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PARIS SCHOOL OF ECONOMICS
ÉCOLE D'ÉCONOMIE DE PARIS

WORKING PAPER N° 2008 - 54

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PARIS-JOURDAN SCIENCES ECONOMIQUES
LABORATOIRE D'ECONOMIE APPLIQUÉE - INRA

48, BD JOURDAN – E.N.S. – 75014 PARIS
TÉL. : 33(0) 1 43 13 63 00 – FAX : 33 (0) 1 43 13 63 10
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The Rise and Fall of Spatial Inequalities in France: a long-run perspective*

Pierre-Philippe Combes† Miren Lafourcade ‡
Jacques-François Thisse§ Jean-Claude Toutain¶

October 16, 2008

Abstract

This paper uses a unique database that provides value-added, employment, and population levels for the entire set of French departments for the years 1860, 1930, and 2000. These data cover three sectors: agriculture, manufacturing, and services. This allows us to study the evolution of spatial inequalities within France and to test the empirical relevance of economic geography predictions over the long run. The evidence confirms the existence of a bell-shaped evolution of the spatial concentration of manufacturing and services. In contrast, labor productivity has been converging across departments. Last, our study also confirms the presence of strong agglomeration economies during the full time-period. Market potential during the first sub-period (1860-1930), and higher education during the second (1930-2000), together with sectoral diversity, account for the spatial distribution of these gains.

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*We are especially grateful to Claude Diebolt and to Alexandre Kych (CMH-ADISP) for crucial help in collecting human capital data. We also thank Vianney Brandicourt, as well as seminar participants at the Atelier Simiand, the Paris School of Economics, the Universities of Cergy-Pontoise and Lille I and the CESAER of Dijon, for insightful comments and suggestions. Financial support from CNRS (Combes) is also gratefully acknowledged.

†GREQAM-Université d'Aix-Marseille, Paris School of Economics (PSE) and CEPR. pp-combes@univmed.fr. http://www.vcharite.univ-mrs.fr/pp/combes/.

‡Université de Valenciennes and PSE. lafourcade@pse.ens.fr. http://www.enpc.fr/ceras/lafourcade/.

§CORE-Université Catholique de Louvain, PSE-ENPC and CEPR. jacques.thisse@uclouvain.be.

¶Université de Paris I-Panthéon-Sorbonne and ERMES-Université de Paris II-Panthéon-Assas. toutain.jean-claude@neuf.fr.

1 Introduction

The emergence of the concept of nation in Europe has led the fathers of political economy to think of countries as the only entities of reference at the exclusion of other geographical breakdowns, and to consider them as homogeneous. However, most European countries have been, and are still, displaying strong regional disparities. For instance, Jacobs (1984) accurately observes that:

> "Nations are political and military entities, and so are blocs of nations. But it doesn't necessarily follow from this that they are also the basic, salient entities of economic life or that they are particularly useful for probing the mysteries of economic structure, the reasons for rise and decline of wealth. Indeed, the failure of national governments and blocs of nations to force economic life to do their bidding suggests some sort of essential irrelevance." (pp. 31-32).

To the best of our knowledge, there exist very few trustworthy historical data at a high level of spatial disaggregation, thus making it hard to study the long-run evolution of spatial economic inequality within a given country.[1] That said, in the case of France, we are privy to three different variables (value-added, employment and population) for three basic sectors (agriculture, manufacturing, and services) at two points in time (1860 and 1930), and at a *fine* geographical level (88 continental "départements" in 1860).[2] Working with three aggregate sectors is not as restrictive as it looks at first glance. Indeed, over such a long span, very few industries covers the entire period (e.g. the automotive and computer industries). Consequently, studying the evolution of spatial inequality at a more disaggregated industrial level is at best very problematic. Adding the corresponding data for the year 2000 gives us a sample of $88 \times 3 \times 3 = 792$ observations. This data-set may then be used to study how France's economic space has evolved over two, 70-year sub-periods. The years spanning from 1860 to 2000 have seen a number of dramatic changes in the economic structure of France: the rise of manufacturing, the development of transportation means, the expansion of services, the mechanization of agriculture, the "Trente Glorieuses",[3] the growth of the Welfare State, the process of European integration, a recent move towards de-industrialization, and the birth of new information and communication technologies. This non-exhaustive list is enough to portend fundamental changes in the geography of economic activity, even at a very aggregated sectoral level.

This paper focuses on analyzing *the evolution of spatial economic inequality among the French departments since 1860.* In order to better understand this evolution, we use concepts and results drawn from economic geography. It is worth recalling that this field stresses the importance of transport cost in accounting for the location of economic activity. This is because these costs may serve as an accurate measure for the degree of economic integration within a given territory. In addition, when studying long-run trends, these costs may also be considered as a meaningful index of a country's level of economic and technological development. The period under consideration (1860-2000) has seen an

[1] Most existing studies use proxy-variables or country-data extrapolations to construct regional output. See, e.g. Good (1994), Esposto (1997), and Fenoaltea (2003).

[2] The division of France into "départements" was adopted in 1790 during the French Revolution. They were designed to replace the old "provinces", which exhibited significant variations in tax systems, population and land areas. In contrast, the new administrative division aimed to create more homogeneous and regular spatial units under a common central legislation and administration. Their size was chosen so that individuals from any point in the department could make the round trip by horse to the capital city in no more than two days, which translated into a radius of 30 to 40 km. Initially, France included 83 departments, the number of which was gradually increased to 100 (94 continental) departments.

[3] This refers to the thirty years $1945 - 1975$ that follow the end of World War II in France.

uninterrupted fall in freight costs, brought about by the birth of the railroads and the development of a dense network of roads and highways. With these observations in mind, looking to economic geography for an analytical tool-kit seems particularly warranted.

Let us briefly summarize economic geography's main findings (Fujita et al., 1999; Fujita et Thisse, 2002; Combes et al., 2008c). When transport costs are high, economic activity is scattered throughout. As transport costs decrease, firms' proximity to natural resources and local outlets matter less. Hence, firms operating under increasing returns find it more profitable to cluster near their largest markets in order to better exploit scale economies (this is especially true of manufacturing firms). Indeed, a drop in transport costs makes supplying peripheral areas less expensive, thus leading these areas to lose a significant share of their industries. The setting of new firms and the launching of new industries in a given region go hand-in-hand with a geographic concentration of the labor force, which in turn leads to an increase in demand stemming from the arrival of these new consumers and producers. In other words, the size of the local labor and goods markets increases, making these regions even more attractive for both firms and workers. Thus, a self-reinforcing agglomeration process is triggered for industrial and ancillary activities as well as for labor. Conversely, decreasing or constant returns to scale sectors remain to a large extent dispersed (e.g. agriculture), or mirror the observed changes in the spatial distribution of population (e.g. the service sector).

At the same time, the agglomeration of firms and workers gives rise to new costs linked to land use (higher land rents, commuting costs and wage rates, as well as congestion of local transport networks), which make these larger markets less attractive. With further decreases in freight costs, we thus observe a gradual undoing of the agglomeration process: the manufacturing industries and the corresponding business-to-business services tend to gradually relocate to the periphery. In other words, *the evolution of spatial economic inequality is described by a bell-shaped curve.*[4] Namely, at first a reduction in transport costs leads to greater spatial concentration, but below a certain threshold a further drop gives rise to the re-dispersion of economic activity. Land-intensive industries are likely to be the first to move to the outskirts of large cities or peripheral areas in order to benefit from lower land rents.

Our analysis shows that this theoretical prediction is confirmed for both manufacturing and services in France over the long-run. First of all, we observe that population, employment and the value-added all become highly spatially concentrated within France. The Theil concentration index allows us to measure this evolution at two, nested geographical levels, regions and departments.[5] While inequality across regions has remained stable since the 1930s, *the concentration of economic activity across departments within a given region* has continued to increase until the year 2000. At the sectoral level, we note that the dispersion of agriculture has increased over time. As for manufacturing and services, their spatial concentration increases over the 1860-1930 period, and decreases thereafter. Last, we note that *labor productivity converges among departments from 1860 to 2000*, thus favoring a greater equalization of primary incomes across space.

It goes without saying that checking the validity of the bell-shaped curve for three years only is questionable. Our line of defense is that the spatial distribution of human activity changes fairly slowly (Davis and Weinstein, 2002), and France is certainly not an exception (Eaton and Eckstein, 1997). Hence a long-span analysis such as ours has some factual relevance. In addition, the period 1860-2000 has experienced many different shocks,

[4]In a way, economic geography provides solid micro-economic underpinnings to the ideas developed much earlier by Williamson (1965).

[5]In 1956, departments were grouped together into 26 (21 continental) regions, in order to lead some policies at a larger spatial scale.

which could have affected the location of sectors in ways that are not accounted for by economic geography. In such a context, the fact that the bell-shaped curve seems to prevail makes us fairly confident in its existence. Nevertheless, to test further its robustness, we have considered two additional years: 1896 for which incomplete information is available, and 1982, the oldest year for which the INSEE[6] reports full sectoral data at the level of departments. It turns out that the Theil-index values for 1896, computed in terms of either employment or value-added, fall right in between those of 1860 and 1930, for manufacturing and services. Similarly, the 1982 Theil-index values also fall between those of 1930 and 2000 for manufacturing. The Theil-index value of value-added for services, slightly too low in 2000, is the only exception, but it can be explained by the high employment volatility of this sector at the end of the century.

Economic geography also underscores the role played by three types of agglomeration economies. The first deals with the size of the local market and the intensity of local interactions; it is typically captured by the local employment density. Furthermore, the concentration of firms belonging to the same industry is conducive to the rapid imitation and diffusion of innovations and new production processes as well as to the sharing of specific inputs – thereby creating gains linked to *specialization*. However, increasing the spatial concentration of firms within the same industry intensifies labor market and product market competition, which fosters the dispersion of firms. The third force emphasizes the potential benefits of being located amongst a *diversified* range of industries. Under this view, radical innovations developed in one industry may be borrowed and implemented in other industries – resulting in significant productivity gains. Sectoral diversity also allows the local population to be more resilient to negative shocks specific to one industry by falling back on the other industries present within the same area. According to Jacobs (1969) and Glaeser et al. (1992), gains from diversity are the driving force behind the agglomeration of economic activity, whereas Porter (1998, chapter 7) and Henderson et al. (1995) put more weight on the role of specialization in the rise of successful clusters. Our analysis confirms the existence of density economies for the manufacturing and service sectors, while agriculture displays diseconomies. Specialization has a positive effect on services, but a negative one on agriculture. Finally, gains stemming from diversity are significantly positive for all sectors.

Two further factors also account for the shaping of the space-economy. Bearing in mind the role of transport costs in economic geography, one would expect that firms' proximity to large outlets help increase their profitability. And indeed, we find that the access to departmental *markets* affects positively firms' productivity during 1860-1930, a time period characterized by relatively high transport costs in France. With the spectacular decline in transport costs, the openness to international trade, and the growth of knowledge-intensive activities, however, the importance of the access to departmental markets has been overshadowed by the educational levels of local population (as is true for the year 2000). While the positive influence of education on growth is well documented for nations (Lucas, 1988), more recent contributions also shed light on the role of education in structuring the spatial distribution of economic activity (Moretti, 2004; Combes et al., 2008a). More precisely, skilled workers and skill-intensive firms tend to cluster in order to benefit from technological or informational spillovers, and from a better match between jobs and workers (Duranton and Puga, 2004). During the 1860-1930 period, human capital did make positive contributions to the average level of productivity, but without playing a significant role in the emergence of inter-regional disparities. This finding is probably the result of France's very diffuse and fairly homogenous elementary schooling over that time-period. In contrast, *human capital has played a significant role in structuring France's economic space more*

[6] The French national institute for economic and statistical studies.

recently. This is especially true of higher education. Indeed, the metropolitization of the economy involves the clustering of high value-added activities in large urban agglomerations.

In the remainder of this paper, we present the method used for recovering value-added, employment and population at the departmental level for the years 1860 and 1930. In turn, these data are used to analyze aggregate and industry-specific spatial inequalities of both productivity and standard of living. Last, we study the magnitude of agglomeration economies and other determinants of the spatial distribution of economic activity.

2 The data

Our analysis is based on Toutain's work, which recovers the population-, employment-, and output-levels for each French department in 1860 and 1930.[7] As with all quantitative research in economic history, the usual caveat holds: the data are susceptible to a certain degree of imprecision. That said, we believe that our analysis grasps the essence of the main long-run trends.[8] Population, employment and value-added for the year 2000 come from the INSEE.

2.1 Recovering departmental GDPs

Agriculture and Industry Surveys are used to reconstruct GDP data for each department, but they cannot be dated precisely. The Agriculture survey of 1929 was ordained by the December 27, 1927 Law of Finances; while the brunt of this survey was conducted in 1929, it was meticulously inspected for errors and corrected from 1930 to 1933, only to be published in 1939. As for the agricultural survey of 1862, data collection took place during that year, but a number of 1865 prices were used and the survey was published in 1868-1870. The 1860 Manufacturing Survey is actually derived from two sources: (i) the Parisian Survey of 1860, conducted by the Parisian Chamber of Commerce in 1860 but published in 1864; and (ii) the Manufacturing Survey (which excludes Paris) labeled as 1862, but which actually covers 1861-1865 and was published in 1873. The manufacturing data of 1930 are drawn from the Population Census of 1931, published in 1935. As for the service sector, the data are drawn from the 1861 and 1931 Census.

2.1.1 Agricultural output

The domestic agricultural product is reconstructed using the Agriculture Survey of 1862 and 1929. Methods and data are published in Toutain (1992-1993). The 1862 survey is fairly exhaustive and allows us to distinguish between seeds, animal consumption, the food-industry's consumption, and human consumption. The values obtained for each category closely match those recovered by Delefortrie and Morice (1959). The 1929 survey is also very detailed, but it required making a few corrections discussed in Toutain (1992-1993).

2.1.2 Manufacturing output

Regarding manufacturing, Desaigues (forthcoming) has meticulously reconstructed data for value-added by department. The sources used are the Manufacturing Surveys of 1860 (Paris) and 1861-1865 (the rest of France). The Manufacturing Survey of 1861-1865 is

[7] These data, which have never been published, are made available in the Appendix (See Tables A.1, A.2 and A.3).

[8] Moreover, given that we are interested in studying variations in the spatial distribution of economic activity, any shocks that affect all departments uniformly have no bearing on our findings.

drawn from a poll conducted at the arrondissement-level for a total of 16 sectors (including state-owned industries). The value-added data from this poll have been applied to the manufacturing labor force, industry-by-industry. While this survey defines manufacturing in the modern sense, it does not include small firms with less than five employees. Desaigues overcomes this shortcoming by imputing the value-added created by these firms based on the size of non-polled firms. The total value-added is then obtained by adding these two components to the 1860 Paris data.

As for 1930 data, the appendix for the 1931 Census provides a partial estimate of the value-added for a number of manufacturing industries. This estimate is based on having polled one-fourth of firms with ten or more workers, which account for one third of the total employment included in the survey. Given that the total amount of firms included in the survey only represent 60% of total manufacturing employment, it follows that the estimates for value-added only apply to one-fifth of total manufacturing employment.

2.1.3 Services output

As outlined in Toutain (1987, 1997a), service output data are reconstructed by adding up revenues from different service groups: housing and construction, professions, household services, public services, transport and trade. Revenues from housing and construction are drawn from the net income reported on the Fiscal Survey of 1851-1853 and 1887-1889, and linear interpolation is used to fill in years 1860-1865. Calculating revenues for the remaining five service industries is more complex. Public sector wages were reconstructed by Fontvieille (1976, 1982) using records of the State's and local communities' yearly accounts. The sum of these wages is then prorated across departments, based on the size of the local public labor-force. For the transportation industry, Toutain (1967) sums up salaries from a number of sub-industries (roads, railroads, sea-transport, tramping, navigable rivers, air-transport) to create a national aggregate. This aggregate is then prorated across departments based on the size of the local transportation labor-force. Income data for household services are calculated using the labor force's output as well as the average salary for different types of household services, by department. As for retail and wholesale trade and professions, income data are primarily drawn from trading dues.[9] Non-licensed workers account for half of the corresponding labor force and are treated separately (Toutain, 1997a).

2.2 Recovering the labor force

Figures regarding the size of the agricultural labor force vary. The 1866 Census measures the agricultural labor force at 8.126 million people, whereas the Agriculture Survey of 1862 reports 10.352 million people. Marchand and Thélot (1991) estimate this agricultural labor force at 9.245 million in 1861 and 9.289 million in 1866, two figures that nearly mirror the average of the Census and Agricultural Survey estimates. The quantitative discrepancies between contemporary works and the original surveys can be attributed to differences in the proportion of women and the share of the rural population partaking in the agricultural labor force.

The sizes of the manufacturing and services' labor forces are derived from the 1866 Census. This source measures the manufacturing population at 4.327 million workers, and the service population at 3.112 million, making for a combined, French labor-force of 7.439

[9] We refer the reader to Lévêque (1980) for more information on the use of trading dues and inter-departmental comparisons.

million workers.[10] Marchand and Thélot (1991) propose an estimate of 8.5 million for the non-agricultural labor force in 1861, and of 9 million for 1866. These authors estimate that 1.1 million workers were not accounted for in the 1866 Census (0.7 million in the manufacturing sector, including child labor; 0.2 million in services; and 0.2 million unemployed workers not counted in the effective workforce). However, Marchand and Thélot agree that their data slightly over-estimate the size of the non-agricultural workforce. With respect to the 1862 Agricultural Survey, it is worth noting that 1.149 million farmers admitted to working in "related industries" an average of 148 days per year. It is therefore reasonable to believe that the "missing" industrial workers according to Marchand and Thélot were considered as full-time agricultural workers in the 1862 Agriculture Survey, and simply overlooked in the 1866 Census.[11]

The 1866 Census is used to reconstruct the service sector's labor force, estimated at 3.112 million. Marchand and Thélot (1991) put forth a figure of 3.286 million for 1861 and 3.835 million for 1866. This latter estimate seems too large, as it implies that more than half a million workers joined the service sector in a mere five year time-span. Estimates for the workforce and the total population are drawn from the 1931 Census published in 1935.[12]

3 The spatial aggregate dynamics

3.1 National trends

Table 1 presents the population level, the employment level, and the value-added at three, equally spaced dates (1860, 1930 and 2000), which allows us to unearth long-run trends. The *per capita value-added* and the *value-added per worker* measure, respectively, the standard of living and labor productivity. In order to make intertemporal comparisons possible, all monetary figures are expressed in year 2000 francs. To this end, all figures are deflated by the year 2000 average annual price index published by the INSEE, and the cost of living for years 1860 and 1930 is estimated using the index of Singer-Kerel (1961).[13]

Table 1: Population, employment and value-added

Year	Pop.	Emp.	Emp./Pop.	Liv. Cost	Curr. VA	Cons. VA	Cons. VA/capita	Cons. VA/Emp.
1860	37.8	17.7	0.47	1	20.5	541.0	14.3	30.6
1930	41.2	20.1	0.49	7.4	317.6	1136.3	27.6	56.5
2000	58.6	23.9	0.41	26.4	8398.0	8398.0	143.3	351.4

Notes: Pop.: population (millions), Emp.: employment (millions), Emp./Pop.: Share of the labor force in total population, Liv. Cost: cost of living index, normalized at 1 in 1860, Curr. VA: value-added in billions of current francs, Cons. VA: value-added in billions of constant (2000) francs, Cons. VA/capita: VA in thousands of 2000 francs per inhabitant, Cons. VA/Emp.: VA in thousands of 2000 francs per employee.

[10] The labor force matrix (89 departments, 16 industries) is reconstructed by Desaigues (forthcoming) using incomplete data provided by the population survey of 1866. Specifically, the missing values were balanced by using (i) a line vector of the total manufacturing labor force by industry, and (ii) a column vector of the total manufacturing labor force by industry (L'Hardy, 1976).

[11] The Survey and the Census do not abide by the same accounting standards and do not conduct their investigation at the same time of the year – two differences that may account for the individuals working in more than one industry.

[12] The 1931 Census overestimates Lyon's population by 120,000 inhabitants, Marseille's by 191,000. This error is taken into account and corrected in our analysis (Insee, "Annuaire Statistique de la France", 1966, p.32, footnotes 15 and 19).

[13] This cost is weighted by budget coefficients. See Toutain (1997b) for a detailed description.

Adopting 1952 as the reference year with a base of 100, the index takes on the value of 0.425 in 1860 and 3.13 in 1930, which implies a 7.4-fold increase in the cost of living over this period. According to the INSEE, 100 francs in 1952 are worth 11.2 francs in 2000 (which accounts for rescaling the French franc by a factor of 100 in 1960).

Before proceeding any further, a number of comments naturally arise. While the share of the labor force remains relatively stable over the 1860-1930 period, it experiences a sharp decline afterwards, moving from 49% to 41% of the total population. This drop could be due to the increase in life expectancy and in years of schooling. As for the cost of living, its increase is staggering. While the 7.4-fold increase during the first sub-period is impressive in itself - the cost of living continues to soar during the second sub-period due to World War II and the post-war period, as well as because of high inflation during the 1970s. Yet, this trend does not curb the average real wealth of French inhabitants. Indeed, in addition to the growth that France experienced in *total* value-added (doubling over the 1860-1930 period, and increasing seven-fold thereafter), the country also saw its real *per capita* value-added increase ten-fold during 1860-2000 in spite of a growing population. During the 1860-1930 period, the average annual growth rate is 0.94%, which implies that the standard of living doubles every 70 years. Rising to an annual average of 2.4% during 1930-2000, the new growth rate ensures a doubling of the standard of living in less than 30 years. These differences can be attributed to France's spectacular growth during the Trente Glorieuses. It should be kept in mind, however, that growth rates during the 1930-2000 sub-period were fairly volatile.

As shown in Table 1, the growth of the value-added per worker is slightly higher than the value-added per capita due to the waning share of workers in the total population. Value-added per worker falls just short of doubling between 1860 and 1930, whereas it increases more than 6-fold during the second sub-period, 1930-2000. Thus, over the entire period labor productivity is multiplied by 11.5. The stark contrast between the two sub-periods underscores the substantial productivity gains that have taken place over the last fifty years. This gain becomes particularly remarkable in light of the momentous changes undergone by Western economies during the preceding time period, spanning from the Industrial Revolution to World War I.

3.2 Local trends

Our analysis focuses on 88 French continental departments, as they were defined in 1860.[14] In order for the today map to line up with the 1860 departmental boundaries,[15] we have reconstructed the Seine department (which includes today Paris, Hauts-de-Seine, Seine-Saint-Denis, and Val de Marne) and the department of Seine-et-Oise (today Essonne, Val d'Oise and Yvelines). The "Territoire de Belfort" is also used to reconstruct the Haut-Rhin department as defined in 1860.

Different tools can be used to study the spatial distribution of economic activity. The Theil index (1967) bears the advantage of allowing the inequality across space to be captured through two nested geographical levels. More precisely, interdepartmental inequality can be decomposed into a measure of concentration *within* and *between* the 21 today French continental regions. Moreover, we adopt a definition of the Theil index which measures the difference between the actual distribution of economic activity and the benchmark uniform distribution. Formally, for a given activity distributed across the number D of departments,

[14] Corsica and overseas departments and territories are not included.

[15] Today, continental France includes 94 departments.

the Theil index is defined as follows:

$$T = \sum_{d=1}^{D} \frac{A_d}{A} \log \frac{A_d}{A/D} \tag{1}$$

where A_d is the actual level of activity within department d, while $A = \sum_{d=1}^{D} A_d$ denotes the total level of activity. The Theil index is equal to zero when the activity is uniformly distributed across departments: $A_d = A/D$ for all d. At the opposite extreme, if the whole activity were to be concentrated in only one department, this index takes on the positive value $\log D = 1.94$ (for $D = 88$). Thus, intermediate values capture varying degrees of spatial concentration: *the greater the Theil index, the higher the spatial concentration of economic activity.*

As said above, an attractive property of the Theil index is to permit the decomposition of the observed interdepartmental inequality into its within-region (T_w) and between-region (T_b) components:

$$T = T_w + T_b.$$

The T_w-term captures the weighted average of Theil indices within region r, T_r:

$$T_w = \sum_{r=1}^{R} \frac{A_r}{A} T_r$$

where R is the number of regions, and $A_r = \sum_{d=1}^{D_r} A_d$ the level of activity in region r which includes D_r departments. The Theil index for region r is given by the same expression as for T, but is now applied to the departments belonging to region r:

$$T_r = \sum_{d=1}^{D_r} \frac{A_d}{A_r} \log \frac{A_d}{A_r/D_r}$$

The T_b-term corresponds to the between-region Theil index:

$$T_b = \sum_{r=1}^{R} \frac{A_r}{A} \log \frac{A_r/D_r}{A/D}.$$

Table 2 presents the figures obtained for population, employment, and value-added.

Table 2: Theil indices for population, employment, and value-added

Variable	Theil	1860	1930	2000	Variable	Theil	1860	1930	2000
Pop.	total	0.12	0.34	0.39	Emp.	total	0.13	0.37	0.50
	within	0.07	0.21	0.26		within	0.07	0.22	0.33
	between	0.05	0.12	0.13		between	0.06	0.15	0.17
Unoc.	total	0.13	0.32	0.34	VA	total	0.30	0.68	0.71
	within	0.08	0.21	0.23		within	0.17	0.43	0.48
	between	0.05	0.11	0.11		between	0.13	0.25	0.23

Notes: Pop.: population, Emp.: employment, Unoc.: Unoccupied people, total: total Theil index, within: intra-regional Theil index, between: inter-regional Theil index.

It reveals the *strong increase in spatial concentration the French population has seen over the course of the past century and a half*, as illustrated by a three-fold increase in the total Theil index between 1860 et 2000. Indeed, over time the population finds itself increasingly concentrated within a small number of departments, if not cities, but the data are not disaggregated enough for us to confirm this conjecture. The spatial concentration of employment is even more pronounced, increasing dramatically over time. On the other hand, the concentration of unoccupied people stabilizes after 1930, which may in part reflect an increasing number of individuals returning to their native place upon retiring. Last, although the value-added consistently exhibits more spatial inequality, it gets concentrated less rapidly than population and employment.

When considering the time-period as a whole, we note that *the inequality across departments is primarily due to a higher concentration of activity within regions.* During the 1860-1930 sub-period, the within- and between-region variations of both population and employment increase more or less at the same rate (the Theil indices fall just short of tripling for both variables). Regarding the value-added, the rise in spatial inequality is stronger within than between regions, which might explain the increase in overall concentration. Over the course of the 1930-2000 sub-period, we note that the inter-regional inequality remains remarkably stable; the observed increase in concentration is chiefly driven by intra-regional variation across all three variables. This suggests that a few French departments (regional capitals are the most likely candidates) have progressively become more attractive to the detriment of the other departments belonging to the same region. In other words, during the 1930-2000 sub-period, while spatial inequality between regions became stable, it kept growing within regions. Consequently, spatial inequality in France occurs mostly within rather than between regions. While a cursory glance might lead one to conclude that the French national territory mirrors a core-periphery structure - Paris and the "French desert" - our analysis lends credence to *the emergence of multi-polarization through the rise of second-tier urban regions.*

In contrast to total value-added, per capita value-added has spread among French regions as well as among the departments that make up each region (see Table 3). The average productivity of labor exhibits even greater dispersion over time. Overall, the spatial inequality of productivity has decreased, experiencing a five-fold decline over the course of 140 years. As a result, *alongside an increase in the spatial concentration of the population and production is a decrease in labor productivity inequality across departments.* It is worth noting that, unlike value-added and employment, this convergence occurs primarily *among* the departments belonging to the same region.

Table 3: Theil indices for value-added per capita and per employee

Variable	Theil	1860	1930	2000	Variable	Theil	1860	1930	2000
VA/capita	total	0.04	0.02	0.02	VA/Empl.	total	0.05	0.03	0.01
	within	0.02	0.01	0.01		within	0.04	0.02	0
	between	0.02	0.01	0.01		between	0.02	0.01	0

Notes: total: total Theil index, within: intra-regional Theil index, between: inter-regional Theil index, VA/Empl.: VA per employee.

Although economic geography does not have much to say about the spatial distribution of individual incomes, these a priori surprising evolutions can be explained by the following two rationales. First, it seems reasonable to believe that the substantial increase in the number of public jobs (to a large extent brought about by the carving out of French administrative zones) has contributed to the convergence of standards of living across the whole country. Furthermore, given that workers tend to migrate towards areas that offer the highest wage, it follows that the wage gap should decrease, ceteris paribus. However, 'everything else' is rarely held constant: economic activity tends to be redistributed across industries, which naturally gives firms incentives to change their locations. It turns out that the French work force exhibits a greater rise in concentration than the value-added, especially between 1860 and 1930 (see Table 3). Economic geography suggests that spatial concentration is most pronounced in industries characterized by scale economies, the other industries remaining dispersed (Kim, 1995; Puga, 1999). In this context, migration arises along both spatial and sectoral dimensions which, from a theoretical standpoint, favors the leveling-out of wages across space, as is confirmed here through the convergence of labor productivity. The theoretical reasoning thus reads as follows: (i) workers tend to migrate to places that offer the highest wage, (ii) industries characterized by increasing returns to scale initially offer relatively higher wages, and (iii) because the marginal productivity of labor increases at a decreasing rate, the rising wage rate is curbed by the large inflow of workers in these industries. Conversely, the law of diminishing returns makes more productive the agricultural regions from which workers have drifted from the land. As a result, the most concentrated departments exhibit slower labor productivity growth, while the increasingly depleted departments are effectively "catching-up" in terms of labor productivity. It is important to underscore that *the decline in the spatial inequality of labor productivity is not brought about by the dispersion of economic activity,* as a smaller number of departments host an increasing share of total value-added over time. Somewhat paradoxically, it seems to be triggered by the concentration of increasing returns activities. The maps provided in the next section bring these observations to life.

3.3 A cartographic illustration

Figure 1 maps the departmental distribution of the per capita value-added as a percentage of the national average: $(VA_d/Pop_d)/(VA/Pop)$. The boundaries of the six classes are determined by the automatic allocation of 1860 data.[16] These boundaries are retained for 1930 and 2000 in order to allow for inter-temporal comparisons.

Wealth disparities across departments vary by a factor of 1 to 4. The highest two classes include 16 departments in 1860, but only three in 1930 and two in 2000. Over time, the Northern departments of France are no longer host to the greatest value: Seine (Paris) and Rhône (Lyon) are the only two departments to remain in the two highest classes throughout the whole period.[17] Not surprisingly, Parisians are twice as rich as the national average, while people from the Rhône, though less affluent, have a per capita income which is 30% above the national average. At the other end of the spectrum, six departments (Ardèche, Ariège, Lozère, Cantal, Lot and Côtes du Nord) find themselves in the sixth and lowest class over the entire period. These departments represent approximately one quarter of all departments in the lowest class; the least successful department has a standard of living equal to half of the national average. Aside from these very few departments that maintain their positions at the extremities of the distribution, the remaining departments experience a certain degree of mobility, which may account for the income convergence mentioned above. The Haute-Garonne, and the block formed by Isère, Haute-Savoie and Savoie have seen their standard of living grow regularly, with the two latter departments experiencing gains substantial enough to catch-up to the national average in 2000. Conversely, Ardennes, Calvados, Herault, and Seine-et-Marne are the primary losers in the wake of France's spatial restructuring, falling from the first class to the last two classes.

[16] More precisely, classes are defined in such a way as to minimize the sum of their class-specific variances.

[17] French départments are named in the map provided in the Appendix (See Figure A.1).

Figure 1: Value-added per capita (% of the national value)

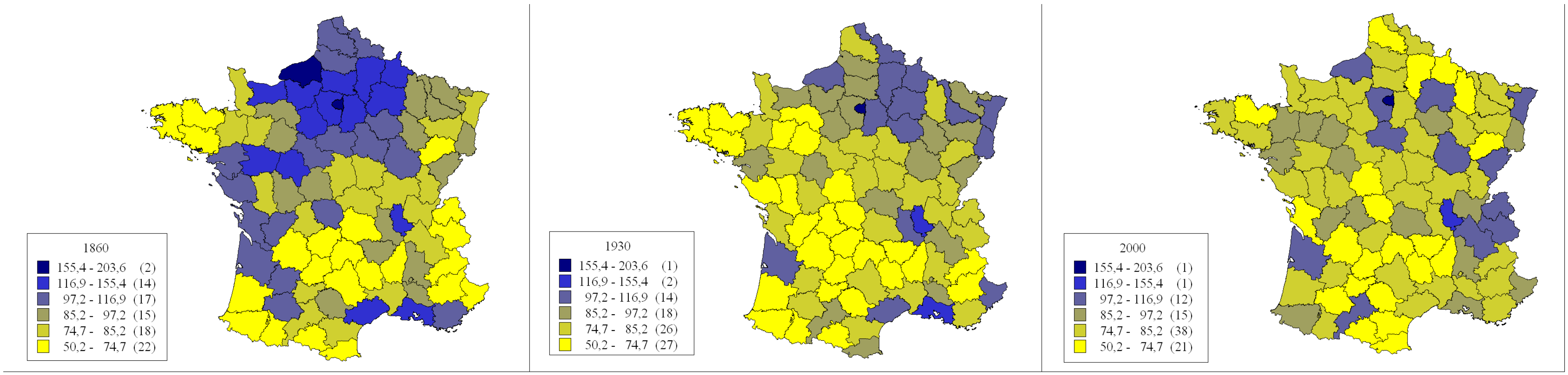
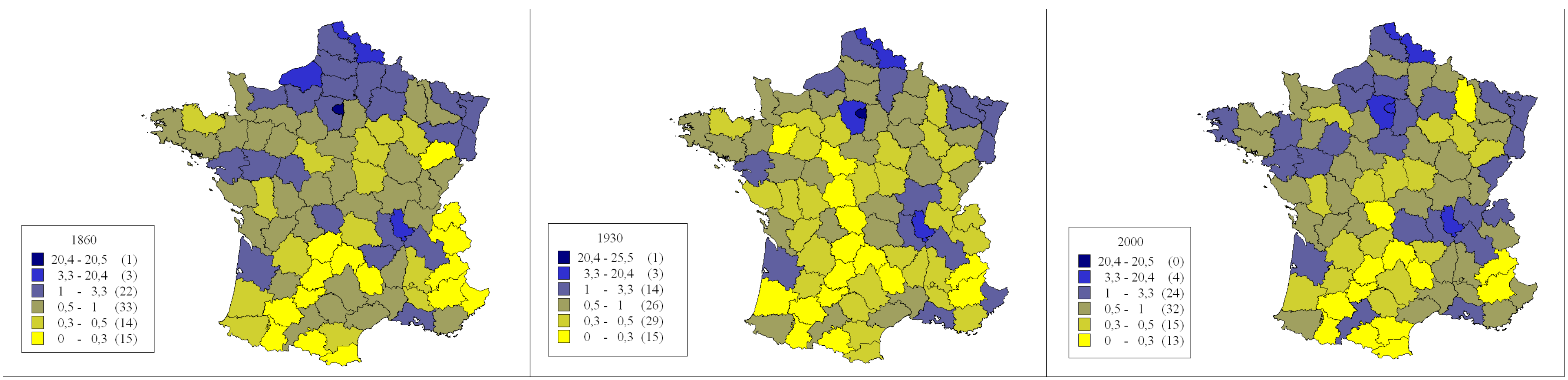


Figure 2: Spatial distribution of value-added in manufacturing (% of the national value)



Note also a marked decline on the Atlantic coastline, save for Seine-Maritime and Gironde. Finally, a last category of departments do not exhibit much variability over the entire period (e.g. Pyrénées-Orientales), even though a high degree of fluctuation can be observed from one sub-period to the next. In sum, if the primacy of Paris - and to a lesser extent, Lyon - remain unchallenged, there has been a fairly high mobility in the departmental hierarchy.

In order to get a different picture of this mobility, we compute the Spearman rank correlation coefficient (ρ) for the value-added and the per capita value-added. Recall that this coefficient measures the stability of a given ranking, displaying a value of $\rho = 1$ when the ranking remains constant, and a value of $\rho = -1$ when it is completely reversed. For value-added, we obtain $\rho = 0.74$ between 1860 and 2000, $\rho = 0.83$ between 1860 and 1930, and $\rho = 0.90$ for the 1930-2000 period, which suggests a high degree of stability in the departmental distribution of this variable. On the other hand, the ranking of value-added per capita exhibits less persistence, as the corresponding Spearman coefficients are $\rho = 0.24$, $\rho = 0.62$ and $\rho = 0.47$, respectively.

4 The spatial dynamics of sectors

4.1 National trends

Table 4 illustrates France's progressive transformation from a rural to an industrial society, followed by the emergence of a service economy. Agricultural employment has known a staggering decline over the years, accounting for a mere 4% of total employment in 2000, down from nearly 60% in 1860. After having accounted for over a third of total employment in 1930, in 2000 the manufacturing share of employment had reverted to its 1860 level. In addition, the share of manufacturing in national value-added, which fell just short of 50% in 1930, is lower in 2000 than in 1860. This bears witness to the precipitous decline of traditional industries (textiles, steel, chemistry, etc.) after the oil shocks. Last, to date services account for nearly three quarters of France's employment and value-added.

Table 4: Sectoral share of employment and value-added

Variable	Industry	1860	1930	2000	Variable	Industry	1860	1930	2000
Employment	Agr.	0.58	0.34	0.04	VA	Agr.	0.44	0.20	0.03
	Manu.	0.24	0.36	0.24		Manu.	0.31	0.48	0.25
	Ser.	0.17	0.30	0.73		Ser.	0.25	0.31	0.72

Notes: Agr.: agriculture, Manu.: manufacturing, Ser.: services.

4.2 The bell-shaped curve

In this section, we examine the evolution of sectoral inequalities. To this end, we use a sector-specific Theil index, which measures the gap between the observed and the uniform distributions of a given sector. This requires replacing the national, regional, or departmental variables in expression (1) by their sectoral counterpart.

Table 5 reveals that agricultural employment has remained quite diffuse throughout the entire 1860-2000 period (with a slightly lower degree of dispersion in 2000), in spite of a 14-fold decline in its national share of both employment and value-added. This is due to the fact that agricultural activity requires a considerable amount of space. That said, while agriculture's spatial distribution remains stable between 1860 and 1930, its value-added becomes more concentrated during the second sub-period, when the share of agriculture regresses the most.[18] This finding may be explained by the intensification and mechanization of farming within a few departments, as well as the development of new intra- and inter-regional transport infrastructure. Let us consider the specific, but representative, case of Brittany to illustrate this feature. In 1860, the value-added of Finistère was barely 1.03% of the national average. In 2000, its share rose to 2.81%, above the three other departments in Brittany, which accounted for less than 2% each (Côtes du Nord, Ille-et-Vilaine and Morbihan). This points to the polarization of agricultural production within Brittany.

Table 5: Theil index by sector for employment and value-added

Variable	Theil	1860	1930	2000	Variable	Theil	1860	1930	2000
Agr. Empl.	total	0.10	0.10	0.12	Agr. VA	total	0.10	0.10	0.22
	within	0.06	0.07	0.07		within	0.06	0.04	0.09
	between	0.03	0.03	0.05		between	0.04	0.06	0.12
Manu. Empl.	total	0.43	0.66	0.34	Manu. VA	total	0.69	0.93	0.50
	within	0.25	0.43	0.23		within	0.40	0.62	0.33
	between	0.18	0.22	0.11		between	0.29	0.30	0.17
Ser. Empl.	total	0.46	0.77	0.60	Ser. VA	total	0.61	1.00	0.84
	within	0.25	0.49	0.40		within	0.35	0.63	0.58
	between	0.21	0.28	0.20		between	0.27	0.37	0.26

Notes: Emp.: employment, Agr.: agriculture, Manu.: manufacturing, Ser.: services, total: total Theil index, within: intra-regional Theil index, between: inter-regional Theil index.

Let us now turn to the manufacturing sector. A first point is worth noting: the non-monotonous evolution of employment and value-added concentrations over time. While a considerable increase in concentration characterizes the first sub-period, this trend is reversed and fully undone during the second sub-period, the level of dispersion in 2000 exceeding the 1860 level. Thus, *the spatial concentration of the manufacturing sector follows a bell-shaped curve*, as is predicted by economic geography. Recall that a decline in transport costs facilitates the concentration of activities exhibiting increasing returns. Below a certain threshold, transport costs are sufficiently low for differences in market access to become secondary to other costs brought about by spatial concentration, so that firms begin to relocate to peripheral areas where land is available and cheaper. By way of illustration, during the 1990-1999 period, French manufacturing employment increased by 7.9% in rural zones but decreased by 2.9% in urban centers (Gaigné et al., 2005).[19] The right-side of the above bell-shaped curve describes a similar trend, but over the course of a much longer period. Figure 2 depicts the departmental distribution of manufacturing output in 1860, 1930, and 2000, which traces out an unambiguous portrait of the bell-shaped curve: in the middle map, the number of dark areas (the three top classes) is smaller than in the two adjacent maps (18 instead of 26 and 28, respectively). [20]

The same overall trends are observed in the service sector. The first sub-period is characterized by an increase in concentration and the rise of urbanization, which in turn paved the way for the development of firm- and consumer-specific services. However, the dispersion of services during the second sub-period is less pronounced, which may be explained by

[18]This trend is corroborated by the Theil-index values provided for 1896, 1982 and 2004 (See Table A.4 in the Appendix).

[19]In the same vein, Chatterjee and Carlino (2001) observe the thinning out of employment in American metropolitan areas over 1951-1994.

[20]It could be argued that the progressive disappearance of mining and heavy industries has fostered the concentration of manufacturing. However, in France this de-industrialization occurred after 1960. This makes our point even stronger as the bell-shaped curve is actually decreasing after 1930.

the fact this sector is less land-intensive than manufacturing. As is true of manufacturing, services exhibit a greater spatial inequality within than between regions, but *the bell-shaped curve holds true for both employment and value-added regardless of the spatial scale.*

As expected from the above, analyzing the spatial distribution of labor productivity (see Table 6) leads us to make that statement more precise. Over 1860-1930, we witness a marked decline of inter-departmental disparities in agricultural productivity. As in the foregoing, this result may seem surprising at first, given that value-added remained constant and employment became more diffuse over this period. The key is to bear in mind that agriculture was for a long while characterized by decreasing returns, meaning that labor productivity increased as the agricultural workforce declined. This trend was especially pronounced in areas replete with agricultural employees, which ended up benefiting from the rural exodus. This trend is slightly reversed during the second sub-period, over the course of which the agricultural income diverges within and between regions. This is likely related to the Common Agricultural Policy, which has favored certain crops (e.g. cereals), hence some territories, over others. On the contrary, manufacturing and services follow the same paths as the national average, namely the convergence of labor productivity throughout France over time for the reasons given above.

Table 6: Theil index by sector for value-added per employee

Variable	Theil	1860	1930	2000
VA/Emp. Agr.	total	0.11	0.05	0.07
	within	0.08	0.03	0.04
	between	0.03	0.02	0.03
VA/Emp. Manu.	total	0.04	0.01	0.01
	within	0.01	0.01	0
	between	0.03	0.01	0.01
VA/Emp. Ser.	total	0.02	0.01	0.01
	within	0.01	0	0.005
	between	0.01	0.01	0.005

Notes: VA/Emp.: VA per employee, Agr.: agriculture, Manu.: manufacturing, Ser.: services, total: total Theil index, within: intra-regional Theil index, between: inter-regional Theil index.

As acknowledged in the introduction, our claim is based on the minimum number of points that allows us to test the existence of the bell-shaped curve. In order to provide more evidence, we have considered two additional years: 1896 for which incomplete information is available, and 1982, the oldest year for which the INSEE reports full sectoral data at the level of departments.[21] Unpublished data built by Toutain for 1896 report the employment level for both the manufacturing and service sectors, as well as the value-added for services. As for the manufacturing sector, only the total wage bill per department is available. Furthermore, it should be kept in mind that the three French departments of Alsace-Lorraine (Bas-Rhin, Haut-Rhin and Moselle) were part of Germany from 1871 to 1918. Therefore, the number of observations is slightly lower in 1896 than in the other years, which directly affects the value of the index. Despite those shortcomings, we have found it worthy to compute the corresponding Theil-index for each of these magnitudes. It turns out that its values for 1896 fall right in between those of 1860 and 1930, computed in terms of either employment (manufacturing and services) or value-added (services). As for 1982, the Theil-index values of the manufacturing sector also fall in between those of 1930 and 2000. The same holds true regarding employment in services, but their value-added

[21] The values of the Theil-index for those two years are given in the Appendix (See Table A.4).

is slightly less concentrated in 1982 than in 1930 and 2000. This is the only point that does not perfectly match the bell-shaped pattern. Having computed the Theil index for a few more years during the last two decades reveals that the spatial distribution of services exhibits some volatility as shown, for example, by the 2004 value of the Theil-index for value-added, which is lower than in 2000. This could well be due to two major trends that have affected this sector: (i) the range of services has grown substantially since the 1960s and (ii) the dynamics triggered by the development of new information technologies has not yet produced its long run effects. In any case, it seems fair to say that this additional evidence agrees with the bell-shaped curve.

5 Spatial concentration and productivity

A number of theoretical and empirical papers suggest that the agglomeration of activities plays a central role in determining labor productivity. Agglomeration-related productivity gains can arise from a number of different sources: better market access to final or intermediate goods, better matching between employers and employees, as well a more rapid diffusion of information and innovation (Duranton and Puga, 2004; Rosenthal and Strange, 2004).

5.1 Do agglomeration economies exist?

Let us begin by examining the correlations between labor productivity and employment density. In the United States, Ciccone and Hall (1996) find that over half of the labor productivity variance across American states in 1988 can be explained by differences in the concentration of economic activity. The first column of Table 7 mirrors these findings by unearthing the existence of a positive and increasing correlation between labor productivity and total departmental employment density across time: 0.34 in 1860, 0.40 in 1930, and 0.59 in 2000. In other words, higher densities correspond to higher productivity, and this relationship has grown stronger between 1860 and 2000. Hence, for the last 140 years, *the French economy has been characterized by the presence of agglomeration economies, which seem to have played an increasingly important role over time.*

Table 7: Correlations between labor productivity and employment density

	Total employment				Employment by industry		
	Total	Agr.	Manu.	Ser.	Agr.	Manu.	Ser.
1860	0.34	0.37	0.31	0.22	-0.46	0.31	0.22
1930	0.40	0.11	0.45	0.29	-0.34	0.45	0.28
2000	0.59	-0.22	0.44	0.64	-0.02	0.46	0.63

Notes: Agr. : agriculture, Manu. : manufacturing, Ser. : services.

It remains to be seen whether these agglomeration economies are operating primarily within or between sectors. The three columns on the left-side of Table 7 provide the correlation between sector-specific productivity and total employment density. Services and manufacturing exhibit the same trends as at the aggregate level, although the correlation for manufacturing levels-off between 1930 and 2000. In services, the last 70 years have seen the strengthening of agglomeration economies. In agriculture, however, the correlation between employment density and labor productivity decreases over time, even becoming negative in 2000. This is due to the fact that this sector is increasingly drawn to sparsely populated zones, most likely in order to take advantage of larger acreage. Indeed, the average size of farms greater than one hectare was approximately 10 hectares in 1860 and 1930, but reaches slightly over 30 hectares in 2000 (Toutain, 1992-1993). We can account for the relatively high correlation in 1860 by noting the presence of agricultural activity in every department, even those characterized as predominately urban. On the other hand, agriculture essentially ceases to enjoy agglomeration economies by 1930. In fact, by the year 2000, diseconomies of agglomeration have set in, meaning that greater productivity is associated with sparser zones. In sum, this suggests that the agglomeration economies observed at the aggregate level are due to manufacturing and services.

The three right-most columns of Table 7 provide the correlation between sector-specific productivity and sector-specific employment density. The idea is to determine whether the positive relationship between productivity and density arises from the total size of the local economy (urbanization effect) or from the size of the local sector itself (specialization effect). The only differences worth mentioning between these two types of effects are observed in agriculture, where the correlations are always negative but increasing. This is in line with the gradual reduction in the degree of decreasing returns that characterizes this sector. Moreover, in 1860, agriculture's main market outlets were often confined to those departments which hosted farms, thus making local competition among farmers strong. With the extension of market outlets and the decline in the number of farmers, this downward pressure on farmers' wages is relaxed and agglomeration diseconomies become weaker. Hence, the positive relationship between agricultural productivity and total employment density at the beginning of the period stems from the other two sectors. In manufacturing and services, the correlations are nearly identical, which suggests that the agglomeration economies may be operating both within and between sectors. Nonetheless, it is worth noting that these simple correlations may conceal more complex phenomena, and so because total and sectoral concentrations are typically correlated. The multivariate analysis in the next section sheds further light on these issues.

5.2 The magnitude of agglomeration economies

Economic geography underscores the importance of market size and market access in determining the location choices of economic agents and factor prices. In order to evaluate the relative influence of each of these explanatory variables, it is customary to regress the logarithm of labor productivity on the logarithm of employment density, as well as a few additional explanatory variables. Using a logarithmic specification allows for the estimated coefficients to be interpreted as elasticities. Moreover, the panel structure of our data (88 departments, 3 industries, 3 dates), allows us to estimate a specification with the following two sets of fixed-effects: sector fixed effects, γ_s which captures the sector-specific variables that affect all departments in the same way, irrespective of time (e.g. labor productivity is on average higher in manufacturing than in agriculture); and a time-fixed effects, γ_t, which captures temporal variable that affect all departments and all sectors in the same way (e.g. productivity gains stemming from technological progress).

The economic size of a territory is assessed by the *employment density*, i.e. the volume of employment per unit of surface area of department d at date t, denoted den_{dt}. After conditioning over time and sector fixed-effects, the estimated impact of this variable is equal to 0.08 when yearly data are pooled together and no other controls are considered (column 1 of Table 8). This implies that, on average, increasing density by 1% raises productivity by 0.08% over the period as a whole. Doubling the density (a realistic thought-experiment given that the inter-decile ratio of employment density is 6.6 in 2000) implies a productivity increase of $2^{0.08} - 1 = 5.7\%$.[22] Observe that, for Spanish provinces, Martinez-Galarraga et al. (2008) find a decreasing average impact of employment density on labor productivity from 1860 to 1999, which never exceeds 5%. Ciccone and Hall (1996) obtain an estimate of 0.06 for American counties in 1988. As for the EU-15 five largest countries, Ciccone (2002) obtains an estimate of approximately 0.05 for the end of the 1980s. Thus, elasticities seem to have similar orders of magnitude across studies, as confirmed by Rosenthal and Strange (2004).

Our results need qualification once estimations are conducted for each year separately (columns 2 through 4). In 1860 and 1930, the elasticity remains constant and equal to 0.10. However, it decreases by half in 2000. This does not seem to be consistent with the correlations given in Table 7. This is because pooling sectors gives the same weight to all observations, and therefore to agriculture, manufacturing and services; in contrast, data were aggregated in the above, thus taking into account the relative importance of sectors in the overall activity. In addition, low values for R^2 suggest that determinants other than density also play an important role in explaining productivity differences across space, especially in 1860 and 2000. It is worth stressing that the estimated impact of density may be tainted with an endogeneity bias. First, employment density may be capturing the impact of omitted variables, such as specialization and diversity effects, the overall access to external outlets, as well as the skill-level of the local labor force. Moreover, employment density is conditioned over wage levels, and thus also over productivity, since workers are drawn to areas offering the highest wage. The potential bias arising from this *reverse causality* is simply the manifestation of the self-reinforcing agglomeration process or *circular causality* discussed in the introduction. In other words, higher productivity also yields higher density. All of this invites us to move to multivariate estimations in order to account for more explanatory variables and to possibly instrument some of them.

Table 8: Industry-specific productivity and employment density: simple regressions

	Independent variable $\ln lp_{dst}$			
Model :	(P)	(1860)	(1930)	(2000)
$\ln den_{dt}$	0.08^a	0.10^a	0.10^a	0.05^a
	(0.01)	(0.03)	(0.02)	(0.02)
Year fixed-effect	Yes	No	No	No
Industry fixed-effect	Yes	Yes	Yes	Yes
N	792	264	264	264
R^2	0.97	0.34	0.62	0.31
RMSE	0.280	0.326	0.217	0.249

Note: Standard errors are in parentheses : ^{a}, ^{b} and ^{c} are significance levels at the 1%, 5% and 10% threshold, respectively.

In order to address the endogeneity problem raised by omitted variables, we add variables drawn from economic geography. In the first place, the impact of employment density may vary considerably according to the size of the territory under consideration. For instance, for a given density level, a larger territory is more likely to exhibit more non-market interactions among agents than a smaller territory because the total number of individuals is larger in the former than in the latter case. Thus, departments varying in their sur-

[22] If we let y be labor productivity and x employment density for a given territory, then the elasticity β is such that $\log y = \beta \log x$. When comparing two territories i and j with $x_i = 2x_j$, the difference between their productivity is such that $\log(y_i/y_j) = \beta \log(x_i/x_j) = \beta \log 2$, which in turn implies that $y_i/y_j = 2^\beta$.

face areas, we must keep track of both the department's employment density and surface area, $area_d$. Furthermore, economic geography suggests that proximity to large outlets is conducive to firms' higher profitability. We capture the effect of market access by using a *market potential* variable, as defined by the American geographer Harris (1954). Market potential for department d is defined as the sum of the other departments' ($i \neq d$) total employment, divided by the crow-fly distance between the centroids of departments ($dist_{id}$):

$$MP_{dt} = \sum_{i \neq d} \frac{emp_{it}}{dist_{id}}. \tag{2}$$

This leaves us with the need to consider the existence of agglomeration economies that may arise from the sectoral distribution of economic activity. Specialization effects are usually measured as sector s' share of economic activity in department d at date t, spe_{dst}.

In order to estimate the impact of sectoral diversity, we resort to the Herfindhal index. Recall that this index is defined as the sum of the squares of each sector's share in a given department:

$$H_{dt} = \sum\nolimits_s (spe_{dst})^2.$$

The lower the index value, the greater the sectoral diversity in department d. In order to make the estimated coefficient easy to interpret, we reformulate the diversity index as $div_{dt} = 1/H_{dt}$.

Column 1 of Table 9 presents the ordinary least squares estimates of specification (3):

$$\ln p_{dst} = \alpha + \beta \ln den_{dt} + \delta \ln area_d + \eta \ln MP_{dt} + \theta \ln spe_{dst} + \lambda \ln div_{dt} + \gamma_t + \gamma_s + \varepsilon_{dst} \tag{3}$$

where p_{dst} is the labor productivity in sector s and department d at date t, while ε_{dst} is an error term that captures local productivity shocks that are unexplained by the model.

Table 9: Industry-specific productivity and employment density: multivariate analysis

	Independent variable: $\ln lp_{dst}$			
Model:	(Pool.)	(Agr.)	(Manu.)	(Ser.)
$\ln den_{dt}$	0.09^a	-0.11^b	0.13^a	0.07^a
	(0.02)	(0.05)	(0.02)	(0.01)
$\ln area_d$	0.06^c	0.28^a	0.05	-0.01
	(0.04)	(0.09)	(0.05)	(0.03)
$\ln MP_{dt}$	0.16^a	0.27^a	0.13^b	0.01
	(0.04)	(0.09)	(0.05)	(0.04)
$\ln spe_{dst}$	-0.05^a	-0.31^a	0.03	0.13^a
	(0.01)	(0.06)	(0.06)	(0.04)
$\ln div_{dt}$	0.61^a	1.02^a	0.16	0.17^b
	(0.06)	(0.13)	(0.14)	(0.07)
Year fixed-effects	Yes	Yes	Yes	Yes
Industry fixed-effects	Yes	No	No	No
N	792	264	264	264
R^2	0.972	0.960	0.987	0.992
RMSE	0.258	0.320	0.183	0.133

Note: Standard errors are in parentheses : ^{a}, ^{b} and ^{c} are significance levels at the 1%, 5% and 10% threshold, respectively.

We observe that the elasticity of density ($\beta = 0.09$) does not decrease after the introduction of additional explanatory variables: given a constant surface area, doubling density increases productivity by 6.4%. Yet, this average value hides the existence of important disparities across sectors, which is consistent with the correlation analysis presented above. As expected, the effect of density in the agricultural sector (column 2) is negative ($\beta = -0.11$), which bolsters the idea that this sector is more productive in sparser regions. However, when it comes to manufacturing and services (columns 3 and 4), density has a positive and significant impact. A higher elasticity is found for manufacturing ($\beta = 0.13$) than for services ($\beta = 0.07$), which may be due to manufacturing's greater reliance on market and supplier access, as well as its need for skilled labor. In contrast with density, the impact of surface area is not very robust: this variable is only statistically significant at the 10% level for the pooled regression, which may come from the fact that it has a no effect in manufacturing and services (see column 3 and 4). In spite of the growing incentives to decentralize employment due to higher land rents and commuting costs, it turns out that surface area does not play a decisive role in these two sectors once total employment density is controlled for.

The elasticity of market potential is equal to 0.16, which suggests that labor productivity is even more responsive to market access than employment density. Once again, this average value conceals a large degree of variability across sectors. The elasticity is highly positive and significant for agriculture ($\eta = 0.27$), takes on intermediate value for manufacturing ($\eta = 0.13$), and is essentially zero for services. Thus, proximity to large outlets is an important determinant in agriculture, probably because of the perishable nature of many products. Access to large markets is less important in manufacturing, which may be due to the strong decline in transport costs for manufactured goods. Market access plays no role in services, which is of little surprise given that this activity is mostly consumer-oriented and, therefore, very localized, within departments.

Let us now turn to agglomeration economies triggered by the local industrial structure. Specialization has a significant and negative impact on labor productivity ($\theta = -0.05$). In particular, the specialization effect is strongly negative for agriculture ($\theta = -0.31$), validating the justification provided for the negative impact of density in agriculture. Specifically, increasing agriculture's share by 10% reduces agricultural productivity by 2.2%. However, the specialization effect is weak and non-significant for manufacturing ($\theta = -0.03$). It seems reasonable to surmise that positive agglomeration economies specific to these sector are offset by negative congestion effects in local markets (such as fiercer competition on both the output and input markets). It is also worth noting that areas hosting a strong concentration of one sector are more vulnerable to specific shocks, as illustrated by the fate of the textile and steel industries in Northern France. Specialization has a large positive impact in services ($\theta = 0.13$), probably because of the existence of common intermediate goods, thicker labor markets, local public goods and/or informational spillovers specific to this sector. Increasing services' share by 10% leads to a 1.3% productivity increase.

The diversity effect is significantly positive ($\lambda = 0.61$). It is the strongest in agriculture ($\lambda = 1.02$), which has become increasingly reliant on diversified services and suppliers (Mendras, 1994). Diversity also plays a positive role in services, but to a lesser extent ($\lambda = 0.17$). Last, diversity is not significant in manufacturing. In sum, specialization and diversity economies seem to have no impact on manufacturing productivity, the total employment density capturing most of the agglomeration effects. As for agriculture, it loses from specialization but gains from diversity. Services benefit from all types of agglomeration effects.

In order to deal with the issue of circular causality, we follow the two-stage procedure proposed by Combes et al. (2008a). First, we estimate the following equation by ordinary least squares:

$$\ln p_{dst} = \nu + \theta \ln spe_{dst} + \gamma_{dt} + \gamma_s + \epsilon_{dst}$$

where γ_{dt} is a department-year dummy which captures the influence of non-sectoral (observable and non-observable) variables on labor productivity. In the second stage, we regress the first-stage predicted value $\widehat{\gamma_{dt}}$ on the non-sectoral observable variables (density, surface area, market potential, and diversity):

$$\widehat{\gamma_{dt}} = \alpha + \beta \ln den_{dt} + \delta \ln area_d + \eta \ln MP_{dt} + \lambda \ln div_{dt} + \gamma_t + \xi_{dt}. \tag{4}$$

As density, the market potential is likely to be endogenous since market sizes depend on workers' and firms' location decisions. Hence, in the estimation of the second-stage equation (4), we instrument both the density and market potential by adopting two-staged least squares, with the aim of removing the possible spurious correlation between these variables and the error term. This method entails obtaining exogenous predictors for the variables suspected of being endogenous, and then replacing each of the latter variables by their predictors in the estimated equation. We choose as instruments the 1801 population density, den_{1801}, and the market potential, MP_{1801} in which employment level is replaced by population size. Indeed, these variables are highly correlated with employment density and market potential (with correlation coefficients at 0.82 and 0.80, respectively), but weakly correlated with sectoral labor productivity (0.04 and 0.03, respectively), suggesting that these two instruments are valid.[23] Thus, the predictors $\ln \widehat{den}_{dt}$ and $\ln \widehat{MP}_{dt}$ are provided by the following instrumental regressions (see Table 11):

$$\begin{cases} \ln \widehat{den}_{dt} = \widehat{a_1} + \widehat{b_1} \ln den_{1801} + \widehat{c_1} \ln area_d + \widehat{d_1} \ln MP_{1801} + \widehat{e_1} \ln div_{dt} + \widehat{\gamma_{1t}} \\ \ln \widehat{MP}_{dt} = \widehat{a_2} + \widehat{b_2} \ln den_{1801} + \widehat{c_2} \ln area_d + \widehat{d_2} \ln MP_{1801} + \widehat{e_2} \ln div_{dt} + \widehat{\gamma_{2t}}. \end{cases}$$

The so-obtained predictors are then used as explanatory variables for productivity in specification (4). The instrumented regression produces the results displayed in Table 10. Ultimately, we observe that endogeneity is responsible for overestimating the positive effects of density by approximately 20%. This result is in perfect line with Combes et al. (2008a,b) who focus on the period 1976-1998. Once this bias is corrected, *doubling employment density within a department leads to an average productivity gain of* 5% instead of 6.4% as obtained previously. The market potential as well as the other variables' coefficients are left almost unaffected by the instrumental procedure.

5.3 The role of human capital

New growth theories emphasize the role of human capital as an explanatory variable for the level of productivity (Lucas, 1988). In this context, the positive effect of density may stem from the fact that dense areas (especially cities) often host a larger share of skilled labor. The impact of density would not arise from the aforementioned agglomeration economies, but instead from the composition of the local labor force (Combes et al., 2008a). This idea can be tested by augmenting the previous specifications with variables that capture the skill-mix of the local labor force with respect to education. Adopting a linear approximation of a Cobb-Douglas production function requires adding the share of skilled labor as an explanatory variable (Hellerstein et al., 1999). With this in mind, we estimate the following specification:

$$\widehat{\gamma_{dt}} = \alpha + \beta \ln \widehat{den}_{dt} + \delta \ln area_d + \eta \ln \widehat{MP}_{dt} + \lambda \ln div_{dt} + \mu HC_{dt} + \gamma_t + \xi_{dt}$$

[23] In the absence of a sufficient number of instruments, we cannot formally test their validity. However, as revealed by table 11, the partial R^2 and the F statistic for the first-stage estimates lend credence to the quality of these instruments. Moreover, Combes et al. (2008b) show that long-lagged density and market potential are valid instruments in general.

Table 10: Industry-specific productivity and employment density: instrumented variables

Independent variable : $\widehat{\gamma_{dt}}$	
$\ln \widehat{den}_{dt}$	0.07^{a}
	(0.01)
$\ln \widehat{MP}_{dt}$	0.15^{a}
	(0.03)
$\ln div_{dt}$	0.61^{a}
	(0.03)
$\ln area_{d}$	0.03
	(0.02)
Year fixed-effects	Yes
N	792
R^2	0.991
RMSE	0.147

Note: Standard errors are in parentheses : [a], [b] and [c] are significance levels at the 1%, 5% and 10% threshold, respectively.

Table 11: Instrumental regression (first stage)

Independent variable	$\ln(den_{dt})$	$\ln(MP_{dt})$
$\ln den_{1801}$	1.26^{a}	0.03^{a}
	(0.04)	(0.01)
$\ln MP_{1801}$	-0.42^{a}	1.19^{a}
	(0.09)	(0.02)
$\ln div_{dt}$	-0.67^{a}	-0.01
	(0.09)	(0.02)
$\ln area_{d}$	-0.39^{a}	0.04^{a}
	(0.06)	(0.01)
Year fixed-effect	Yes	Yes
N	792	792
R^2	0.733	0.869
Shea Partial R^2	0.588	0.824
F(2,785)	559.85	1843.91
Prob $> F$	0.000	0.000

Note: Standard errors are in parentheses : [a], [b] and [c] are significance levels at the 1%, 5% and 10% threshold, respectively.

where HC_{dt} is a proxy for the share of skilled workers in department d at date t. The coefficient μ cannot be compared to the other coefficients of the regression since it is not an elasticity. Nevertheless, its sign and significance allow us to determine the monotonicity of the relationship between $\widehat{\gamma_{dt}}$ and HC_{dt}. Whether introducing human capital leaves the other coefficients unchanged is critical for our purpose.[24]

Given the time-span, it is hopeless to construct a homogenous measure of human capital. The average education level has risen considerably, especially since World War II. Given the very low percent of students who obtained their baccalaureate in 1860 and 1930, it seems reasonable to choose, for the first sub-period, the enrollment in elementary schools as a proxy for human capital. The only available data at the department level are for 1856 and 1933 (Daures et al., 2007; Rivet, 1936). The ratio of the number of pupils to the labor force is 22% in 1856 and only 27% in 1933. This low variability in schooling levels over a long period allows us to use the 1856 and 1933 ratios as approximations for the departmental share of skilled labor in 1860 and 1930.

While more detailed data are available for the year 2000, the share of skilled workers is actually calculated using the 1999 Census. Averaging across all departments, the share of employees whose reported educational attainment is elementary school reaches 12.2%, whereas it is 45.1% for middle schools, 18.4% for high schools, and 24.3% for graduates and post-graduates. Since these shares sum up to 1, one category must be removed from the regression. We thus retain three of them, namely, elementary schooling, $HC_{dt}(1)$, in order to allow for inter-period comparisons, middle schooling, $HC_{dt}(2)$, and graduate studies, $HC_{dt}(4)$, which are both likely to influence labor productivity due to either professional specialization or high human capital.

In order to deal with the heterogeneity of these measures across time, we split the sample into two subsets. Table 12 is the counterpart of Table 10 for the 1860-1930 sub-period (column 1), where column 2 presents estimates for the regression augmented by variable HC_{dt}. This latter variable has a positive and significant impact on the level of labor productivity (at the 1% level), even though it has no bearing on the R^2 value. While its inclusion slightly reduces the impact of diversity, it does not affect the elasticities of density and market potential. This is likely to be due to the weak spatial disparities in elementary education's share: the coefficients of variation are 0.42 and 0.18 for 1860 and 1930, respectively. In addition, the correlation between total density and human capital is low and slightly negative contrary to the intuition: -0.15 in 1860 and -0.26 in 1930. Given these numbers, it seems natural to believe that, during the first sub-period, agglomeration economies did not rely on human capital. Instead, education fostered the development of all areas, especially the less populated ones. This may come as a surprise since the Jules Ferry laws, which made elementary schooling mandatory all over France, were enacted only in 1881-1882. However, a recent econometric study by Diebolt et al. (2005) reveals that educational convergence between French departments began as soon as the July Monarchy and the Second Empire. By imposing a fixed minimum wage for teachers, the Guizot law of June 28, 1833 made a first contribution to the leveling of educational costs across French local jurisdictions. The law of April 10, 1867, which ordained the development of female schools and introduced free education in all jurisdictions that sought it, reinforced the convergence of education levels. In sum, *while human capital positively influences the overall level of labor productivity over 1860-1930, it does not explain the positive impact of density.* This lends credence to the existence of the agglomeration economies discussed in the foregoing.

[24]Reverse causality may jeopardize the effect of human capital but we have no way to instrument this variable.

Table 12: The effect of human capital over 1860-1930

	Independent variable: $\widehat{\gamma_{dt}}$	
$\ln \widehat{den}_{dt}$	0.05^a	0.05^a
	(0.01)	(0.01)
$\ln \widehat{MP}_{dt}$	0.25^a	0.24^a
	(0.03)	(0.03)
$\ln div_{dt}$	0.74^a	0.70^a
	(0.04)	(0.04)
$\ln area_d$	-0.05^c	-0.05^c
	(0.03)	(0.03)
HC_{dt}		0.26^a
		(0.09)
N	528	528
R^2	0.987	0.987
RMSE	0.144	0.143

Note: Standard errors are in parentheses : [a], [b] and [c] are significance levels at the 1%, 5% and 10% threshold, respectively.

Table 13: The effect of human capital in 2000

	Independent variable: $\widehat{\gamma_{dt}}$	
$\ln \widehat{den}_{dt}$	0.10^a	0.07^a
	(0.02)	(0.03)
$\ln \widehat{MP}_{dt}$	0.10^a	-0.02
	(0.04)	(0.05)
$\ln div_{dt}$	-0.26^b	-0.69^a
	(0.11)	(0.14)
$\ln area_d$	0.22^a	0.18^a
	(0.03)	(0.04)
$HC_{dt}(1)$		3.54^a
		(0.80)
$HC_{dt}(2)$		2.68^a
		(0.86)
$HC_{dt}(4)$		2.74^a
		(1.02)
N	264	264
R^2	0.417	0.453
RMSE	0.124	0.121

Note: Standard errors are in parentheses : [a], [b] and [c] are significance levels at the 1%, 5% and 10% threshold, respectively.

Table 13 provides the same information as in Table 12, but for the year 2000. We see that, after having introduced our three human capital variables, the elasticity of density drops by 30% (from 0.10 to 0.07), which still leaves it above its 1860-1930 value. This suggests a strengthening of agglomeration economies over time. This also indicates that the regressions that do not control for human capital suffer from an omitted variable bias: the impact of density is thus overestimated. Moreover, *market potential loses its significance.* This is not surprising in light of the considerable drop in transport costs during the last decades (Combes and Lafourcade, 2005) and the role of World markets, which has made the accessibility to the other deparments' markets more similar across departments, thus losing its importance. In other words, *during the recent period, human capital supersedes market potential in accounting for spatial disparities in labor productivity.* That said, it is worth stressing that the three types of human capital, which are all significant at the 1% level, impact differently on labor productivity. First, as before, elementary schooling keeps accounting for a small share of inter-departmental disparities (the coefficient of variation of the elementary education's share is 0.20). Second, since middle schooling is negatively and significantly correlated with density (-0.5), we expect this variable to have a stronger productivity impact in less populated areas, which accommodate a growing number of industrial plants. Last, to the extent that the correlation between total density and the share of graduate students in employment is high and positive (0.48), it is reasonable to believe that *higher education is the main driver of current spatial differences in labor productivity.*

6 Conclusion

Our cliometric study corroborates two fundamental results predicted by economic geography. Firstly, the spatial distribution of manufacturing and services has been tracing out a bell-shaped curve since the mid-nineteenth century: the 1860-1930 sub-period witnesses an increase in spatial concentration, whereas the 1930-2000 sub-period is characterized by dispersion. The suggested explanation for this phenomenon is the sustained decline in transport costs. Secondly, the existence of agglomeration economies is substantiated: a rise in the density of economic activity increases labor productivity in manufacturing and services. Market potential during the first sub-period, and higher education during the second, together with diversity account for the spatial distribution of these gains. As expected, only agriculture seems to operate more efficiently in sparser regions. In addition, total employment and value-added have heavily concentrated within continental France over 1860-2000. Contrary to general beliefs, however, discrepancies in labor productivity have decreased. In the long run, France thus reveals quite contrasted patterns of spatial inequalities.

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Appendix

Figure A.1: French “départements”

Table A.4: Theil index by sector for employment and value-added

Variable	Theil	1860	1896	1930	1982	2000	2004
Agr. Emp.	total	0.10	0.12	0.10	0.12	0.12	0.12
	within	0.06	0.09	0.07	0.08	0.07	0.07
	between	0.03	0.03	0.03	0.03	0.05	0.05
Manu. Emp.	total	0.43	0.53	0.66	0.47	0.34	0.32
	within	0.25	0.33	0.43	0.31	0.23	0.21
	Between	0.18	0.21	0.22	0.16	0.11	0.12
Ser. Emp.	total	0.46	0.60	0.77	0.64	0.60	0.59
	within	0.25	0.36	0.49	0.41	0.40	0.39
	between	0.21	0.24	0.28	0.23	0.20	0.20
Agr. VA	total	0.10	0.12	0.10	0.14	0.22	0.19
	within	0.06	0.08	0.04	0.07	0.09	0.09
	between	0.04	0.04	0.06	0.07	0.12	0.09
Manu. VA	total	0.69	-	0.93	0.61	0.50	0.47
	within	0.40	-	0.62	0.40	0.33	0.31
	between	0.29	-	0.30	0.21	0.17	0.16
Ser. VA	total	0.61	0.97	1.00	0.77	0.84	0.81
	within	0.35	0.60	0.63	0.52	0.58	0.56
	Between	0.27	0.38	0.37	0.24	0.26	0.26

Notes: Emp.: employment, Agr.: agriculture, Manu.: manufacturing, Ser.: services, VA: Value Added, total: total Theil index, within: intra-regional Theil index, between: inter-regional Theil index.