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# Agglomeration Effects in Europe and the USA

**Antonio Ciccone**

## 1. Introduction

Regional productivity differences in European countries and in the USA are large. In part, these differences are driven by the level of education of the labor force and by public infrastructure. However, neither differences in levels of education nor of public infrastructure appear to be the main reason for regional productivity differences. Attention has therefore shifted to the role of agglomeration effects. Agglomeration effects describe all factors that make firms in places of dense economic activity especially productive. For example, a larger variety of producer services is available in cities than in small towns. These services enhance firms' productivity. Furthermore, firms that are located close to other firms in the same industry tend to find out more rapidly about new technologies and markets. They are therefore more productive than firms located far away from the industry.

This article reviews some of the recent work on the role of agglomeration effects in explaining regional productivity differences in European countries and in the USA. The two main conclusions are easily summarized. First, a large part of regional productivity differences can be explained by agglomeration effects. In fact, agglomeration effects appear to be more important for explaining regional productivity differences than, for example, education. Second, the strength of agglomeration effects is similar between the USA and European countries.

Before entering into a more detailed exposition of agglomeration theories and empirical evidence, it is useful to review briefly the data on regional productivity differences in some European countries and in the USA. The European countries analyzed will be France, Germany, Italy, Spain, and the UK. All other European Community countries lack some of the relevant data.

In Germany, the finest level of geographic detail where data on productivity is available are the so-called *Kreise*. Labor productivity in the five most productive *Kreise* is almost two-and-a-half times average labor productivity in the five least productive *Kreise*. Table 1 summarizes some of the key aspects of the data for Germany.

France, Italy, and Spain have similar levels of inequality of regional labor productivity. Average labor productivity in the five most productive French *Départements*, Italian *Provincie*, and Spanish *Provincias* is approximately 65 percent higher than in the five least productive *Départements*, *Provincie*, and *Provincias*. Table 2 contains some descriptive statistics for the Spanish case.



**Table 1**

**Descriptive Statistics for German *Kreise***

| | Mean | Maximum/Minimum |
|---|---|---|
| Productivity (1986) | *32 500 ECU (1988)* | *60 025/22 169* |
| Employment (1986) | *81 000* | *857 000/15 000* |
| Area | *745 km2* | *2185/35* |

**Source:** *Eurostat (1992)*

**Table 2**

**Descriptive Statistics for Spanish *Provincias***

| | Mean | Maximum/Minimum |
|---|---|---|
| Productivity (1986) | *22 400 ECU (1988)* | *36 640/16 342* |
| Employment (1986) | *193 000* | *1 454 000/21 000* |
| Area | *10 478 km2* | *21 657/1 997* |

**Source:** *Eurostat (1992)*

**Table 3**

**Descriptive Statistics for British *Counties***

| | Mean | Maximum/Minimum |
|---|---|---|
| Productivity (1987) | *23 700 ECU (1988)* | *28 131/20 557* |
| Employment (1987) | *381 000* | *3 893 000/38 000* |
| Area | *3 561 km2* | *26 137/416* |

**Source:** *Eurostat (1992)*

The country with the smallest regional differences in average labor productivity is the UK. Average labor productivity in the five most productive British *Counties* is only one-third higher than average labor productivity in the five least productive *Counties*. Table 3 summarizes data from the UK.

The data on regional productivity must be used cautiously when making cross-country comparisons on regional inequality. This is because the average size of the regional units is very different across countries. For example, Spanish *Provincias* have an average size of 10500 square kilometers and are therefore on average 14 times larger than German *Kreise*. However, the data are good enough to draw some partial conclusions on the degree of regional inequality. For example, productivity differences between the top five and the bottom five geographic units are basically identical in France and in Italy, but French geographic units are somewhat larger than those of Italy. Hence, regional inequality in productivity in France appears to be at least as large as in Italy. This is rather surprising as the unequal distribution of productivity in Italy is much discussed, while there is little written about regional inequality in France. Moreover, productivity differences between the top five and the bottom five geographic units in France and Italy are larger than in England, although both the French and Italian regional units are larger than British *Counties*. Hence, regional inequality in productivity appears to be larger in France and Italy than in the UK.

Regional differences in average labor productivity in the USA are also very large. For example, the most productive US state is two-thirds more productive than the least productive state. Table 4 gives average labor productivity in the three most productive states and in the three least productive states in 1988.

**Table 4**
**The Three Most and Least Productive US States (1988)**

| State | Productivity |
|---|---|
| *New Jersey* | *44 488 US$* |
| *Connecticut* | *41 927 US$* |
| *New York* | *41 921 US$* |
| *Idaho* | *29 861 US$* |
| *South Carolina* | *29 623 US$* |
| *South Dakota* | *26 196 US$* |

**Source:** *Ciccone and Hall (1996)*

These data cannot be used to compare the degree of regional inequality between Europe and the USA however, as states cover a much larger land area on average than *Kreise*, *Départements*, *Provincie*, *Provincias* or *Counties*.

To get a sense of potential average-labor-productivity differences in the USA at a finer level of geographical detail, it is necessary to look at average-wage differences across US *Counties*. I found (Ciccone 1997) that average wages (in manufacturing and services) in the 50 highest wage counties are more than three times average wages in the 50 lowest wage counties (there are just over 3000 counties in the USA). Given that counties are somewhat larger than German *Kreise*, it seems reasonable to suspect that regional productivity differences in the USA are larger than in Germany.

## 2. Theories

Agglomeration effects arise for a variety of reasons. The simplest one is that new technologies are adopted and exchanged more rapidly in places of dense economic activity. Technological diffusion across different firms is achieved through different channels, for example spying or hiring key workers from competitors. Another reason for agglomeration effects is related to the size of markets and specialization economies. The large volume of business in places of dense economic activity renders a large variety of specialized business services profitable. These specialized services make firms more productive. Agglomeration effects may also arise because the provision of business services is more competitive in places of dense economic activity, as the large volume of business attracts more service firms and results in pressure on profit margins.

One of the common features of different agglomeration theories is their implication that regional productivity should depend positively on the regional density of economic activity. The simplest measure of the regional density of economic activity is employment per square kilometer. Using this measure we can examine the role of agglomeration economies by estimating the following relationship:

$$\text{Regional Labor-Productivity} = \text{Other Determinants} + a \times (\text{Regional Density Index}) \quad (1)$$

"Other Determinants" stands for the usual suspects for explaining regional productivity differences: i.e. level of education, public infrastructure, and the institutional setup. If the estimation of this relationship were to yield a positive and significant value for "*a*" then we would conclude that agglomeration effects play a role in explaining regional productivity differences. Notice that the amount of physical capital used in regional production is not included as a determinant of regional average-labor-productivity differences, as the physical capital intensity across regions depends itself on education, public infrastructure, and institutional differences when physical capital is mobile across regions in the same country.

## 3. Empirical Approach

The main problem with the estimation of agglomeration effects is that it is difficult to distinguish between two competing explanations for a positive relationship between agglomeration and productivity. The first explanation is that productivity is high because of agglomeration effects. The second explanation is that agglomeration may be a consequence – not a cause – of high productivity. Telling these explanations apart (i.e. determining causality) is complicated when not all the variables that determine regional productivity are observed. The correct way to resolve the issue of causality is an econometric technique called instrumental-variables estimation. The details of this method are complex but the principle is rather simple and can be illustrated with an example. Suppose that gold was found in half of a country's regions 200 years ago but that gold resources were exhausted 100 years ago. Suppose also that the population of the country was evenly distributed in space and that all regions were equally productive before gold was found. Once gold was found, however, all regions where gold started to be extracted experienced a significant inflow of workers and hence an increase in the density of economic activity. Applied to this example, instrumental-variables estimation would yield a causal effect of economic density on productivity if the regions where gold was extracted until 100 years ago were to have a higher density of economic activity and a higher productivity today. The reason is quite intuitive. We know that the high density of economic activity in the former gold regions was originally caused by the extraction of gold. Gold resources were, however, exhausted 100 years ago and can therefore not explain why the density of economic activity in these regions is still high today. The most likely explanation for this is that the high density of workers in these regions 100 years ago (caused by gold extraction) increased productivity and that this was the reason why workers stayed after gold resources were exhausted. Thus, we may conclude that the high density of workers induced by gold being extracted until 100 years ago caused a high level of productivity, which was the reason why workers did not leave once gold resources were exhausted.

The example is based on gold being found in some regions and not others. However, it should be clear that all factors that are related to a high regional population density in the past but no longer relevant for productivity today could take the place of gold in the example. In the empirical work below the place of gold will be taken by the land area of the regions that are analyzed empirically. It turns out that the land area of German *Kreise*, French *Départements*, Italian *Provincie*, Spanish *Provincias*, and British *Counties* is (significantly) negatively correlated with their employment density today. The same is true for US *Counties*. This is somewhat surprising because these geographic divisions go back to the 19th century at least. The likely explanation for the correlation is that these geographic divisions served administrative purposes. This made equalization of population size a natural criterion, which in turn induced a negative correlation between total land area and employment density. This correlation has persisted into modern days. These historical considerations suggest that the total land area of these regions can be used to determine the causality of the density/productivity relationship as long as the sources of population agglomeration in the 19th century (being close to a navigable river or a river-crossing, for example) did not affect modern productivity directly.

## 4. Evidence

I will start discussing the evidence for agglomeration effects in the USA. There, agglomeration effects can be estimated either using average labor productivity data at the state level or wage data at the county level. Then I turn to the analysis of agglomeration effects in France, Germany, Italy, Spain, and the UK using data at the level of *Kreise*, *Départements*, *Provincie*, *Provincias*, and *Counties* respectively.

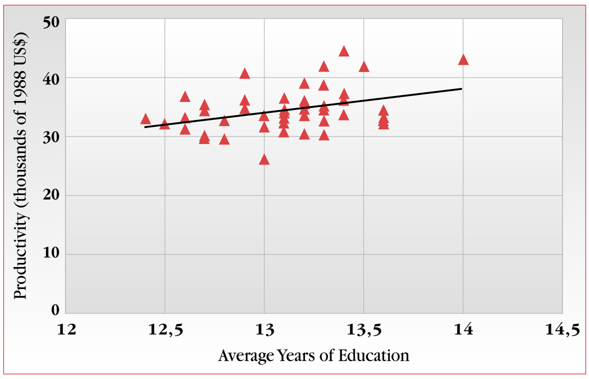
### 4.1. US Evidence

In the USA, the finest level of geographical detail where data on output is available is the state level. Thus, the observations on average labor productivity used in the estimating equation (1) for agglomeration effects are for the 50 states and the District of Columbia. It would not make sense, however, to relate average labor productivity across US states directly to their employment density. This is because most land in the USA supports essentially no economic activity at all. Moreover, agglomeration theories postulate externalities among firms that are located close to each and other and most US states cover a very large land area.

To get a theoretically meaningful measure of the density of economic activity in each US state, it is therefore necessary to construct a density index based on employment densities at a much finer level of geographical detail. This is the approach that I took in my work with Robert Hall (Ciccone and Hall 1996). There, we used two popular agglomeration theories to construct state density indices that depend on the density of employment in each of a state's counties and on the total number of workers in each county. Both theories postulate agglomeration effects at the county level; counties are used because they are the finest level of geographic detail where data on employment are available in the USA. We show that these indices have two properties: first, increasing the density of employment in all counties increases the index and should therefore yield higher productivity at the state level if the postulated agglomeration theories are empirically valid. Second, distributing employment more unequally across counties (by moving workers from less dense counties to dense counties) also increases the index and should therefore also yield higher productivity at the state level. This last property is driven by the fact that agglomeration effects imply that workers are more productive in denser regions. These state density indices are then combined with data on average labor productivity across US states in 1988 to estimate agglomeration effects. It is important to note that this approach yields the strength of agglomeration effects at the county level (not the state level). Still, the results can be used to determine how much of the differences in average labor productivity across US states can be explained by agglomeration effects. Our main findings are strong agglomeration effects at the county level and that agglomeration effects can explain over 50 percent of the variation in average labor productivity across US states. According to our estimates, a doubling of the employment density in a county results in a 5-percent increase in the county's average labor productivity. We also find that the human capital of the regional labor force and the regional infrastructure play a minor role in explaining differences in average labor productivity across states once agglomeration effects are taken into account.

Before illustrating our results on agglomeration effects, it is useful to start out by relating average labor productivity across US states to average years of education. This gives a sense of whether the education of the labor force is a key determinant of US regional productivity differences. Moreover, it allows us to compare the explanatory power of human capital for average labor productivity differences at the state level to the explanatory power of agglomeration effects. Figure 1 illustrates the relationship between average labor productivity and average years of education at the state level. The vertical axis measures average labor productivity in 1988 US$. The horizontal axis measures average years of education of workers in the state.

**Figure 1**
**Education and Productivity (1988)**




**Source:** *Ciccone and Hall (1996)*

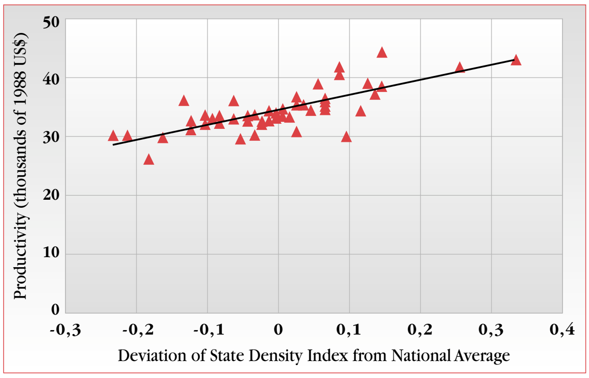
Figure 1 illustrates that there is a positive but weak relationship between average years of education and average labor productivity across US states. The simple correlation coefficient is 0.34. The rightmost point in the figure is the District of Columbia where average years of education are by far the highest in the USA but average labor productivity is lower than in New York state. This is explained by the concentration of US governmental and international institutions in the US capital. These institutions drive up average years of education but do not affect average labor productivity, as the measure of output used includes data for the private economy only. The weak positive relationship between average years of education and average labor productivity across US states in the figure would completely vanish if New York, New Jersey, Connecticut, and the District of Columbia were eliminated from the data.

Figure 2 illustrates the relationship between the density of economic activity and average labor productivity across US states. The vertical axis measures average labor productivity in 1988 US$. The horizontal axis measures the deviation of our state density index from the national average. For example, the rightmost point in the graph stands for the District of Columbia, which is 36 percent denser than the US average and the second most productive region in the USA. It is important to keep in mind that the state density index is itself estimated by using data on density and employment in all counties that are part of the respective state.

The relationship between average labor productivity and the density of economic activity is positive and much stronger than the relationship between productivity and education in Figure 1. The simple correlation coefficient is

**Figure 2**

**Density of Economic Activity and Productivity (1988)**




**Source:** *Ciccone and Hall (1996)*

0.74. Comparing Figure 2 with Figure 1, it is evident that the relationship between density and average labor productivity is not only stronger than the relationship between education and average labor productivity but also more robust, in the sense that the positive relationship holds over the whole range of density in Figure 2, while it only holds when comparing the four or five best educated states with all other states in Figure 1.

Table 5 gives the state density index and average labor productivity for the five US regions with the highest index and the five regions with the lowest index.

According to the table, New York state is approximately 10 percent denser than Illinois, which in turn is approximately 30 percent denser than Montana.

The construction of the state density index implies that, conceptually, a high value of the

**Table 5**

**Density Index and Productivity (1988)**

| | Density Index | Productivity |
|---|---|---|
| *District of Columbia* | *1,67* | *43 164 US$* |
| *New York* | *1,59* | *41 921 US$* |
| *New Jersey* | *1,48* | *44 488 US$* |
| *Massachusetts* | *1,47* | *37 296 US$* |
| *Illinois* | *1,46* | *39 150 US$* |
| *Nevada* | *1,20* | *36 234 US$* |
| *Idaho* | *1,17* | *29 861 US$* |
| *South Dakota* | *1,15* | *26 196 US$* |
| *North Dakota* | *1,12* | *30 248 US$* |
| *Montana* | *1,10* | *30 302 US$* |

**Source:** *Ciccone and Hall (1996)*

density index for a given US state may be due to two different factors. First, a high value may be explained by a high average density of employment in the state. Second, it may be explained by a very unequal distribution of employment densities across counties in the state. In other words, the density index is constructed in such a way that, other things being equal, states with a more unequal distribution of employment across counties will have higher values. It was already mentioned that this is because the density index postulates agglomeration effects – and hence aggregate increasing returns to scale to employment – at the county level. Table 6 gives an idea of whether states' average labor productivity is explained by a high average employment density or by an unequal distribution of employment in the state. The states in the table are those with most unequal distribution of employment across counties and those with the most equal distribution. The sum of the columns labeled "State Effect" and "Distribution Effect" is the predicted difference between average labor productivity in the state and in the country, expressed as a percentage. For example, according to the first row in the table, productivity in New York state is approximately 28 percent (9 plus 19) higher than in the rest of the USA. The "State Effect" estimates how much of the productivity differential between the state and the country is due to differences in the average density of employment between the state considered and the country. For example, according to the first row, 9 percentage points of the productivity differential between New York state and the USA are due to the fact that the average employment density in New York state is higher than in the USA. The "Distribution Effect," on the other hand, estimates how much of the

**Table 6**

**State and Distribution Effects (1988)**

| | State Effect | Distribution Effect | Productivity |
|---|---|---|---|
| *New York* | *9* | *19* | *41 921 US$* |
| *Utah* | *-9* | *18* | *32 160 US$* |
| *Colorado* | *-6* | *17* | *33 342 US$* |
| *Nebraska* | *-8* | *16* | *30 323 US$* |
| *Minnesota* | *-2* | *15* | *35 494 US$* |
| *South Carolina* | *1* | *3* | *29 623 US$* |
| *New Hampshire* | *3* | *3* | *36 688 US$* |
| *Vermont* | *-2* | *2* | *33 733 US$* |
| *Connecticut* | *14* | *2* | *41 927 US$* |
| *Rhode Island* | *16* | *1* | *30 055 US$* |

**Source:** *Ciccone and Hall (1996)*

productivity differential between the state and the country is due to the fact that employment is unequally distributed across counties within the state. For example, according to the first row, 19 percentage points of the productivity differential between New York state and the USA are due to the unequal distribution of employment density in space in New York state (mostly due to the concentration of employment in and around New York city).

The state with the most equal distribution of employment in space in the sample is Rhode Island. Most of its productivity-differential relative to the USA is explained by a high average employment density, which is not too surprising as Rhode Island is a very small state. Vermont has a level of average labor productivity exactly equal to the US average. According to its average density, it should be 2 percentage points below the US average, but the unequal density in space compensates this effect exactly.

The empirical work for US states considers two determinants for states' average labor productivity in addition to the density of economic activity. The first determinant is public capital. There, we found that the effect of public capital on states' average labor productivity is positive, but statistically insignificant once agglomeration effects are taken into account. The second additional determinant considered is aggregate scale effects. This is accomplished by allowing counties with a large labor force (as opposed to a high employment density) to be more productive than counties with a small labor force. The effect of employment is found to be positive but less important than the density of economic activity in explaining variations in average labor productivity across states.



Agglomeration effects at the US county level using data on average wages are analyzed in my 1997 paper and confirm the results found using data on average labor productivity at the state level. In particular, agglomeration effects estimated using wages at the county level are basically identical to agglomeration effects estimated using average labor productivity at the state level. One of the advantages of working at the US county level compared to the state level is that the large number of observation (just above 3000) on wages and the density of economic activity allows controlling for institutional and other differences at the state level. This is done by estimating agglomeration effects with data on average wages and on the density of economic activity across counties within the same state. This approach ensures that productivity differences across US states do not influence the analysis of agglomeration effects at all. Another advantage of the large number of observations is that they allow for an analysis of how average wages in counties are affected by production factors in neighboring counties. One of the most striking findings is the empirical evidence on spatial technology diffusion. The spatial technology diffusion hypothesis is that counties produce more efficiently – i.e. with better technologies – the more efficient production in neighboring counties. Efficiency of production is measured as the ratio of output to a weighted average of inputs used. The more output a county produces with the same inputs (or the fewer inputs a county uses to produce the same output) the more efficient is the production. The spatial technology diffusion hypothesis can be examined using the data for counties in two different ways. First, it is possible to examine if, holding inputs constant, counties produce more output the more output produced in neighboring counties. Second, one can also look at whether, holding the output of neighboring counties, counties produce more output the fewer inputs used in neighboring counties. The first way to verify the spatial technology diffusion is not very powerful. This is because there are several other theories that make the same prediction. For example, if market size in neighboring counties affects sales, then total output in neighboring counties may increase efficiency because firms become more productive the more they sell. The second prediction however is unique to the technology diffusion hypothesis. Hence, spatial technology diffusion is best tested by looking at whether, holding average wages in neighboring counties constant, counties have higher wages the fewer inputs used in neighboring counties. This prediction is robustly true for US counties, supporting the spatial technology hypothesis.

### 4.2. European Evidence

While agglomeration effects have been examined in detail for the US, there has not been much empirical work for European countries. This is quite surprising as spatial differences in average labor productivity within European countries are large. Furthermore, many European countries collect data at a fine level of geographic detail. For example, regional data on value added for France, Germany, Italy, Spain, and the UK can be found at a level of geographic detail that corresponds roughly to the county level in the USA. This allows for a more flexible empirical approach to agglomeration effects with European data than with US data.

In my 2001 (forthcoming) paper I combine regional data on value added for Germany, Italy, France, Spain, and the UK with data on employment and education in order to estimate



agglomeration effects. The European sample consists of 628 regions, which correspond to *Départements* in France, to *Kreise* in Germany, to *Provincie* in Italy, to *Provincias* in Spain, and to *Counties* in the UK. The large number of observations makes it possible to account for institutional factors that affect the productivity of large European regions and also examine technology diffusion across regions.

The empirical results on agglomeration effects across European regions are easily summarized. There are substantial agglomeration effects in the five European countries in the sample. According to the estimates, a doubling of the employment density in European regions increases their average labor productivity by approximately 4.6 percent. Moreover, agglomeration effects do not appear to differ significantly across the European countries in the sample. Finally, the (average) estimate of agglomeration effects in Europe is very similar to the value obtained with data on value added across US states. Moreover, the estimate remains unchanged when spatial externalities across neighboring regions are taken into account.

The equation that I estimate for European regions is basically identical to the equation (1) estimated for the USA. The main difference is that the large number of observations for regional average labor productivity in the European countries in the sample allows me to take into account exogenous productivity differences across large regions. Before turning to the empirical approach and results, however, it will be useful to review the geographic detail of the European data. The data are assembled by *Eurostat* (1992). *Eurostat* divides each European Community country into so-called *Nuts 1* regions, each *Nuts 1* region into so-called *Nuts 2* regions, and each *Nuts*

*2* region into so-called *Nuts 3* regions. It is important to understand this structure because estimation of agglomeration effects at the level of *Nuts 3* regions will control for productivity differences at the level of European countries, *Nuts 1* regions, and *Nuts 2* regions. *Nuts 3* regions correspond to *Départements* in France, to *Kreise* in Germany, to *Provincie* in Italy, to *Provincias* in Spain, and to *Counties* in the UK. The median size of *Nuts 3* regions in these counties is 1511 square kilometers. This is somewhat smaller than the median size of US counties. *Nuts 2* regions correspond to *Régions* in France, to *Regierungsbezirke* in Germany, to *Regioni* in Italy, to *Comunidades Autónomas* in Spain, and to *Groups of Counties* in the UK. Finally, *Nuts 1* regions correspond to *Zeat* in France, to *Länder* in Germany, to *Gruppi di Regioni* in Italy, to *Agrupaciones de Comunidades Autónomas* in Spain, and to *Standard Regions* in the UK.

Table 7 presents the results of estimating agglomeration effects within the European countries in the sample using data on average labor productivity at the *Nuts 3* level and controlling for the level of education of the regional labor force. Regional average labor productivity is measured as value added in manufacturing and services divided by the number of manufacturing and service workers. The empirical approach assumes implicitly that all regions within the same country have the same underlying level of exogenous productivity as determined by institutions, for example. Moreover, it is also assumed that regional agglomeration effects are equally strong in all countries in the sample.

The estimate of agglomeration effects in the table indicates that a doubling of the regional employment density increases regional average



**Table 7**

**Agglomeration effects for France, Germany, Italy, Spain, and the UK when controlling for the education of the labor force**

| | |
|---|---|
| Estimate of Agglomeration Effects | 4,55 |
| Standard Error | 0,51 |

**Source:** *Ciccone (2001, forthcoming)*

labor productivity by 4.6 percent. Moreover, it can be seen from the low standard error that this estimate is rather precise. In fact, there is a 95 percent probability that the true value of agglomeration effects lies between 3.5 and 5.7 percent.

Differences in the strength of agglomeration effects across the European countries in the sample can be tested for by allowing agglomeration effects to vary by country in the estimating equation. This yields an estimate for regional agglomeration effects in Germany – which will be the benchmark – of 4.8 percent with a standard error of 0.63 percent. The difference in regional agglomeration effects between France and Germany on the one hand and Spain and Germany on the other hand are small and not statistically significant. The difference in agglomeration effects between Germany and the UK as well as Germany and Italy are larger, however. Agglomeration effects are approximately 3 percent weaker in the UK than in Germany and 2 percent stronger in Italy than in Germany. These differences are estimated less precisely, however, and are consequently not statistically significant.

Table 8 contains the estimate of agglomeration effects in the European countries in the sample when controlling for productivity differences across *Nuts 1* regions in addition to the education of the regional labor force. The basic idea of this approach is to allow for differences in exogenous productivity across German *Länder* or Spanish *Agrupaciones de Comunidades Autónomas,* for example. This is desirable because these large regions differ in history, institutions, and climate, for example. Maybe surprisingly, the result in Table 8 is basically identical to the result in Table 7. In other words, not much of the agglomeration effects found in the previous table are explained by exogenous differences in productivity across the larger *Nuts 1* regions.

### Table 8

**Agglomeration effects for France, Germany, Italy, Spain, and the UK when controlling for productivity differences across *Nuts 1 regions.***

| | |
|---|---|
| Estimate of Agglomeration Effects | 4,44 |
| Standard Error | 0,55 |

**Source:** *Ciccone (2001, forthcoming)*

As before, this approach finds that differences in agglomeration effects across the European countries in the sample are not statistically significant.

Table 9 estimates agglomeration effects when controlling for productivity differences across *Nuts 2* regions in addition to the education of the regional labor force. *Nuts 2* regions correspond to *Régions* in France, to *Regioni* in Italy, and to *Communidades Autonomas* in Spain for example. The estimate for agglomeration effects is again very similar to the result in Table 8. This suggests that productivity differences across *Regioni* or *Communidades Autonomas,* for example, do not play a major role in explaining agglomeration effects. Once again the test for differences in agglomeration effects across countries indicates no significant differences.



### Table 9

**Agglomeration effects for France, Germany, Italy, Spain, and the UK when controlling for productivity differences across *Nuts 2 regions.***

| | |
|---|---|
| Estimate of Agglomeration Effects | 4,43 |
| Standard Error | 0,59 |

**Source:** *Ciccone (2001, forthcoming)*

One of the problems of the analysis so far is that it has been implicitly assumed that the density of production is the same throughout any *Nuts 3* region. There is little that can be done to improve upon this assumption because there are no data on the distribution of production within *Nuts 3* regions. The assumption is especially unrealistic because *Nuts 3* regions differ in the extent to which land is used for agriculture. One way to resolve this problem would be to use non-agricultural employment per non-agricultural acre in *Nuts 3* regions as the determinant of the increase in regional productivity due to agglomeration. Unfortunately, there are no data on land used for agriculture at the *Nuts 3* level. An alternative approach that seems useful given the lack of data is to include the share of total value-added generated in agriculture at the *Nuts 3* level as an additional explanatory variable in the estimating equation (1) for agglomeration effects. Including the share of agriculture in total value-added reduces the estimate of agglomeration effects to 3.4 percent with a standard error of 0.9 percent (from 4.6 percent in Table 7). Estimation also shows that a 1-percent increase in the share of agriculture in total value added reduces average labor productivity in manufacturing and services by 0.9 percent with a standard error of 0.3 percent.

Externalities across neighboring *Nuts 3* regions can be estimated by also including the employment density of neighboring regions into the estimating equation (1). In this case, agglomeration effects in each region are estimate as 4.4 percent with a standard error of 1 percent. Hence, agglomeration effects are basically unaffected by externalities across neighboring regions. However the density of economic activity in neighboring regions does have a significant effect on regional productivity. Doubling the employment density of a region's neighbors increases average labor productivity in the region by 3.3 percent (with a standard error of 1.3 percent).

## 5. Summary and Conclusions

This article has reviewed empirical work on agglomeration effects in the USA as well as in France, Germany, Italy, Spain, and the UK. The empirical results summarized here suggest significant agglomeration effects in all these countries. Furthermore, agglomeration effects do not vary significantly across European countries and are only slightly lower in Europe than in the USA.

One of the questions requiring further research is the effect of agglomeration on industry structure. It seems reasonable to suspect that productivity gains in regions with dense economic activity are partly realized through a change in industry structure. Addressing this question would require detailed and comparable data on the industry structure of regions in different European countries. Such data are not yet available. It would also be interesting to use the estimates of agglomeration effects to assess the consequences of European economic integration on aggregate productivity. It has been argued that European economic integration may increase the degree of regional specialization in Europe, bringing it closer to the pattern in the USA. This reasoning may also apply to the degree of spatial agglomeration. The estimates of agglomeration effects reviewed in this article suggest that this would increase aggregate productivity in Europe. Whether this effect is economically significant is an open question.

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