Roads And Regional Integration In Spain

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Synopsis

One of the reasons why transport facilities are developed is territorial integration across regions in a country and across Member States within the European Community. It is becoming increasingly common for infrastructure plans to cite territorial integration as one of their aims, with a view to securing adequate transport networks as a means of accessing and connecting the various regions with other areas and with their own internal districts, thus boosting their economic potential.

On the present approach to regional integration, regions seek to enhance their economic prospects by reinforcing their own capabilities so as better to mesh with an increasingly competitive and fast-changing environment. Against this background, measures must be taken to encourage trade, transport infrastructure (which for a long time has been inadequate) and industrialisation in the regions.

This paper examines the relationship between road infrastructure and regional integration in Spain and looks at hypothetical cause-and-effect relations. The research on which this paper is based compares and contrasts the behaviour of demand for road transport of freight (intra-regional and inter-regional), road transport infrastructure and wealth generated in the fifteen mainland Autonomous Communities (self-ruling regions) of Spain. The study covers the period 1995-2003. The period is sufficient to examine the various Spanish territories on both an individual and on a comparative basis.

The conclusions of the paper will clearly show that the economic development of the regions directly affects one of the key aspects of regional integration: the exchange of freight. Further, we shall assert that over the course of recent years, a few notable instances excepted, inter-regional differences in road usage have lessened.

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1.- INTRODUCTION

As in any other field of knowledge, the study of transport is often prefaced with a rationale stating the aims of the matter of inquiry and its uses for the wider community. Transport emerged and developed because of 'the need to connect urban settlements and dwelling locations; the separation between centres of production and consumption; geographical distances between resources; the search for economies of agglomeration and economies of scale, giving rise to the development of major agglomerations; the recurring movements of people; social needs for connections; strategic and military aims; access needs and territorial integration' and more.

We shall not detail the numerous uses of transport because they are well known and are largely implied in the reasons for transport cited above. We shall focus on one of those uses, which might be defined as 'helping to unify and integrate the State, the regions and the European Community through inter-connection and inter-operability of national networks' or as 'an instrument of social integration'.

Both definitions emphasise the role of transport in territorial integration: integration across regions in a country and across Member States within the European Community. The term 'transport' encompasses both the infrastructure and the service (which, with vehicles, constitutes the fundamental elements of transport); we may say that both these constituents have 'integration' among their aims.

This paper is titled *Roads and Regional Integration*; it examines the relationship between road infrastructure and regional integration in Spain and looks at hypothetical cause-and-effect relations. Further on, we shall explain why we look at roads rather than other means and infrastructure of transport. In this introduction, we shall dissect the concept of 'regional integration'.

The concept of regional integration has traditionally been associated with trade: territories, regions and countries endeavoured to foster the exchange of freight and capital, seeking wider markets and complementarity. Many such efforts hinged on two axes: trade liberalisation and the construction of transport infrastructure.

But those territories and regions often started out from a state of imbalance, and integration could in practice lead to the disappearance of weaker economies in favour of the stronger; these processes were reminiscent of the colonialism of the eighteenth and nineteenth centuries or, indeed, the way developed nations make use of developing nations. Hence it is necessary to have in place mechanisms of regional solidarity so that such free exchange is not deleterious and does not harm the countries that start from a position of lesser capabilities.

The new approach to regional integration hinges on an opening-out from each region in order to enhance its economic prospects by reinforcing its own capabilities so as better to mesh with an increasingly competitive and fast-changing environment. Against this background, , as well as to encourage trade and transport infrastructure as mentioned earlier, measures have had to be taken to foster a third element: industrialisation in the regions.

The issue, then, is not so much one of cooperation but of complementarity. The concept of regional integration points to unity. Not all the organs of the human body, for example, are equally 'vital' to survival, but all are needed, and play a role which, if lacking, the body would suffer for. The transport system is like the blood flow or nervous system, which connects all bodily organs. That disinterested integrity and unity means that the weakness of one organ is felt almost immediately throughout the whole body: hence the weak organ must be re-integrated in order to attain complementarity.

Hence the notion of regional integration, that goal of unity, has political and cultural implications as well as commercial and economic aspects. A major need is solidarity from the more developed regions or more prosperous areas within a region. Integration allows for increasing competition in the integrated whole and rising investment and growth.

From the standpoint of transport, it is increasingly common for infrastructure plans (whether nation-wide or regional), both global and sector-specific (roads, railways, etc.), to list among their aims, besides the traditional goals such as territorial structuring, improved accessibility, connection with higher- and lower-level networks, environmental protection, etc., objectives relating to territorial integration, having regard to the

economic potential of the various regions so as to provide adequate transport access and connections to other regions and areas within each region.

After examining the concept of regional integration, this paper will set out our research in the Transport Area of the Santander Faculty of Civil Engineering, consisting of analysing relationships among road infrastructure, freight transport demand and wealth creation in the Autonomous Communities (self-ruling regions) of Spain.

2. RESEARCH METHOD. INFORMATION

This paper is the outcome of research entrained over the past year at the University of Cantabria. Work began largely as a result of the cooperation requested by the University of Bari, which sought to supplement its own research in the field. The research focused on correlations among infrastructure capabilities, trade in freight, declared value of transported freight and income in the region of reference, although we soon found that it was impossible to keep freight value within the set of elements to be correlated.

We shall not address here the utility of framing correlations and models that might provide us with freight transport demand forecasts (one of the goals of any regional integration plan) or infrastructure needs favouring such demand. The primary objective of the research underlying this paper was to compare the behaviour of the relationships among freight transport demand, transport infrastructure and wealth creation in the various Autonomous Communities. What we have not attempted to do is to define functions forecasting transport demand, infrastructure needs or hypothetical economic growth in each region.

On that basis, we worked on two different lines of research. First, we sought out those correlations for all fifteen mainland Autonomous Communities in each year of the period 1995-2002.

Secondly, we studied each Autonomous Community individually, establishing the correlations for the period 1995-2002, using historic data series. We aimed to establish a basis for planning infrastructure planning and produce operational indications for the areas examined.

Having set those two main objectives for our research, our next step was to determine the variables to be correlated and seek them out for each mainland Autonomous Community. As pointed out earlier, those variables were divided into three main groups: freight transport demand, infrastructure and socio-economic features of each Autonomous Community of reference.

As regards transport demand, we worked with overall demand data, demand by means of transport and, in some cases, figures for freight dispatched and received; in all those fields figures were expressed in tons and tons per kilometre. Very soon, given that we could not obtain reliable information for railway transport in each region, we chose to focused our study of demand on domestic transport by road, although reference was also made to marine transport (in Autonomous Communities where it is present) and air transport. Domestic transport accounts for 92% of road transport, while road transport accounts for more than 85% of all domestic transport in Spain. There is a wealth of data on road transport, but not on other means of transport. Therefore, our decision to focus on roads rested on a solid rationale.

As regards infrastructure in each Autonomous Community, our search for data followed a parallel path. We first determined for each means of transport the variables that would reflect variations in transport demand. We obtained the data for roads (kilometres of road network by type of road, etc.), ports (length of docks by depth, land surface, storage area, etc.), and airports; but, as with railways, it was wholly impossible to find data by Autonomous Community.

Finally, for the social and economic features of the Autonomous Communities, we looked at variables such as population, household income and GDP (Gross Domestic Product) in each region (we used Gross Value Added – GVA – for sector-specific data).

Once we had determined the variables, we entered them in a spreadsheet, together with the new variables and indexes derived from them. In total, we worked with over sixty variables. After studying possible correlations among them, our research began to focus on a very small set, which was unsurprising given that these had also been found to be significant in earlier research in Spain and abroad.

The variables finally chosen guided our research towards examining freight transport demand in Autonomous Communities from an aggregated perspective. The variables selected to define transport demand were, as mentioned earlier, tons and tons per kilometre moved by road, as global figures and

broken down into freight dispatched and received by each Autonomous Community; only domestic transport was considered.

Infrastructure, as a determining variable of freight transport demand, was represented by the variable 'kilometres of dual carriageways and open motorways plus toll motorways'. Finally, the economic features of the Autonomous Communities were represented by GDP (Gross Domestic Product) and, for specific sectors, Gross Value Added – GVA.

The functions that best correlated the different variables with freight transport demand in all respects were linear and power functions, but power functions were finally selected in virtually all cases. The simplicity of linear functions often made them too fragile to represent the correlations. Furthermore, power models of the form $y = Ax^b$ enable us to analyse results and in some cases draw interesting conclusions on the values taken by exponent *b*, which parameter represents the elasticity of the chosen variable as exogenous as against the selected endogenous variable; its value 'reports' the degree of development of a country or region.

3. RESEARCH IMPLEMENTATION

We now present the various relationships examined, followed by analysis and commentary. First, we shall set out the results of the relationships between freight transport demand and socio-economic figures of the Autonomous Communities; next, the relations between transport infrastructure (roads) and transport demand; and finally relations between infrastructure and socio-economic figures. In all three cases we shall address both lines of research mentioned above: a study of specific years across the fifteen Autonomous Communities; and a study of each Autonomous Community over eight years (1995-2002).

3.1 Transport Demand and Production of Freight

From the outset of our research, it became clear that there was a correlation between the production of freight in an Autonomous Community and the total volume of freight (measured both in tons and tons per kilometre) transported to and from that region and other Spanish regions. We provide two graphs below. The first graph (fig. 1) shows the relationship between GDP and total domestic transport (intra-regional + inter-regional) for the fifteen mainland Autonomous Communities in 2002. The relationship is defined by the function $TotalTransport = 3.9673 PIB^{0.7713}$.

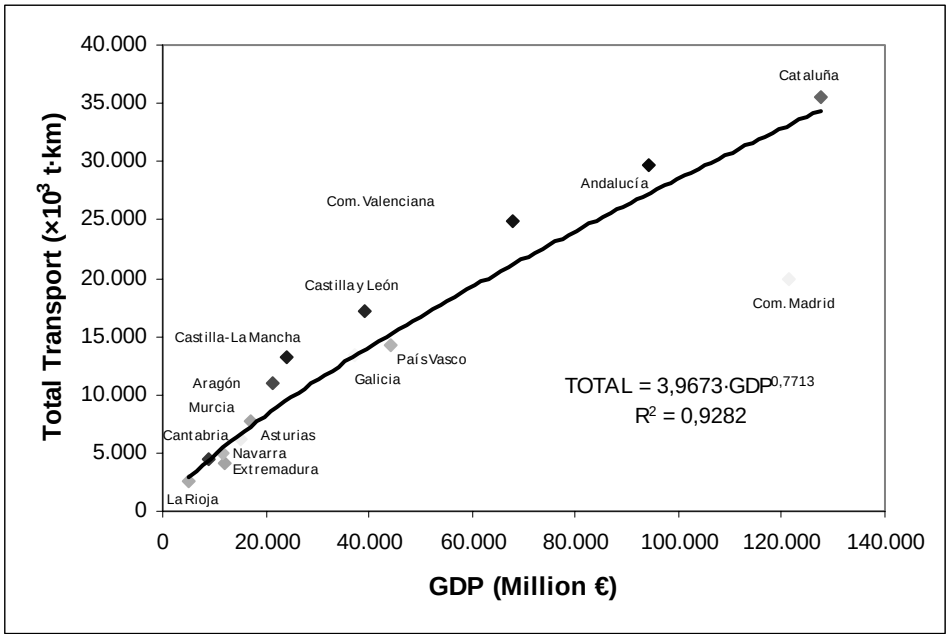

Fig. 1 – Relationship between GDP (current prices) and domestic freight transport by road (2002)

There is a close correlation (R^2 close to 0.93). The graph also shows that the Community of Madrid is an outlier from the curve, no doubt because of the significance of the services sector in its total GDP. Therefore, we have also correlated total domestic freight transport by road with the GVA of industrial activity, which also turns out to be a close correlation in every year of the reference period (1995-2002). Fig. 2 shows the correlation (the formula is shown in the graph itself) for 2002.

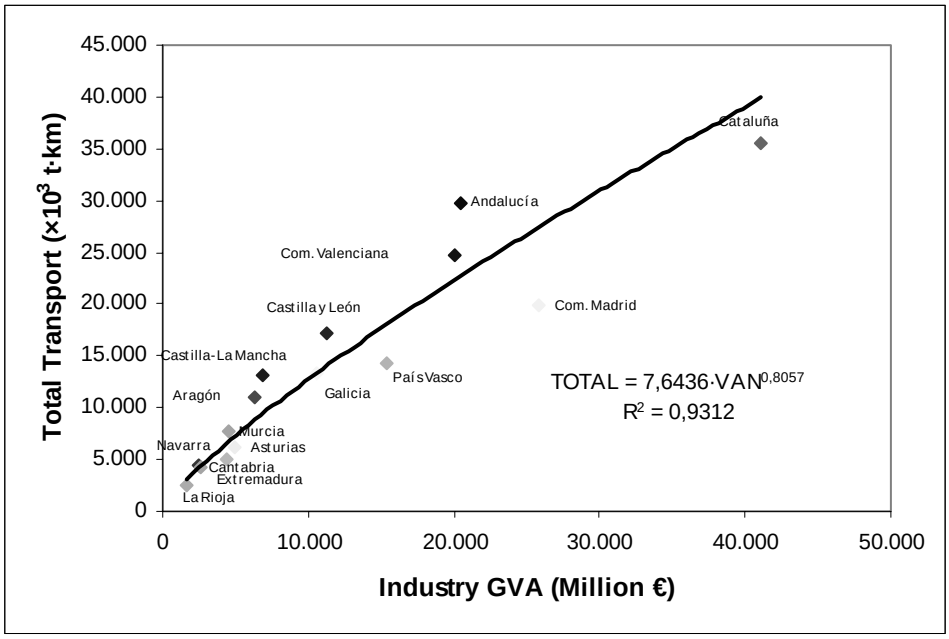

Fig. 2 – Relationship between GVA (current prices) and domestic freight transport by road (2002)

May we then draw the conclusion that there is functional relationship between the production of freight as represented by GDP or GVA and demand for freight transport by road? Since it is not possible to show the graph for every year of the period 1995-2002, we show in the table below the different coefficients of the function $TotalTransport = a * GDP^b$.

Year	a	b	R^2
1995	3.2388	0.7814	0.9242
1996	3.8714	0.7576	0.9162
1997	3.3096	0.7711	0.9125
1998	4.0522	0.7608	0.9247
1999	3.8359	0.7674	0.9187
2000	3.9965	0.7664	0.9294
2001	4.0261	0.7666	0.9172
2002	3.9673	0.7713	0.9282

Table 1. Value of coefficients of the function Total Transport - GDP

As shown, the respective values for coefficient ‘a’ and exponent ‘b’ hardly change over the eight reference years, so we may conclude that that model of the relationship between domestic transport of freight by road and GDP in Autonomous Communities holds over time, thus strongly shoring up the initial hypothesis linking economic growth in a region to the flow of freight transported by road.

Similarly, on a regional integration perspective, we can aver a strong inter-relation between the economic growth of Spanish regions and inter-regional transport of freight by road. As discussed earlier, we can design a power model relating the variables, because the coefficients hardly vary over the past few years. Fig. 3 shows that relationship in 2002, while Table 2 shows the value of coefficients of the power model $Inter-regional\,Transport = a * GDP^b$ obtained for the last five years.

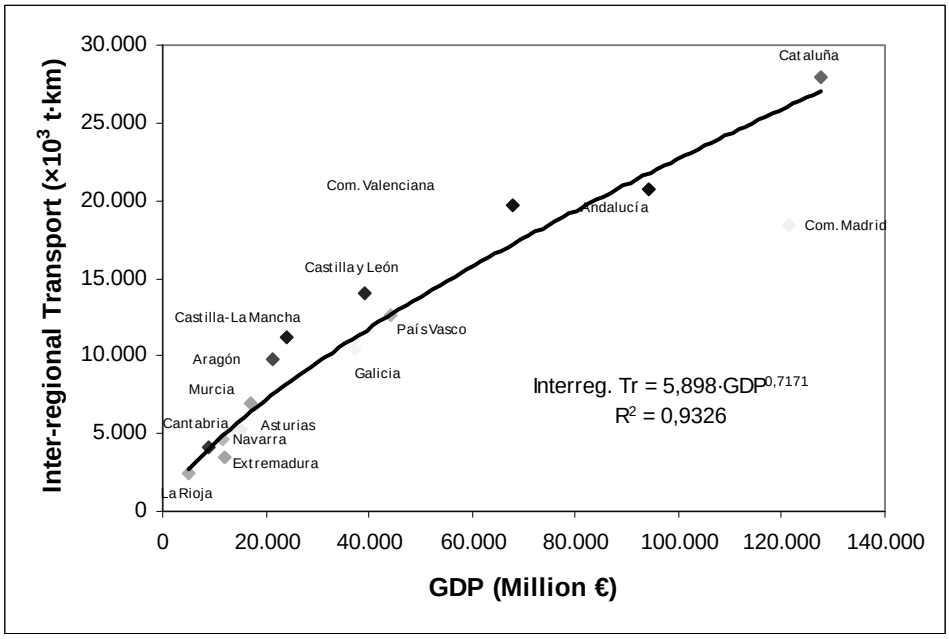

Fig. 3 – Relationship between GDP (current prices) and inter-regional freight transport by road (2002)

Year	a	b	R^2
1998	5.8121	0.7099	0.9334
1999	5.3081	0.7196	0.9302
2000	5.7162	0.7155	0.94
2001	5.934	0.7130	0.9236
2002	5.898	0.7171	0.9326

Table 2. Value of coefficients of the function Inter-regional Transport - GDP

Again, the values of the different coefficients hardly vary over the past few years, which suggests that the model used is persistent.

3.2 Transport Demand and Road Infrastructure

As pointed out in the section on research planning, one of the key objectives of our study was to examine correlations among infrastructure capabilities, trade in freight and income in the region of reference. This section will attempt to propose a model relating infrastructure and freight transport.

As also discussed above, we found that among the many variables examined the ones most likely to correlate were those on road infrastructure. As regards freight transport, therefore, we have selected domestic road transport demand as the representative variable, expressed both as tons and tons per kilometre (total domestic demand for each region, and inter- and intra-regional demand figures).

Our research is still developing its approach to infrastructure equipment, seeking a range of indexes that combine the infrastructure of the various means of transport and place them in relation to freight transport. In this paper, we simply use as the representative variable the number of kilometres of 'large capacity' roads, encompassing dual carriageways and open motorways, and toll motorways. From the beginning this variable has worked well in all correlations, although we are now looking to construct an indicator that reflects the entire road network of each Autonomous Community in terms of the capacity of each of the road types present.

As in the preceding section, we now present a range of graphs and tables of the results of the relations between freight transport by road and the large-capacity road network by Autonomous Community. Figure 4 shows the relationship between the number of kilometres of the large-capacity road network and total domestic transport for the fifteen mainland regions in 2001. The relationship is defined by the power function *Total Transport = 37.422 km*$^{0.8878}$, which shows a close correlation (nearly 0.90).

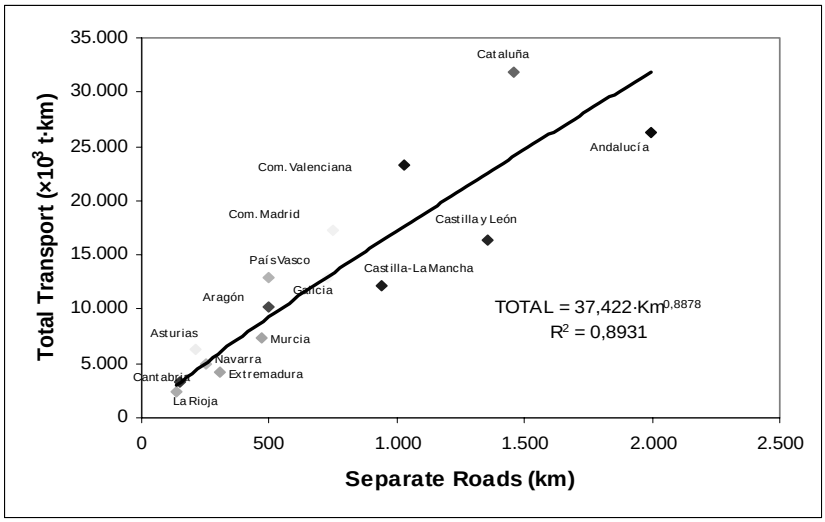

Fig. 4 – Relationship between large-capacity road network and domestic freight transport by road (2001)

We also see that in this case, for 2001, none of the regions are significantly removed from the function curve. The curve may be said to sort the regions which get the most yield (in terms of freight transport) from their large-capacity roads (above the curve) from regions which get poorer yields (beneath the curve).

Year	a	b	R^2
1995	33.891	0.8891	0.8116
1996	36.428	0.8683	0.8094
1997	30.426	0.892	0.8352
1998	42.643	0.8539	0.8425
1999	39.48	0.8684	0.8841
2000	43.724	0.8647	0.8947
2001	37.422	0.8878	0.8931

Table 3. Value of coefficients of the Total Transport function – HC road network km

May we then draw the conclusion, as in the previous section, that there is functional relationship between large-capacity road kilometres and demand for freight transport by road? Table 3 shows that the respective values for coefficient 'a' and exponent 'b' of the function *Total Transport = a·Km^b* hardly change over the seven reference years, so we may conclude that that model of the relationship holds over time.

The data in Table 3 are more widely scattered in the early years studied, and become clustered together over time. We may say, then, that over the past few years – except for some still notable differences in the development of the various regions – the gap across regions in road use has narrowed. Fig. 5 shows the point clusters produced by the functions for 1995 and 1998, respectively; besides displaying the change noted above, we can compare these data to fig. 4 on 2001.

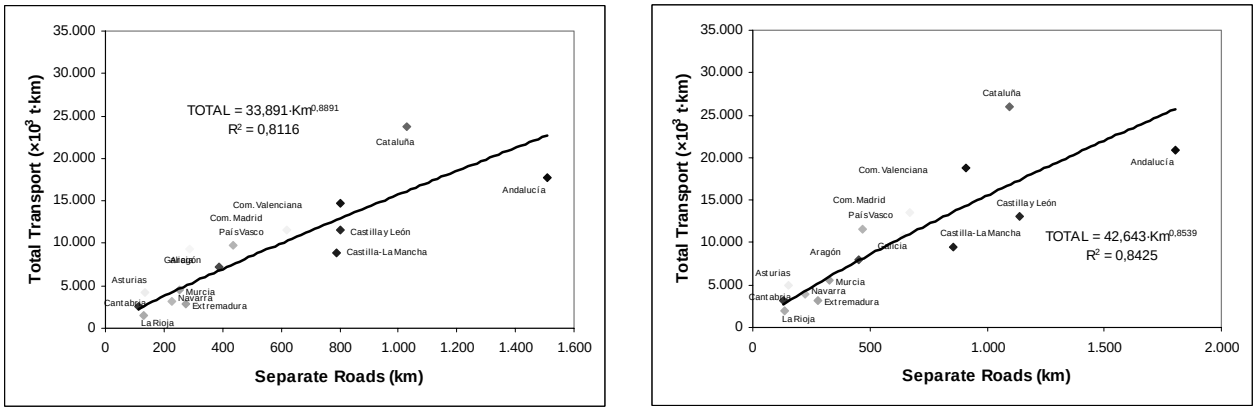

Fig. 5 – Relationship between large-capacity road network and domestic freight transport by road (1995 and 1998).

Our assertion on the narrowing of differences across Autonomous Communities in the use of road infrastructure for freight transport brings us back to the concept of regional integration. Over the years, the relationship between road kilometres (in this case, large-capacity only) and demand for freight transport is becoming clearer. On a regional integration perspective, this assertion can be extended to the relationship between road network kilometres and inter-regional transport of freight by road in each Autonomous Community.

Fig. 6 below shows the point dispersion relating both variables for 1996 and 2001. The models of behaviour defined by the functions are very similar, but in 1996 the point 'cloud' is more widely scattered than in 2001, in which the points representing the regions come close to the model curve, which is tantamount to saying that the behaviours of the various regions are increasingly similar.

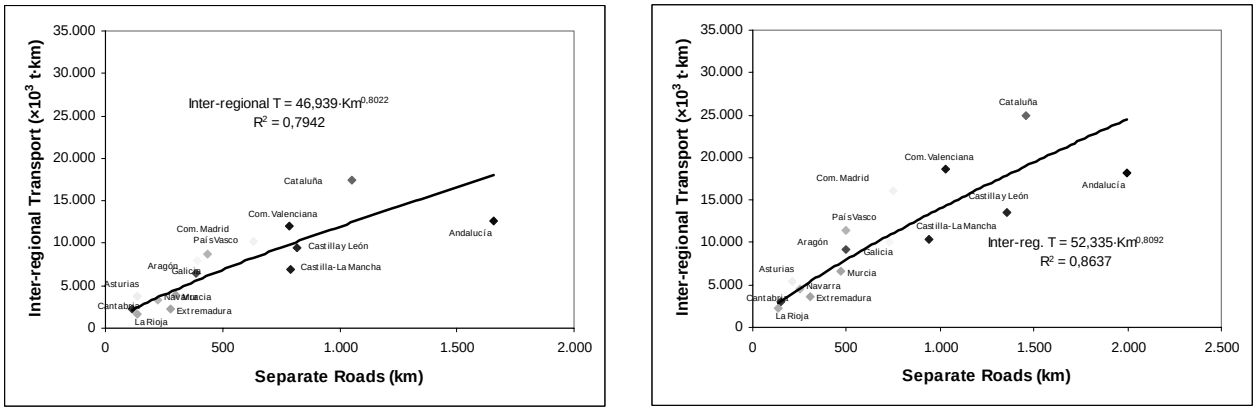

Fig. 6 – Relationship between road network and inter-regional freight transport by road (1996 and 2001)

3.3 Road Infrastructure and Production of Freight

While the two previous sections showed a favourable development toward regional integration in Spain using various models relating the production of freight with freight exchange in each Autonomous Community (by road), and large-capacity road kilometres with freight exchange, this section moves beyond those questions of regional integration and tentatively addresses the issue of whether there is any global relationship or model using aggregate variables that brings out the often merely hypothetical link between infrastructure construction and economic development. We discuss this issue because it has been one of our lines of research, although it is still at a development stage and cannot yet lead us to any major conclusions.

We will anchor this introduction with a quotation from *Transportes, un enfoque integral*, by R. Izquierdo *et al*, 1994: 'Transport, and transport infrastructure particularly, undoubtedly has had and still exerts a powerful influence on national and regional development, and has helped shape the territorial model. 'However, transport has been credited with generating economic growth and bringing about structuring effects, and this is often untrue. Nonetheless, in the 1950s and 1960s it was almost universally thought that transport created economic development, and that a causal relationship held between the two.'

For many years, therefore, transport infrastructure was planned and built on the basis of a belief in that causal relationship, seeking the economic growth that such systems would purportedly bring about. While the concepts of transport infrastructure and economic growth have in many cases been perceived as closely linked, history has also produced many instances in which such causality was not in evidence; rather, the effect of building infrastructure was contrary to what had been hoped. The same author sets forth a conclusion repeatedly reached in the various studies carried on by the European Conference of Ministers of Transport (ECMT): 'expenditure on transport infrastructure cannot of itself assure the success of a regional development policy.'

As we mentioned in the introduction, regard must also be had to the economic potential of the territory so as to provide adequate access allowing for connection among areas within the region as well as with adjacent regions. Only on this approach to transport infrastructure will it have the favourable effect sought for. Even today, many regionally focused demands are still based almost solely on the need for transport infrastructure; and though inadequate transport is probably the cause of isolation in a few cases, in many others transport infrastructure alone will not be enough to drive regional development.

The research done to date, on which this paper is based, has not been able to produce a scientifically sound model or theory providing a global explanation of the relationship between transport infrastructure and the development of Spanish regions. But several of the trends in that relationship have come to light.

Table 4 shows where we stand from the global point of view, offering various data by Autonomous Community:

- Relative increase of large-capacity road network kilometres from 1995 to 2002
- Relative increase in GDP (euros per annum) from 1995 to 2002
- Density index of the road network (network km/territory km sq) in 2002
- GDP per capita in 2002

Autonomous Community	% network growth (1995 - 2002)	% GDP growth (1995 - 2002)	Network density (2002)	GDP per capita (2002) €
Andalucía	44.52	60.64	0.02275192	12610.10
Aragón	33.32	50.36	0.01047779	17662.30
Asturias	77.09	43.81	0.01999246	14171.25
Cantabria	43.01	61.07	0.02837812	16233.54
Castilla y León	83.28	46.47	0.00994449	15775.34
Castilla-La Mancha	17.91	55.23	0.01705196	13445.86
Cataluña	16.67	53.99	0.04536962	19585.26
Com. Valenciana	33.93	64.47	0.04437755	15727.71
Extremadura	31.27	58.62	0.00742182	11132.35
Galicia	171.57	50.97	0.0245824	13548.35
Com. Madrid	21.45	65.17	0.09367215	21971.28
Murcia	76.59	70.24	0.04154513	13915.36
Navarra	19.10	58.04	0.02454047	20682.51
País Vasco	13.79	59.52	0.06856511	20918.29
La Rioja	13.31	55.52	0.0271556	18464.40

Table 4. GDP and road network indexes, by Autonomous Community

These data hardly give grounds for any conclusions about a causal relationship between growth of the large-capacity road network and GDP growth in the study period (1995-2002). The Autonomous Communities with the highest network densities, however (Madrid, País Vasco [Basque Country], Comunidad Valenciana and Murcia), are some of the regions attaining the highest relative GDP growth in the period.

To relate road network kilometres to GDP in Autonomous Communities, we show below, in figure 7, the data of the relationship for 1995 and 2001. In both cases, we have left out the datum for Madrid due to its distorting effect (as explained earlier).

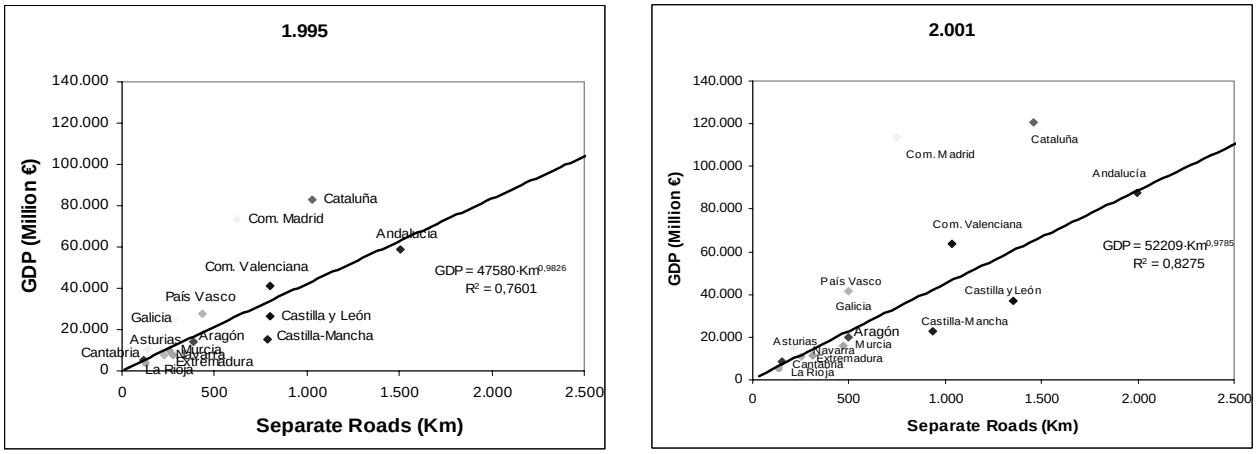

Fig. 7 – Relationship between road network and GDP (1996 and 2001)

Figure 7 shows more widely scattered data in the first study year, and how they are clustered by 2001. We may say, then, that over the past few years – except for some still notable differences in the development of

the various regions and certain local effects on their economies – the Autonomous Communities have converged in their behaviour; this assertion finds further support in the data shown in Table 4 below. In the last four reference years (1998-2001), the power function $GDP = a \cdot km^b$ relating large-capacity road network kilometres and GDP (euros per annum) hardly varies, while the road network grew by almost 20% in that period.

Year	a	b	R^2
1998	52565	0.9683	0.7999
1999	52759	0.9687	0.8361
2000	56840	0.9671	0.8404
2001	52209	0.9785	0.8275

Table 4. Value of coefficients of the function GDP – HC road network km

Finally, to show the difficulty of directly relating change in road network kilometres and change in Autonomous Community GDP, we provide figure 8. This graph examines change in that relationship over eight years (1995-2002) in the regions under study. We obtained the function relating the variables for each region individually (a power function in all cases), even where there were fairly high correlation coefficients, although this was necessary given the low number of points available (eight per region).

This shows the very wide differences in development, as underlined at the beginning of this section. Each of the Autonomous Communities may need to be examined individually to draw out trends to aid future planning.

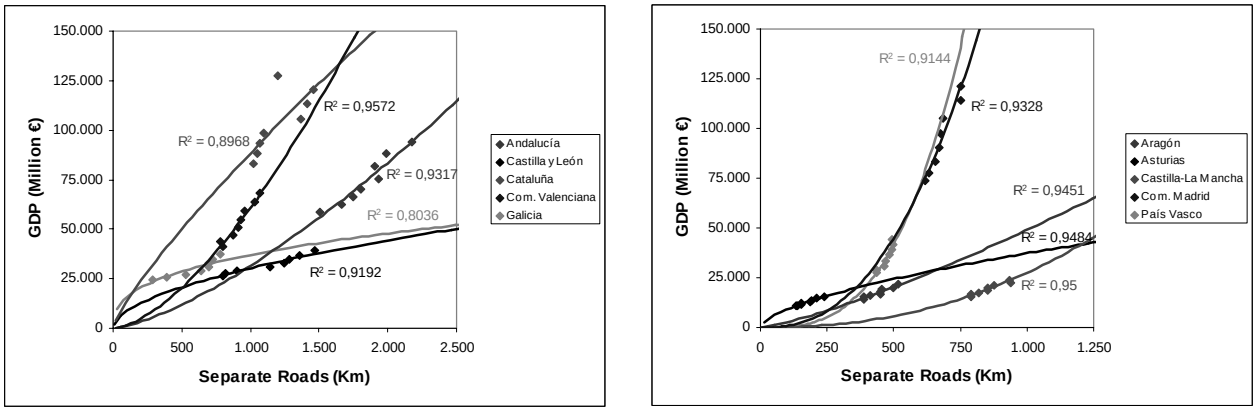

Fig. 8 – Relationship between road network and GDP by Autonomous Community (1995-2002)

4. CONCLUSIONS

The following points sum up the contents of this paper:

- The concept of regional integration involves policy measures in trade, transport (infrastructure and services) and industrialisation in regions.
- Given that one of the ways of detecting the extent of regional integration of a given community is to examine its trade relations with other areas, i.e., freight exchange, our research sought to correlate for the fifteen mainland Autonomous Communities of Spain the variables 'freight transport demand', infrastructure indicators and socio-economic features.
- The infrastructure and demand variables that work best relate to roads.
- We have brought out a correlation between the production of freight (GDP) in an Autonomous Community and the total (and inter-regional) volume of freight transported to and from that region and other Spanish regions.
- There is an acceptable correlation between large-capacity road network kilometres and the volume of freight transported to and from each region. On this model, we may then say that over the past few years – except for some still notable differences in the development of the various regions – the gap across regions in road use has narrowed.
- Although less closely related to regional integration, we have looked at the difficulty of finding a 'clear-cut' model for all Autonomous Communities causally relating road infrastructure with regional development.

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