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Spatial concentration and plant-level productivity in France

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ABSTRACT

This paper analyzes empirically the effect of spatial agglomeration of activities on plant-level productivity, using French firm and plant-level data from 1996 to 2004. We exploit short-run variations of variables by making use of GMM estimation. This allows us to control for endogeneity biases that the estimation of agglomeration economies typically encounters. This means that our paper focuses on a subset of agglomeration economies, the short-run ones. Our results show that French plants benefit from localization economies, but we find very little – if any – evidence of urbanization economies. We also show that those localization benefits are relatively well internalized by firms in their location choice: we find very little difference between the geography that would maximize productivity gains in the short-run and the geography actually observed.

1. Introduction

Aside from its academic interest, the analysis of agglomeration economies has potentially important policy implications. Since the 1980s, agglomeration economies have been used to justify cluster policies by national and local governments in Germany, Brazil, Japan, Southern Korea, Spanish Basque country or more recently in France. Some of those policies are very costly. For example, 1.5 billions euros have been devoted to the "Competitiveness clusters" policy by the French government from 2005 to 2008, and again for the 2009–2011 period. Two separate questions deserve attention. First, how large are the gains from agglomeration? In particular, how much does the productivity of a firm increase when other firms from the same sector or from another sector decide to locate nearby? Second, how much do firms internalize these gains when deciding where to locate? The answer to the first question should help understand how much economic gains can be expected from clusters. The answer to the second question should help understand whether there is a strong case for public intervention in favor of industrial clusters.[1]

Rosenthal and Strange (2004) survey this literature, and report that the elasticity of productivity with respect to the size of the city or to the size of the industry generally lies between 3% and 8%. This survey and another recent work in the literature by Combes et al. (2010) for instance also emphasize that until recently, estimates of agglomeration externalities suffered from serious endogeneity problems. From a technical point of view, the estimation of geographical externalities is subject to two main sources of endogeneity: unobserved heterogeneity and simultaneity bias.

Ciccone and Hall (1996) are the first to address directly and carefully these endogeneity issues. They study the impact of county employment density on American states' labor productivity. The authors insist that if there are unmeasured and/or unobserved differences in the determinants of productivity across states, and if these determinants are correlated with counties employment density within states, the measure of the returns to density by simple OLS may be spurious. They take the example of climate or transportation infrastructures which will both enhance workers' productivity and the attractiveness of the place. They consequently resort to an instrumental variables approach. Also controlling for the average level of education within the state or the county, the authors find that a doubling of local employment density increases labor productivity by 5–6%.

Ciccone and Hall's article represents an important step in the empirical approach of agglomeration externalities. Nevertheless,

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[1] See Duranton et al. (forthcoming) for more detail about this.

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their work relies on an aggregate measure of labor productivity. In the present paper, the use of firms and plants panel data allows a careful treatment of endogeneity issues and a measurement of agglomeration externalities which is very close to the micro theories. As far as we know, Henderson (2003) was the first paper to use plant-level data for such an analysis and is the closest to the present paper. His data is available at five years intervals from 1972 to 1992. He estimates a plant-level production function for two broad sectors, machinery industries and high-tech industries, and measures the elasticity of TFP to the number of other plants of the same industry in the county. Using industry-time and plant-location fixed effects, he finds a positive and significant elasticity of 8% in the high-tech industry only.[2] He does not find evidence of gains arising from agglomeration of firms belonging to different industries . The use of fixed effects accounts for a large part of unobserved heterogeneity. Henderson also addresses the question of simultaneity bias by adding location-time fixed effects.

Our paper goes further than Henderson (2003) in several directions. We use French firms and plants panel data, for all manufacturing sectors, with yearly observations from 1996 to 2004. Our sample is therefore larger and more complete than Henderson's one which allows us to deal with simultaneity bias and instrumentation more directly. We adopt a two-step estimation strategy. We first estimate plant-level production functions for each two-digit industry. Using those coefficients, we then compute individual productivities and estimate agglomeration economies through a GMM specification, decomposing carefully the agglomeration effects into own industry (localization)/other industries (urbanization) externalities, as well as diversity and competition effects. We also discuss spatial selection of firms. In this paper, we find that the gains from clustering do exist: our benchmark regression shows that a 10% increase of employment in neighboring plants of the same industry increases a plant's productivity by around 0.55%. As stated above, these estimates are based on yearly variations in TFP and are therefore *best interpreted as short-run gains from agglomeration*, which has important implications in particular for the source of the effects we are estimating. Since our paper focuses on agglomeration economies that take place over a short period of time, we believe that we capture externalities on the labor and input markets, rather than technological spillovers or human capital externalities that should take more time to realize.

The second consequence has to do with urbanization economies, which take probably even longer to implement. That we do not find evidence of urbanization economies should probably be interpreted as the fact that they are better captured by cross-sectional analysis than by the short-term analysis we conduct here. Another way to understand our method is that it tries to purge productivity from any firm-level component that is constant over time to deal with endogeneity. But doing so, it also purges the analysis from a large part of the long-term agglomeration economies "capitalized" in this fixed firm-level component. Consequently, we consider our paper to complement existing research that relies more heavily on cross-sectional variations and which thus captures longer-term agglomeration gains.

Finally, using a non-linear specification, we can estimate the geography that maximizes short-run productivity gains from clustering and compare it to the observed geography. A disturbing feature of the existing empirical literature is that one would be tempted to conclude from the results usually obtained that more agglomeration is always better because it increases the productivity of plants. This does not look very plausible as congestion costs must necessarily appear and dominate at a certain level of agglomeration. If this was not so, one should also conclude that the observed geography (where all plants of the same sector are not located in the same region) is vastly suboptimal. Another important contribution of this paper is that we find the relation between productivity gains and agglomeration to be bell-shaped. Previous papers have failed to exhibit such a non-linear relationship because they were mostly based on long-run analysis; the presence of "suboptimal" observations in the data, necessary to estimate a bell-shaped curve, is indeed more plausible in the short-run. When using a non-linear specification, we are able to estimate the peak agglomeration that maximizes the productivity gains.[3] We find that a plant that would move (with its time-invariant idiosyncratic characteristics and for a given level of employment and capital) from a location with no other workers to a location with 1150 employees in the same sector (the peak of the observed distribution in France) would gain 53.8% in TFP. However, going to an "over-crowded" area (with more than 9000 employees) would eliminate these TFP gains. Hence, geography matters a lot for French plants and they are aware of it: French plants seem to take into account the TFP gains in their location choice. Indeed, when we compare the geography that maximizes productivity gains and the observed geography, we find very little difference between the two. From this point of view, our paper suggests that the short term gains of cluster policies which aim is to increase the size of clusters, should be very modest.

The remainder of the paper is as follows. Section 2 details our empirical strategy, Section 3 then proceeds to a description of the data used, while Section 4 presents basic results and Section 5 goes further in the comprehension of short-run agglomeration economies and assesses in particular the existence of non-linearities.

2. Estimating agglomeration externalities: empirical strategy

2.1. The model

Agglomeration economies are generally assumed to improve total factor productivity (TFP) of plants through localization economies (externalities on inputs markets, on labor markets or knowledge externalities, following the classification proposed by Marshall (1890)) and urbanization economies (cross fertilizations of different industries on a given territory, as emphasized by Jane Jacobs). When plant-level data is available, this suggests a natural empirical strategy, based on the estimation of a Cobb–Douglas production function[4]:

$$Y_{it} = A_{it}K_{it}^{\alpha}L_{it}^{\beta} \tag{1}$$

where Y_{it} is value-added of plant i at time t, A_{it} is TFP, K_{it} the capital stock and L_{it} the labor-force (in terms of employees) of plant i at time t. We then assume that TFP of plant i depends on a plant-level

[2] In regressions not reported here but available upon request, we also ran the analysis separately for low-tech and medium low-tech industries on the one hand, and high-tech and medium high-tech industries on the other hand. Agglomeration economies are significant for low-tech and medium low-tech industries only. However, instruments do not pass the validity tests for high-tech and medium high-tech industries.

[3] Au and Henderson (2006) analyze this question for Chinese cities and also find a bell-shaped curve.

[4] Combes et al. (2008a) (among many others) estimate agglomeration economies using wages as a dependent variable. An advantage of using wages for the evaluation of agglomeration economies is that wages are measured more precisely than TFP. The measurement of TFP involves a variety of estimation procedures, which all have their own issues or implementation problems. On the other hand, we do not know precisely how agglomeration gains are distributed among production factors. If the gains are not distributed in proportion to the share of each factor in value-added, using wages could bias the estimation of agglomeration effects on productivity. Therefore, we stick to the more direct method using TFP as a dependent variable here (see Chapter 11 of Combes et al. (2008b) for the theoretical relationship between the two methods).