whole period under study, with the only exception of the rate of urbanisation. On the contrary, the distribution pattern of the road network was rather independent from most economic variables at the beginning of the period and it only gradually converged with population density, the level of industrialisation and income per capita although, similar to railways, it remained unrelated to regional figures of urbanisation.

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roads, since the most important cost determinants were the same in both networks (i.e. topography and land and labour prices).

[27] That information is available in the *Anuario Estadístico de España* and *Reseña Geográfica y Estadística de España* (1888).

[28] See, for instance, Alzola y Minondo (1979), p. 41. This opinion seems to be confirmed by the information available on provincial and local institutions' budgets (see below, Table 1).

Table 1
Infrastructure endowment and structural characteristics of the Spanish regions
A) 1870

	RWD Norm.	RD Norm.	Weigh. average	Pop. density[1]	Urb. rate (%)[1]	Industrial tax p.c.[2]	Ind. A.P. (%)[3]	Income p.c.[4]	Fiscal capacity p.c.[5]	Unit cost
Basque C.	325	543	**401**	62	15	na	22	109	19	na
Rioja	245	209	**232**	35	7	117	14	98	9	112
Madrid	241	185	**221**	69	66	129	21	307	27	74
Navarre	194	234	**208**	29	10	na	12	99	13	na
Cantabria	190	200	**194**	42	16	94	16	107	10	133
Catalonia	182	129	**163**	53	31	272	29	124	11	141
Valencian C	156	124	**145**	58	27	90	18	70	8	108
Balearic I.	0	287	**100**	56	32	101	23	87	9	69
Murcia	117	67	**100**	37	68	57	17	78	5	84
Castile-L.	88	103	**93**	23	7	85	10	86	8	81
Andalusia	103	66	**90**	36	39	95	20	114	10	113
Castile-M.	102	63	**88**	16	8	73	11	94	8	64
Asturias	33	154	**75**	52	11	56	7	61	4	184
Aragon	71	54	**65**	19	11	68	13	102	9	102
Extremadura	50	54	**51**	17	8	68	9	81	8	97
Galicia	0	139	**49**	63	7	44	9	51	4	95
Canary I.	0	43	**15**	36	12	13	11	53	4	166
SPAIN	**100**	**100**	**100**	**32**	**22**	**100**	**16**	**100**	**9**	**100**
St Dev. (%)	77.79	78.73		41.63	89.13	63.88	39.34	56.32	57.42	32.31
Correl RW				0.25	0.20	0.58	0.48	0.52	0.72	-0.11
Correl R				0.52	-0.05	0.31	0.39	0.16	0.53	-0.09

B) 1900

	RWD Norm.	RD Norm.	Weigh. average	Pop. density	Urb. rate (%)	Industrial tax p.c.[6]	Ind. A.P. (%)	Income p.c.	Unit cost
Basque C.	324	291	**311**	85	29	491	35	123	na
Cantabria	219	205	**214**	51	25	87	20	129	133
Madrid	206	206	**206**	97	74	97	23	219	74
Catalonia	160	132	**149**	61	41	300	27	154	141
Valencian C.	162	114	**144**	69	37	85	16	90	108
Rioja	101	180	**131**	38	10	86	16	94	112
Navarre	87	184	**124**	29	9	80	11	103	na
Balearic I.	91	174	**123**	62	34	46	22	81	69
Asturias	109	147	**123**	58	15	84	14	95	184
Castile-L.	97	107	**101**	25	9	44	9	92	81
Andalusia	113	76	**99**	41	41	90	17	88	113
Galicia	69	129	**92**	68	9	24	8	67	95
Murcia	94	73	**86**	50	81	51	10	72	84
Castile-M.	67	75	**70**	18	15	63	13	87	64
Extremadura	75	57	**68**	21	16	43	11	71	97
Aragon	62	74	**67**	19	15	54	13	104	102
Canary I.	0	40	**15**	49	27	13	16	66	166
SPAIN	**100**	**100**	**100**	**37**	**29**	**100**	**16**	**100**	**100**
St Dev. (%)	62.98	50.14		46.76	75.28	115.39	42.78	37.29	32.31
Correl RW				0.63	0.30	0.79	0.77	0.62	-0.03
Correl R				0.59	0.02	0.63	0.66	0.54	-0.02

C) 1930

	RWD Norm.	RD Norm.	Weigh. average	Pop. density	Urb. rate (%)	Industrial tax p.c.[7]	Ind. A.P. (%)	Income p.c.	Fiscal capacity p.c.[8]	Unit cost
Basque C.	344	207	**274**	126	45	291	51	143	na	na
Cantabria	199	181	**190**	67	31	162	40	87	95	133
Madrid	201	163	**182**	173	81	174	51	119	214	74
Asturias	148	144	**146**	73	19	108	46	82	82	184
Balearic I.	135	152	**144**	73	42	52	37	98	76	69
Catalonia	154	129	**141**	87	54	322	50	180	175	141
Valencian C.	154	123	**138**	82	44	88	35	121	96	108
Rioja	121	132	**127**	40	23	116	32	90	106	112
Navarre	123	127	**125**	33	15	74	21	111	na	na
Castile-M.	60	107	**103**	26	23	27	25	83	69	64
Murcia	92	108	**100**	56	80	30	32	71	71	84
Galicia	63	135	**100**	77	12	17	26	64	52	95
Andalusia	110	82	**96**	53	50	51	27	76	90	113
Aragon	77	76	**76**	22	21	115	31	102	100	102
Castile-L.	98	80	**70**	23	13	34	27	90	88	81
Extremadura	60	59	**59**	28	26	20	28	76	73	97
Canary I.	0	74	**38**	76	33	15	49	62	na	166
SPAIN	**100**	**100**	**100**	**47**	**38**	**100**	**34**	**100**	**96**	**100**
St Dev. (%)	60.85	32.42		60.18	58.90	92.50	28.49	31.22	43.88	31.35
Correl RW				0.61	0.34	0.78	0.52	0.64	0.65	0.02
Correl R				0.66	0.29	0.62	0.43	0.41	0.33	0.06

RWD Norm: railway density (m per km^2), normalised by the Spanish average.
RD Norm: road density (m per km^2), normalised by the Spanish average.
Ind. A.P.: share of male active population engaged in the secondary sector.
Fiscal capacity p.c.: total expenses of local and provincial public institutions per capita (pesetas).
Unit cost: average of the normalised road construction costs of the provinces within each region.
Correl RW and R: correlation coefficient between each variable and railway and road density, respectively.
Notes: na: not available; (1) population figures for 1870 are obtained by geometrical interpolation of data from the 1860 and 1877 censuses; (2) industrial fiscal returns in 1870 are obtained by geometrical interpolation of data on 1856 and 1878/1879; (3) in 1877; (4) in 1860; (5) in 1865/66; (6) for 1900, industrial tax information is completed with Parejo's estimates for the Basque Country and Navarre (see Zapata Blanco (2001), p. 579); (7) in 1929; (8) in 1927.
Sources: for railway and road density see above, Section 2; population density and urbanisation rate from the official population censuses and Luna Rodrigo (1988); industrial tax per capita from *Estadística Administrativa de la Contribución Industrial*, Zapata Blanco (2001), p. 579, and Betrán Pérez (1997); industrial active population from Zapata Blanco (2001), p. 568; income per capita, from Álvarez Llano (1986); local and provincial fiscal capacity from *Anuario Estadístico de España*; unit construction cost from *MAEOP*.

3. Outcomes of the estimation.

The model that has been presented above has been applied to the explanation of the geographical distribution of Spanish railways and roads throughout the period 1860-1930, on the basis of the pool of cross-section and time-series data that have just been described. All variables have been measured at the provincial level and in the first year of each decade. Tables 2 and 3 show the outcomes of the estimation of that model for the whole railway and road systems, and also for their main components, i.e. broad and narrow gauge

railways, and State and non-State (i.e. local and provincial) roads. For each network, the tables offer the estimation of two different versions of the model, depending on the information that is taken as a proxy for provincial industrialisation. The first version uses the share of industrial active population as explanatory variable, whereas the other is based on the fiscal data of the *Contribución Industrial*.

All specifications include population density and its square, in order to account for the fact that infrastructure density is expected to increase at a decreasing rate with population density. All of them also include the construction cost variable.[29] In addition, as has already been indicated, a dummy variable that reflects the particular fiscal situation of the Basque Country and Navarre has been incorporated to the model, although only in the first specification. As noted earlier, the *Contribución Industrial*, which is used as a proxy for industrialisation in the second specification, was not applied in the four autonomous provinces and, as these are excluded from the estimation, it is not possible to incorporate the "fiscal" dummy.

In order to account for the hypothetical influence of interregional demand (or, in other words, for the presence of interregional spillovers) a spatial autoregresive model has been incorporated in the specification. As is customary in this sort of exercises, the spatial AR model has been specified as:

$$Ay = X\beta + \varepsilon$$

$$A = I - \gamma W$$

where W is a "rowsum=1 standardised" weight matrix that reflects the spatial structure of the data. In this case, the entries of W equal 1 if two provinces are contiguous and 0 otherwise. In the same direction, in order to take into account the contiguity of the province to the sea or to the French or Portuguese borders, two additional dummy variables have been included that take the value 1 in coastal and border provinces, respectively, and the value 0 otherwise.

Estimates in Tables 2 and 3 are two-stage-least squares, which are robust to the presence of cross-section heteroskedasticity. The use of instrumental variables is intended to account for the presence of spatial autocorrelation, as well as to avoid potential

[29] In the cases of the Basque Country and Navarre, the construction cost levels of similar contiguous provinces have been applied.

problems of reverse causation. Time lags of the potentially endogenous right-hand variables (population density and urbanisation and industrialisation rates) and the rest of the explanatory variables have been taken as instruments.

Finally, given the large number of provinces compared with the short number of time periods, no individual effects have been included in the model, and the individual residuals have been assumed to be randomly distributed. Otherwise, the number of parameters to estimate would have grown disproportionately.

Table 2.
The determinants of the provincial distribution of Spanish railways.

	Total Network		Broad Gauge Railways		Narrow Gauge Railways	
Variable	(1)	(2)	(1)	(2)	(1)	(2)
Constant	-0.372 (-0.139)	3.146 (1.600)	4.119* (2.168)	2.836 (1.776)	-2.228** (-3.060)	-4.539** (-6.823)
Population density	0.187** (3.088)	0.559** (7.660)	0.261** (5.668)	0.511** (5.746)	-0.016 (-0.265)	0.172** (5.940)
Population density sq.	0.0001 (0.167)	-0.004** (-5.647)	-0.001** (-3.116)	-0.003** (-3.981)	0.001* (2.236)	-0.001** (-4.429)
Urbanisation rate	0.159** (3.626)	0.012 (0.267)	0.134** (4.990)	0.002 (0.039)	-0.017* (-2.062)	-0.049** (-5.077)
Industrial active population.	0.126** (5.333)		0.039** (3.153)		0.023** (3.180)	
Industrial tax returns per capita		0.026** (8.544)		0.017** (5.384)		0.010** (6.911)
Construction cost	-0.106** (-5.007)	-0.114** (-6.397)	-0.087** (-8.759)	-0.107** (-7.789)	-0.016* (-2.220)	-0.010* (-1.974)
Fiscal dummy	15.397** (2.924)		1.073 (0.379)		5.306 (0.574)	
Railway density in contiguous provinces	0.507** (7.885)	0.316** (5.187)	0.506** (7.640)	0.421** (5.881)	0.657** (20.525)	0.514** (16.133)
Sea	3.626* (2.184)	0.106 (0.084)	-2.489* (-2.475)	-4.216** (-3.802)	3.492** (7.935)	0.714 (1.423)
Border	2.895* (2.084)	2.382 (1.848)	3.608** (4.281)	2.615** (3.348)	0.075 (0.658)	0.416* (2.534)
Adj R^2	0.68	0.86	0.93	0.93	0.51	0.62
T	5	5	5	5	5	5
No of observations	245	225	245	225	245	225

Notes: t-ratios in brackets; * 5 per cent significance level; ** 1 per cent significance level.

Table 3.
The determinants of the provincial distribution of Spanish roads.

	Total Network		State Roads		Provincial and Local Roads	
Variable	(1)	(2)	(1)	(2)	(1)	(2)
Constant	9.990 (1.895)	-13.486** (-4.487)	6.576 (1.410)	-0.871 (-0.247)	-3.923 (-1.294)	-6.959** (-5.210)
Population density	2.207** (12.152)	3.525** (19.498)	1.598** (15.175)	2.138** (12.700)	0.420** (3.582)	0.813** (14.199)
Population density sq.	-0.005** (-3.827)	-0.017** (-11.178)	-0.005** (-8.937)	-0.009** (-7.345)	0.001 (1.570)	-0.002** (-5.096)
Urbanisation rate	-0.656** (-10.195)	-0.965** (-10.776)	-0.462** (-8.971)	-0.611* (-8.471)	0.020 (0.456)	-0.197** (-9.232)
Industrial active population.	0.115** (3.309)		0.026 (1.076)		0.038 (1.591)	
Industrial tax returns per capita		0.073** (8.038)		0.028** (3.507)		0.030** (11.460)
Construction cost	-0.368** (-7.625)	-0.378** (-9.923)	-0.149** (-3.076)	-0.168** (-4.437)	-0.085** (-3.537)	-0.145** (-12.332)
Fiscal dummy	40.733** (7.136)		-62.908** (-21.155)		139.115** (9.702)	
Road density in contiguous provinces	0.664** (63.364)	0.511** (23.707)	0.690** (40.158)	0.570** (20.777)	0.420** (19.305)	0.262** (8.503)
Sea	-10.086** (-2.892)	-19.629** (-5.167)	-7.378 (-1.907)	-17.460** (-5.529)	-3.153 (-1.323)	-0.625 (-0.673)
Border	-14.520** (-8.827)	-7.362** (-5.167)	-12.740** (-9.515)	-8.253** (-8.531)	-4.435** (-4.049)	0.563 (1.405)
Adj R^2	0.97	0.95	0.96	0.95	0.81	0.83
T	5	5	5	5	5	5
No of observations	245	225	245	225	245	225

Notes: t-ratios in brackets; * 5 per cent significance level; ** 1 per cent significance level

Regarding the original hypotheses of the model, the outcomes of the estimation are mixed. As was expected, in virtually all cases provincial endowments of transport networks increased with population density at a decreasing rate. Similarly, in most cases the networks seem to have been denser in the most industrialised regions. Insofar as the level of industrialisation is a proxy for the level of income per capita of each province, it is possible to suggest the presence of a direct relationship between economic growth and transport infrastructure endowment.

By contrast, the impact of the rate of urbanisation seems to have been different among networks. Whereas broad gauge railway endowments appears to have been higher in urban areas (at least according to the first specification), the density of both narrow gauge railways and roads was instead higher in the most rural areas of the country. That negative relationship between urbanisation rates and the provincial endowment of transport infrastructure might probably reflect, in the case of roads, the public effort to bring the network to the largest possible number of people. In the provinces where population was most disseminated, the State would have financed a rather dense road network just to serve the same share of population as in urban provinces. That situation was to be found

particularly in some Northern areas of the country, such as Galicia, Asturias, Cantabria, the Basque Country or Navarre, where people used to live in relatively small centres and where, as a result, the road network had to be denser if it was to serve the transport needs of the population of the area. By contrast, no similar efforts to avoid situations of disadvantage in the most rural regions may be found in the case of the broad gauge railway network. As is well known, the lack of public financial resources led the State to establish a privately owned railway system, which would have been mainly oriented to ensure the companies' private returns and, therefore, to serve the Spanish urban markets. Only in the case of the narrow gauge lines, their lower construction cost as well as the mining character of many of them, would have allowed their extension through relatively rural areas.

Regarding interregional demand, spatial spillovers are significant in all specifications. At the same time, the development of the road network seems to have been discouraged in the coasts and the borders of the country. By contrast, the opposite effects may be noticed in the railway system. In the case of the border areas, this may be an evidence of the international orientation of nineteenth century European railway network, which was mainly devoted to medium-to-long distances, unlike roads, which were mainly used for short-term traffic. On the other hand, the positive influence of the presence of the sea on the development of the railway network might be explained on the basis of the relatively higher economic density of the Spanish coastal areas. Accordingly, the coefficients of the "sea" variable would have captured some of the effects of the regional demand variables (i.e. population density and the level of industrialisation).

As for the "supply" variables, the coefficients of construction cost are negative and significant in all cases, as was expected, whereas the coefficients of the fiscal dummy are positive in all cases (although they are not significant when the railway network is divided between broad gauge and narrow gauge lines), except for the State roads. This exception is due to the fact that most roads in the Basque Country and Navarre, even in the case of the main network, were built by the *Diputaciones* and classified as provincial.

To sum up, as far as the Spanish regional divergence is concerned, the geographical distribution of infrastructure seems to have been a clearly reinforcing factor of previous economic differences among regions, since it responded to a large extent to the population density and the level of industrialisation of each region. However, some qualifications should

be introduced within that broad picture. Firstly, some regions would have suffered the negative effect of a rough geography, as the negative sign of the coefficients of construction costs indicates. This would indeed be very relevant to explain the relative infrastructure deprivation of the North-West of the country (Galicia and Asturias) or the Canary Islands, where the density of the transport networks was always much lower in relative terms than population density.

Secondly, the institutional setting of the country was also essential to explain regional infrastructure endowments. Concretely, the special fiscal situation of the Basque Country and Navarre was clearly positive for the development of the transport network of those areas, which could always benefit from a relatively high endowment of railways and roads in relative terms.

And, finally, the financial poverty of the Spanish State, might have had non-negligible effects on the final geographical structure of the Spanish transport network. In the case of roads, whose lower cost allowed them to be built by the State or the local institutions, public construction seems to have had balancing effects on regional endowments. The road network seems to have been much more oriented by political than by economic criteria, trying to serve the largest possible number of people in each province and, as a consequence, the road network was relatively denser in less urbanised areas, in which population was less concentrated and the number of necessary links was higher. However, the lack of financial resources of the State prevented that balancing influence to go beyond the road network, and the railways, which might not be built on the basis of public resources as it was the case in other countries, seem to have been much more responsive to the level of urbanisation and development of each area than roads, and would therefore have had a much more reinforcing effect on previous situations of regional economic divergence.

4. Conclusions.

This paper has presented the results of the estimation of a model that try to explore the determinants of the uneven availability of transport infrastructure among the Spanish regions before 1936. As could be expected, the outcomes of the estimation show that regional transport infrastructure endowment largely adapted to population density and the level of industrialisation of each region, and constituted therefore a reinforcing factor of the existing

economic divergence. However, there are also some indications of mismatch between economic development and infrastructure endowment that would indicate that infrastructure also had a role in the further definition of Spanish regional economic structure. Firstly, infrastructure investment clearly responded to the level of construction costs in each region, which might have hindered the growth prospects of areas with a difficult topography. Secondly, the special institutional setting of the Basque Country and Navarre seems to have been a source of advantages for those two regions in terms of infrastructure investment. An, thirdly, there is a clear difference between the networks that were constructed on the basis of public resources (i.e. roads) and the railway network, which was mainly the result of private investment efforts. Whereas the latter was much more oriented to serve urban markets, the former had a higher density in the most rural areas of the country, showing the State's willingness to extend the network to the maximum possible number of people. In that context, the impossibility to finance the construction of a public railway network due to the lack of fiscal resources prevented from extending those equity aims to the railways, which were the main transport network of the period under study.

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