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INFRASTRUCTURE AND REGIONAL DEVELOPMENT IN THE MAIN EUROPEAN COUNTRIES: SOME EMPIRICAL ANALYSES

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ABSTRACT

This paper considers the measurement of infrastructure endowment in the regions of the main European Union Countries: France, Germany, Italy, United Kingdom and Spain. The infrastructure categories studied are: transportation, energy and telecommunication (belong to the group of so-called economic infrastructure) and education (from the so-called social infrastructure) and they are aggregated to obtain a physical indicator of infrastructure endowment. This amount of information offers, in the first place, the possibility of analysing the disparities among the regions and studying the trend of infrastructure endowment levels in the regions of the five Countries considered over the time. Besides, the indicator obtained allows us to realice different empirical analyses to stablish the role of this endowment for regional development.

I. INTRODUCTION AND MEASUREMENT OF THE INFRASTRUCTURE ENDOWMENT

This paper considers the measurement of infrastructure endowment in the regions of the main European Union Countries: France, Germany, Italy, United Kingdom and Spain. The infrastructure categories studied are: transportation, energy and telecommunication (belong to the group of so-called economic infrastructure) and education (from the so-called social infrastructure) and they are aggregated to obtain a physical indicator of infrastructure endowment. This amount of information offers, in the first place, the possibility of analysing the disparities among the regions and studying the trend of infrastructure endowment levels in the regions of the five Countries considered over the time. Besides, the indicator obtained allows us to realice different empirical analyses to stablish the role of this endowment for regional development.

The analysis approach – with regard to the base data collection and the method of statistic analysis of the indicators – is, as much as possible, in line with the one already used in similar studies carried out on the same topic in the past (in particular, in the study conducted by Ecoter on behalf of Centro Studi Confindustria at the end of the 80s).This approach allows to significantly compare the current situation (1995) to that of 1985.

The territorial composition of the base statistical data corresponds, as already mentioned, to the Eurostat NUTS 2 level for all the Countries considered, divided by Nation as follows:

Country	**Number of NUTS 2 regions**
Germany	38
Spain	17
France	22
Italy	20
United Kingdom	35
Total (UE5)	132

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Main, intermediate and elementary infrastructure categories (NUT 2 Regions UE5)

Infrastructure categories	*Weights*
TRANSPORTATION	
Roads	
- Highways (km)	width lanes
- Main roads (km)	width lanes
- Provincial roads (km) width lanes	
Railways	
- Electric railways with double track (km)	4,5
- Non electric railways with double track (km)	3,0
- Electric railways with simple track (km)	1,5
- Non electric railways with simple track (km)	1,0
Airports	
- Surface of principal airports runaways (mq)	
Ports	
- Total length of berthing (m)	
COMMUNICATION	
Telephones	
- Office telephone links (n.)	
- Home telephone links (n.)	
- Public telephone links (n.)	
ENERGY	
Electric power supply	
- Electroducts of 200/220 kv (km)	1/10 kv line
- Electroducts of 380/400 kv (km)	1/10 kv line
Oil	
- Oil pipelines (km)	
Gas	
- Gas pipelines (km)	
EDUCATION	
High schools	
- Pupils in vocational training (secondary level) (n.)	
Universities	
- Students (n.)	

Once elementary indicators have been identified, the problem of their aggregation in increasingly synthetic levels arouses: from elementary categories (for example, highways) to intermediate ones (for example, roads) and from these to main categories (transportation), to the indicator synthetically expressing the overall level of infrastructure endowment of the territorial unit considered.

This problem was faced by using an approach which was experimented and improved in previous analyses, producing satisfying and reliable results, even if they could be still obviously improved. Briefly, the procedure adopted for the aggregation and the synthesis of infrastructure indicators is structured as follows:

i) building of the elementary indicators of endowment for the single infrastructure categories;

ii) normalization of elementary indicators, referring the elementary data to territorial surface (space serving infrastructure) or to population (population serving infrastructure);

iii) standardization of normalized indexes, referring the normalized indicators to their maximum in each category;

iv) aggregation of standardized indicators in a synthesis indicator representing the overall infrastructure endowment, by arithmetic or geometric mean, respectively within each main category or between different main categories.

II. MAIN RESULTS FROM THE EUROPEAN REGIONS

The indicators obtained allow to compare the situation among the European regions. The situation of the overall infrastructure endowment is clear, with United Kingdom and Germany clearly above the other three Countries considered. Among the latter, France is substantially in line with the average of the five Countries, while Italy shows an overall level of endowment slightly lower than the average and Spain still seems to be at a much lower level (about 30%) as compared to the UE5 average.

The classification at the European regional level shows that within the first ten positions are 5 British regions, 4 German regions and one French region (Ile de France, the Paris area); among the last 10 classified regions there are a total of 5 Spanish regions, 3 Italian regions, and one French and one British region.

Table 1. Overall infrastructure level in 5 European Countries (UE5 average = 100)

Country	Synthetic index of infrastructure endowment
Germany	115,9
Spain	71,4
France	101,8
Italy	95,0
United Kingdom	117,9

Considering that it is more significant to refer to a classification of classes, rather than to an ordinal classification, we obtain the results summarized at the Country level in Table 3 and Map 1. More than a half of the 132 regions falls

within the two medium classes, with a slight prevalence of the medium-low class over the medium-high one. Of the remaining half, about 2/3 is in the higher area of the classification (synthesis indicator over 125), while 1/3 is in the lowest area (synthesis indicator below 75)[1].

Table 3. Classification of the European regions by level of overall infrastructure endowment and by Country, 1995 (UE5=100)

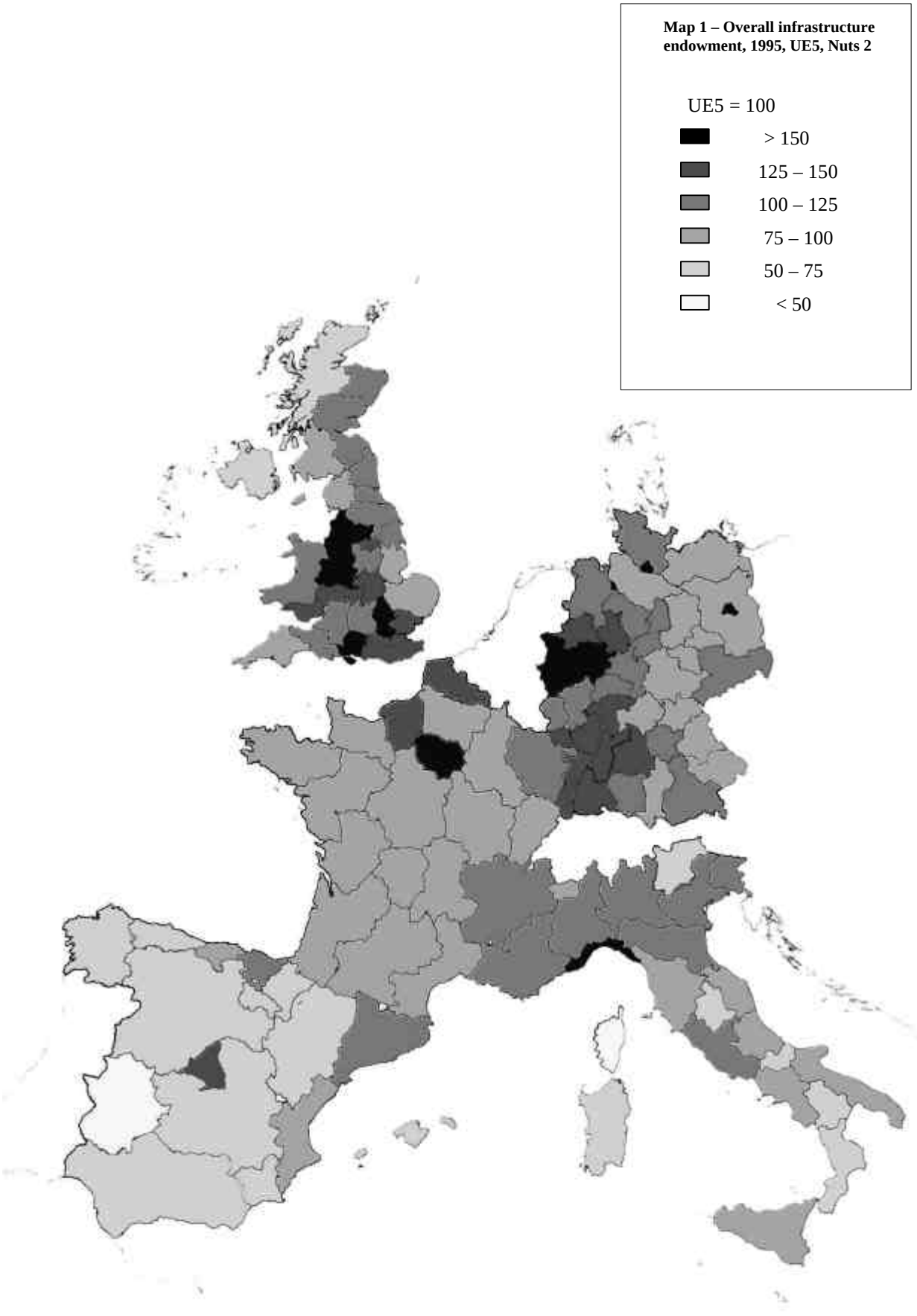
Country	Distribution of the regions by class of infrastructure endowment						
	Very low	**Low**	**Medium-low**	**Medium-high**	**High**	**Very high**	**Total**
Germany	-	-	11	13	8	6	38
Spain	2	10	2	2	1	0	17
France	1	-	14	3	3	1	22
Italy	-	6	7	6	-	1	20
U. K.	-	2	5	11	7	10	35
Total	3	18	39	35	19	18	132

1 Similarly to the analyses previously carried out, 6 classes of infrastructure endowment were identified, each one from an inferior extreme to a superior extreme of the synthetic indicator, according to the table reported below.

Class	Infrastructure endowment	Synthetic indicator *
I	Very high	150,00 and more
II	High	125,00 – 149,99
III	Medium-high	100,00 - 124,99
IV	Medium-low	75,00 - 99,99
V	Low	50,00 - 74,99
VI	Very low	Until 49,99

***** Overall levels of infrastructure endowment (UE5 Average = 100)

Map 1 – Overall infrastructure endowment, 1995, UE5, Nuts 2



If the distribution by Country is examined remarkable differences are shown:

- no German region is below the medium-low class and also United Kingdom and France have very few regions in the classes with the lowest endowment (2 United Kingdom and 1 France, respectively). This means that, clearly, almost all the regions falling within the two lowest classes are Spanish and Italian: of the 21 regions, about 60% are Spanish and little less than 30% are Italian;

- conversely, almost 85% of the first two classes include German and British regions, the latter being the most numerous in the excellence class (over 18 regions belonging to the first class 10 are British, versus 6 German ones and one French and one Italian);

- no Country has at least one region in each class. As a matter of fact, the distribution is either towards the top of the list (Germany and United Kingdom) or towards the end of the list (Spain), while France and Italy have a strong concentration in the two intermediate classes (in particular, more than 3/4 of French regions fall within these classes and almost 2/3 in the medium-low class).

The results obtained can be examined also form the point of view of the consistency of the two opposite phenomena of infrastructure under-endowment and over-endowment, since this consistency is measured in terms of demographic or territorial incidence of the regions concerned as compared to the average of the five Countries (Table 4).

On average, little more than half of the regions of the five big European Countries, – about 63% of the population – enjoy the appropriate level of infrastructures. With regard to the single Countries, in Germany and United Kingdom about 80 inhabitants out of 100 live in regions where the infrastructure endowment is higher than the average UE5 level; in France and Italy, this

percentage is little more than 50%; while in Spain only 1/3 of the population enjoys a level of infrastructures in line with the European average.

Table 4. Synthesis of the level of overall infrastructure endowment of the European regions by Country, 1995 (UE5=100).

Country	% incidence of European regions – in terms of number, population and surface – according to the level of infrastructure endowment					
	Endowment lower than the average			Endowment higher than the average		
	Regions	Population	Surface	Regions	Population	Surface
Germany	28,9	23,5	43,9	71,1	76,5	56,1
Spain	82,4	66,3	90,6	17,6	33,7	9,4
France	68,2	47,0	73,5	31,8	53,0	26,5
Italy	65,0	48,3	60,1	35,0	51,7	39,9
United Kingdom	20,0	15,6	41,4	80,0	84,4	58,6
Total	45,5	37,1	66,5	54,5	62,9	33,55

By separately examining the infrastructure endowment of the 132 regions and the 5 Countries in terms of. the four main categories analyzed, it is possible to see – by simple dispersion indexes: maximum-minimum-ratio (MMR) and standard deviation (SE) – that, within the four series, there are some unbalances between the regions that are rather consistent with regard to the transportation and energy infrastructure endowment, while the situation is much more balanced in the telecommunication network sector and in the education infrastructures (Table 5).

Table 5. Indexes of regional dispersion by the four main infrastructure categories

Dispersion indexes	Transportation	Energy	Telecommunication	Education
SE	199,7	119,8	13,6	22,0
MMR	60,8	322,7	2,1	3,2

The endowment levels that can be observed in each of the four main infrastructure categories are summarized in Table 6 below by Country.

In the **transportation** sector, the best endowed Country seems to be United Kingdom with 85% higher than the average level of the 5 Countries. Probably this is the sector where differences due to the different size of the territorial units studied are most likely to be observed. As a matter of fact, besides British regions (London area, particularly) are the German city-state (Berlin, Hamburg, Bremen) that fall within the top positions of the classification according to the transportation infrastructure endowment

Table 6. Endowment levels by main infrastructure categories in European Countries, 1995 (average UE5 endowment = 100)

Country	Main infrastructure categories			
	Transportation	Energy	Communication	Education
Germany	120,1	153,5	96,6	101,2
Spain	48,6	65,0	95,7	86,1
France	98,4	104,0	115,2	90,9
Italy	97,1	92,9	92,2	98,0
United Kingdom	184,9	85,4	100,1	122,4

With regard to infrastructures in the **energy** sector, Germany is the most endowed Country on average and it's a German region –Hamburg region – that has the best performance among the 132 European regions. More in general, the synthesis indicator for the energy sector is high in all the regions with big urban centers: Bremen, Dusseldorf, Greater London, Berlin, Madrid, Île de France, Lombardia and others. More specifically, the differences of endowment between the Countries seem to be attributable also to the prevailing type of energy infrastructure: electric system, gas or oil pipelines.

With regard to **communication**, the most endowed Country is France, and a French region is the most equipped one (Île de France), with an endowment of 132,7. Overall, however, the presence of the communication (telephonic) systems seems rather balanced, as it is clearly indicated by the dispersion indexes above calculated (Table 5).

The fourth main infrastructure category analyzed is **education**. Also in this case, like in communication sector, differences between national and regional endowments are much less important than those concerning transportation and energy sectors. Among the Countries, United Kingdom showed the highest endowment level, and also at the regional level a British region has the maximum value of the education indicator (North Yorkshire, level of 157). Germany is the other region with an indicator higher than the UE5 average, and in this Country Bremen is the best endowed region. Spain, Italy and France levels are all under the UE5 average; moreover, Spanish regions present the lowest levels of the synthesis indicator in this sector (Baleares and Castilla-Mancha).

The comparison period was identified as the decade starting from the last year when data were available (1995, according to the quantifications summarized in the preceding paragraph 3) and, ending with the year of reference of the analyses already conducted on this topic (1985, subject of the quantifications of the previous study conducted by Confindustria-Ecoter)[2].

It is important to underline that the difficulties associated with the comparison – the main ones: new estimate for 1985 of indicators referring to the 5

2 Obviously, as always in this kind of analyses, these are two "conventional" years, representing a sort of average between assessments actually referring to previous or successive periods of time, according to the specific availability of information for the single categories considered

Countries considered instead of the 12 in the previous study; different territorial basis in 1985 for United Kingdom, France and Germany; impossibility for some categories to refer to the same indicators used in the 1985 analysis (in particular, for airports, gas pipelines, electrification[3], and partially communication) – did not allow to create "punctual" comparisons in the decade considered in the endowment levels of all the categories. The available data referring to the two periods can be considered sufficient, on the contrary, to allow a comparison between the "relative positions" of the Countries and regions considered in the defined classes of infrastructure endowment[4].

The assessments made on the development or delay in development of the European Countries and regions must therefore be considered within this methodological environment, being judgements on developments or delays vis-a-vis the UE5 average calculated for the two years studied.

With regard to the performance of the 5 Countries during the two periods considered (Table 7), the first consideration resulting is the slight nearing of the infrastructure endowment levels: the distance between the best and the worse national endowment, of 2,3 in 1985, after ten years is reduced to 1,6, showing that the less endowed Countries (Spain and Italy) improve their relative position versus traditionally stronger Countries[5]. Moreover, among the latter, a remarkable

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3 In particular, the energy infrastructure endowment levels in 1985 and in 1995 are not perfectly comparable especially in terms of electric power network. As a matter of fact, in 1985, 5 different categories of networks were considered (50-62 kv, 110-132 kv, 220-275 kv, 280-400 kv and >400 kv) while for 1995 data homogeneous between the Countries are available only for two different types of networks (200-275 kv and 380-400 kv). Therefore the difference in the background data does not allow to assess exactly the actual change in the level of endowment over ten years.

4 It should be noted that regions belonging to the former Eastern Germany (DDR) are included in the analisys between 1985 and 1995, because of reconstruction of infrastructure indicators for 1985.

5 Obviously, if we examine the data of infrastructure endowment at the regional level, the dispersion is much wider due to the higher number of the areas considered, but the

difference is to be noted between Germany and Great Britain, on the one hand, and France, on the other. The former always improve their situation and record an increase in their overall endowment as compared to the 5 Countries all together (the positive difference vis-a-vis the UE5 average was 5 to 8% in 1985 and 16 to 18% in 1995); France, on the contrary, looses the top position it used to have ten years ago (overall indicator of 131) and after ten years is just above the UE5 average (indicator of 102).

Tab. 7. Levels of infrastructure endowment in main categories, per Country, 1985 e 1995 (UE5 = 100)

	Transportation	**Energy**	**Communication**	**Education**	**Synthesis Index**
1985					
Germany	125,4	72,5	108,3	125,4	105,4
Spain	61,4	23,9	70,4	107,1	57,7
France	127,8	204,9	128,3	87,5	130,9
Italy	101,6	56,3	73,7	100,5	80,7
U. K:	149,5	117,6	107,8	72,7	108,4
1995					
Germany	120,1	153,5	96,6	101,2	115,8
Spain	48,6	65,0	95,7	86,1	71,4
France	98,4	104,0	115,2	90,9	101,7
Italy	97,2	93,0	92,2	98,0	95,0
U. K:	184,9	85,4	100,1	122,4	117,9

With reference to the infrastructure categories for which it was possible to make a significant comparison between the levels of the relative synthesis indicators

reduction of the gap over time is however confirmed: the maximum and minimum ratio is also in this case decreased, even if less (from 12 in 1985 to 9 in 1995).

observed in two periods considered, the following considerations can be summarized:

- Spain, although remaining at the last position as compared to the other 4 Countries, has experienced a relative remarkable improvement in almost all the infrastructure sectors. Its performance in the road sector is particularly important: the endowment indicator has doubled during the decade, versus an increase of little more than 1/3 of the average of the 5 Countries; also its progress in the port infrastructures and oil transportation is remarkable;

- on the opposite, there is the position of France, that looses relative positions in the transportation (especially, roads), in communications and gas pipelines and gains a few positions only in the port infrastructures[6]. The overall results, as already mentioned, is a clear delay vis-a-vis the UE5 average;

- the changes in endowment observed in Germany are less remarkable (but for an improvement in the energy transportation), in Great Britain (but good performance is reported in road transportation and education) and in Italy (looses positions for roads and ports, is more or less in line with the average for the other sectors).

The regional results of the ten-year dynamics can be effectively synthesized in terms of positions lost or gained by the single regions with regard to the inclusion of each region in one of the infrastructure endowment classes above defined and, therefore, to the change or maintenance of one class as compared to the results of 1985 (Table 8).

6 On Energy category see footnote n. 5.

Overall, more than 50% of the regions considered improved their relative position going from a lower endowment class to a higher one, thus showing an overall improvement in the European infrastructure endowment during the decade studied.

At the Country level, we observe that Italy and Spain report remarkable improvements of their regions (75% of the Italian regions and 60% of the Spanish ones to a higher class), as it was to be expected since both Countries were in the last positions of the UE5 classification in 1985 and could do nothing but improve their positions. For the same reasons – although opposite, being the Countries that recorded the best performances in 1985 – a substantial stability could be expected for French, German and British regions in terms of infrastructure endowment classes.

Table 8. Positions lost and gained between 1985 and 1995 by European regions UE5 in terms of class of infrastructure endowment

Countries	Regions by type of change			
	lost positions	maintained p.	gained p.	total regions
Germany	0	14	24	38
Spain	0	7	10	17
France	11	9	1	21
Italy	0	5	15	20
United Kingdom	1	5	5	11
Total	12	40	55	107

In fact this stability is rather consistent in these three Countries, involving between 37 and 45% of their regions; but the remaining 55-63% show completely different behaviors in the three Countries: in Great Britain and especially in

Germany, the regions which are not stable change their position towards higher endowment classes, while in France more than a half of the total regions (practically all the unstable ones) loose positions and fall within lower endowment classes[7].

The observation of a transition matrix, built basing on the positions occupied by European regions in the infrastructure endowment classes between the beginning and end of the period considered (Tab. 9), allows to confirm the trend toward the reduction of the regional differences. As a matter of fact, the presence of more important values in the boxes over the main diagonal is a clear sign of the distribution sliding toward the higher endowment classes.

Table 9. Transition matrix of European regions between 1985 and 1995 according to their infrastructure endowment class. Percentage incidence of regions in each class as compared to the total distribution of the initial year.

1985	1995						Regions Total
	< 50	50 - 75	75 - 100	100 - 125	125 - 150	> 150	
< 50	11,8	64,7	23,5				17
50 - 75		26,1	56,5	17,4			23
75 - 100			48,0	48,0	4,0		25
100 - 125			25,9	40,7	25,9	7,4	27
125 - 150			14,3	28,6	28,6	28,6	7
> 150					22,2	77,8	9
Regions total	2	17	37	29	12	11	108

7 Obviously, these considerations on the positioning of the regions in the endowment classes should be softened by observing the levels of the synthesis indicator. Considering the latter, we observe that, for example, though loosing relative positions, all the French regions have still today an endowment level higher than 75% of the 5 Countries average; conversely, the Spanish regions, though showing a clear improvement in the relative positions, are still experiencing a severe delay vis-a-vis the other four Countries.

Finally, some useful indications can be drawn from the simultaneous examination of synthesis infrastructure indicators and per capita GNP levels in the two reference periods (Table 10).

In particular, it can be observed that:

- over these 10 years Germany, Spain and Italy have experienced a relative growth of the infrastructure endowment, together with a similar positive trend of per capita GNP;

- in Great Britain, the infrastructure growth occurred was not associated to any similar trend of the relative development levels;

- finally, France's relative position worsened both in terms of infrastructure endowment and per capita GNP, more the former that the latter.

Table 10. Overall levels of infrastructure endowment and per capita GNP in the 5 European Countries, 1985 and 1995 (UE5=100)

Countries	Infrastructure endowment				Per capita GNP			
	1985		1995		1985		1995	
	a. v.	v. c.	a. v.	v. c.	a. v.	v. c.	a. v.	v. c.
Germany	105,4	0,467	116,0	0,435	124,1	0,190	142,9	0,266
Spain	57,7	0,386	71,6	0,352	61,0	0,198	63,5	0,186
France	130,9	0,288	102,1	0,276	129,1	0,149	116,1	0,178
Italy	80,7	0,498	94,4	0,280	70,6	0,264	82,3	0,253
United Kingdom	108,4	0,285	117,6	0,278	95,2	0,110	83,4	0,103
UE5	100,0	0,507	100,0	0,422	100,0	0,378	100,0	0,350

N.B. A.V. = absolute value
V.C. = coefficient of variation

III. THE INFRASTRUCTURE–DEVELOPMENT RELATIONSHIP

Form the theoretical point of view, we assume the "Regional Development Potential" approach, according to which a better infrastructure endowment increases the productivity of private investments and reduces their production costs. Consequently, a better infrastructure regional endowment (even if this is not the only important element) will result into a higher potential revenue and employment.

According to this approach, the Regional Development Potential is a function of "public" capital stock; private resources (traditional production factors as private capital and qualified work) are necessary to fully *exploit* this Development Potential, but they do not *determine it*. The higher the public capital endowment is, the more it is possible to adequately compensate the mobile production factors thus maintaining or attracting them in that region. An excellent combination of public and private resources helps a region reach an actual *output* level similar to the potential one.

The several studies published in literature on the empiric verification of these assumptions (both papers estimating the infrastructure capital stock using monetary variables and papers using estimates in terms of physical indicators) confirm a strict statistical association between the infrastructure variables and the development variable. Moreover, when the functional form adopted allows it (for example, through a Cobb-Douglas), they indicate a level of product elasticity as compared to the infrastructure stock that is constantly high: between 0.30 and 0.50 if infrastructures are the only explicative variable considered in the function, still around 0.20 if near the infrastructure endowment other variables explicative of the development level are present.

Keeping in mind these considerations, we carried out also in this study the quantitative verification of the infrastructures-development relationship. To this purpose, we used, on the one hand, the synthesis indicators of infrastructure

endowment previously built and, on the other, alternative indicators of the regional development (drawn from the EUROSTAT available documentation - reference year 1995), including:

- per capita GNP (PILAB), as measurement of the average level of development of the regions considered;

- per employed GNP (PILOC), that through the measurement of the average productivity of work allows to have a reasonable proxy of the production system efficiency;

- the industrial value added (DVAIN) per surface unit, that measuring the degree of presence of industrial activities in the region[8] can be assumed as the expression of the competitiveness of local industrial systems.

The correlation of the first development indicator considered (per capita GNP) and the overall infrastructure endowment registers values around 0.50 (Table 11). On this level, the following factors have a negative influence:

– from the territorial point of view, the fact that the United Kingdom regions show a correlation between per capita GNP and overall infrastructure indicator equal to half of the overall one registered for the 5 Countries considered. This low correlation can depend on the fact that this Country experienced over the last decade a non-consistent trend between infrastructure endowment (increasing) and economic development (decreasing). This seems to have been a “revolution” of the

8 Since data on the industrial added value are not available for Germany and Great Britain, for these Countries the indicator refers to NUTS 1 regions (11 for Great Britain and 10 for Germany, for which also the information about the Eastern regions is missing). The correlation analyses which will follow will therefore be made in this case on a lower number of observations, equal to 80 regions.

traditional co-presence in the most developed regions of high development levels and high infrastructure endowment[9]

– from the sector point of view, the fact that the Transportation and Education categories show a low level of correlation. In particular, Transportation is little correlated with per capita GNP in Italy, being the endowment of this type of infrastructures almost completely independent from the level of development reached in the different regions: that seems to highlight an under-endowment situation in the most developed areas of the Country and of over-endowment in the less developed areas; with regard to education, the low correlation may be due to the fact that this infrastructure provides a socially useful service, linked more to the population needs that to the production system ones.

With regard to other development indicators, in the case of GNP per employed the correlation is slightly lower than the value verified for GNP per inhabitant; however, the existence of a stronger binding with energy and communication sectors is confirmed.

Tab. 12. Correlation coefficients between development and infrastructure endowment indicators (by category and overall). UE5 regions, 1995.

Development indicators	Infrastructure categories				
	Transport.	Energy	Commun.	Education	Overall
PILAB	0,27	0,56	0,48	0,20	0,49
PILOC	0,17	0,48	0,49	-0,02	0,34
DVAIN	0,55	0,83	0,29	0,56	0,89

9 Another reason, more "statistic", for the low correlation reported in Great Britain is the fact that for this Country, at the regional level, data on the communication infrastructures for 1995 were not available and this seems to be on average the category more strongly related to the development level. As a matter of fact, for the three Countries (Germany, Spain and Italy) for which the data at the regional level is complete and available, the correlation levels in both periods are about 0.80

With regard to the location of industries, its correlation with the infrastructure endowment is absolutely higher than that observed for the other development indicators (with a partial exception for the communication category), as highlighted by a value almost twice as much as the coefficient with the overall index of infrastructures. This can be attributed to the fact that the concentration of industrial sites cannot be independent from an adequate level of infrastructure services, especially those for transportation and energy provision[10].

However, the relationship between the infrastructures at the development level is not necessarily of a linear type. On the contrary, if we want to estimate a so-called "quasi-production function", where the per capita income is explained by appropriate synthesis indicators of infrastructure endowment and by other development factors, it is more appropriate to use a function of exponential, expressed in terms of logarithm variables, where the coefficients express the elasticity of the product as compared to each explication variable, including the one representative of the infrastructure endowment.

According to the theory of the Regional Development Potential, among the factors that, together with infrastructures, influence the development of a regional economy in the medium-long term, the following are considered the most important ones: i) localization as compared to the main centers of economic

10 On the other hand, the fact that Eastern Germany regions were not considered and that the analysis for German and British regions was limited to NUTS 1 level undoubtedly contributes to the reduction of the number of anomalous observations which tend to reduce the degree of correlation between the series.

activity; ii) agglomeration consistency of the different territories considered; iii) sector structure of the local production apparatus; iv) activity rate of the relative regional populations.

These variables substantially identify and synthesize the productive potential of a given territorial economic system. In other words, thanks to their presence, the private production factors, work and capital, can be exploited in an effective way in order to increase competitiveness in an area at a national and international level.

The indicators used to represent the factors having an impact on the regional development are the following:

Infrastructure INFR	Synthesis indicator of overall infrastructure endowment
Location PER	Distance (in km) of the various regions from the center characterized by the most intensive economic activity (Frankfurt)
Agglomeration DPOP	Population density (inhabitants per kmq) at NUTS2 regions level
Labor force ATT	Activity rate (working forces ranging from 15 to 65 years over the regional population with corresponding age)
Sector structure OINSER	Share of people employed in non-agriculture activities over the total number of employed people
OIND	Share of people employed in the industry over the total number of people employed
OSER	Share of people employed in the services sector over the total number of people employed

Table 12 reports the results of the “quasi-production function” estimates, expressed in the double-logarithm form, where the above-identified variables were

included. Moreover, some "dummy" variables were included for the regions of Eastern Germany and Great Britain[11].

Table 13. Estimate of the quasi-production function with reference to three separate dependent variables

	Development level indicators (dependent variables)		
	LNPILAB	LNPILOC	LNDVAIN
C	-8,360 **	1,628 **	-2,837 *
	(-4,533)	(3,057)	(-2,502)
LNINFR	0,386 **	0,351 **	1,139 **
	(5,276)	(5,545)	(5,026)
LNDPOP	-0,074 **	-0,054 *	0,774 **
	(-3,152)	(-2,609)	(9,833)
LNOINSER	1,552 **		
	(3,527)		
LNOSER		0,540 **	
		(4,308)	
LNPER	-0,076 **	-0,088 **	-0,387 **
	(-4,449)	(-6,393)	(-5,238)
LNATT	1,258 **		
	(7,042)		
DUMUK	-0,496 **	-0,468 **	
	(-11,34)	(-15,20)	
DUMDEE	-0,412 **	-0,329 **	
	(-6,419)	(-6,053)	
Observations:	130	130	80
R-squared	0,826	0,789	0,921
Adjusted R-squared	0,816	0,778	0,918
S.E.	0,138	0,128	0,368
F-statistic	82,85	76,54	296,4
Prob (F-statistic)	(0,000)	(0,000)	(0,000)

* 95% significance level

** 99% significance level

11 For German Countries, some historical considerations can justify the fact that the development level is significantly lower as compared to that expected considering their regional characteristics. With regard to British regions, the lower level of revenue is to be probably attributable to the reconversion ongoing in the less-industrialized areas, where the conditions for the location of production activities in the medium-long range are however favorable.

Generally speaking, the determination coefficient (R^2) reveals a high degree of adaptation of the model, with a value around 0.8 both for the development indicator (GNP per inhabitant) and for the value of the overall efficiency (GNP per employed person). The estimate is still better if we take the industrial activity density in the area as dependant variable (determination coefficient over 0.9).

In the three functions considered – therefore independently from the dependent variables used as expression of the development regional level – the degree of infrastructure endowment is a powerful explicative variable (see also the t-Student high value) of the corresponding regional development level.

In particular, considering the function where GNP per inhabitant is the dependant variable, the variables selected are those related to the location, the sector structure (calculated as percentage of people employed in non-agriculture activities), the infrastructure endowment, the activity rate and the population density. All the variables, excluding the latter, present the expected sign and have a significance level of 99%. The per-capita product elasticity as compared to infrastructures, that is the relative contribution of public capital to the product growth, results to be high, reaching levels slightly below 0.4.

The function where the dependent variable is work productivity does not present characteristics very different from the previous one, both with regard to the degree of adaptation to the model and with regard to the values of the coefficients of the explicative variables. The only remarkable difference concerns the indicator of the sector structure, stressing the presence of productivity levels much higher in the economies which are more oriented towards the services sector.

Finally, particularly good are the results of the function which takes into consideration the level of industrial concentration as dependent variable. As expected, this level increases when the infrastructure endowment, population density increase and distance from the main economic center decreases.

In conclusion, the "quasi-production function" specification supports, for the regions of the main European Countries, the existence of a direct and remarkable relationship between the development level and the infrastructure endowment. The presence of other important location conditions, represented by the other variables included in the analyzed function, improves overall the explicative capacity of the function itself therefore substantially confirming the important role played by the infrastructure component.

IV. CONCLUSIONS

The main conclusions can be summarized as follows:

- on the whole, little more than half of the regions of the five big European Countries – about 63% of the population – enjoy the appropriate level of considered infrastructure categories. In particular: in two Countries (Germany and United Kingdom) this percentage increases to 80% of the population; in other two Countries (France and Italy) this percentage is little more than 50%; in Spain only 34% of the population enjoys a level of infrastructures in line with the European average;

- more specifically, in **Germany** all regions have an overall infrastructure endowment higher than 75% of the UE5 average. In particular, 27 regions out of 38 (71%) fall within the two top classes, while 11 regions fall within the medium-low class, therefore just below the average. It should be noted that 5 of these 11 regions belong to the former German Democratic Republic;

- in the **United Kingdom** no region falls within the lowest endowment class: the less equipped region (the Scottish region of Highland Islands) presents an endowment synthetic indicator equal to 55% of the UE5 average. Moreover, almost 80% of the British regions have an endowment level higher than the UE5 average. Finally, more than half of

the United Kingdom regions fall within the highest endowment class in Europe;

- the regions belonging to **France** are strongly concentrated in the two medium classes (more than three quarters), and in particular in the medium-low one (about two thirds). Outside these two classes are the regions of Île de France (in the highest class), Alsace, Haute-Normandie and Nord-Pas-de-Calais (high class); while Corsica falls within the lowest endowment class;

- in **Italy** Liguria is confirmed to be (as already in 1985) the only Italian region falling within the top class. Moreover, no Italian region falls within the lowest endowment class, unlike 1985 results, when 3 regions (all of them in Southern Italy) fell within this class. The other regions fall mostly within the medium-high or the medium-low endowment class (about 65% of the total), while the remaining 35% falls within the low endowment class (of which 4 are in Southern Italy and 2 in the Central-Northern Italy);

- **Spain** is confirmed to be – among the five Countries considered – still the less endowed from the infrastructure point of view: 12 regions out of 17 have an endowment of over ¼ less of the UE5 average and two of them, Canarias and Extremadura, do not even reach half the average level of overall endowment. Madrid, the only region with an endowment level that can be classified as high, seems to be an exception, very far from the rest of the Country.