Specialization versus concentration: A note on theory and evidence*

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Abstract: We use the spatial trade model in Rossi-Hansberg (2003) to predict that under quite general circumstances, lower transport costs increase the specialization of regions and decrease (regional) concentration of industries. We show that this finding is consistent with the trends across US States and EU member countries.

Keywords: trade, concentration, specialization, European integration, NAFTA.

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1. Introduction

Specialization of countries in particular sectors and concentration of industries in regions or countries have long been treated as closely related economic phenomena, if not identical. In the two countries and two industries case, any increase (decrease) in specialization is tautologically replicated by a parallel increase (decrease) in concentration. Empirical studies subsequently often focus either on specialization or concentration, sometimes intentionally, and sometimes by assuming that these would develop in parallel.

In this note we use the model developed in Rossi-Hansberg (2003), to obtain the prediction that for a large set of plausible specifications, lower transport costs imply higher specialization and lower concentration. The model features two industries, a continuum of regions, iceberg type transport costs, and agglomeration effects via production externalities. We contrast this prediction with the "New Economic Geography" where concentration and specialization move in most models in parallel. We then present two data sets to show that in the manufacturing sector in the US and Europe specialization and concentration have not moved in parallel and that their movement is broadly consistent with the implications of the model.

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2. The model and its prediction

Consider a finite region with a border at the west (north) given by $-S$ and one at the east (south) given by $S$. Countries are intervals in the line. There are two industries, one of which produces a final good (FG) and the other intermediate goods (IG) which are used as inputs in the production of the FG. Firms cluster because of a location specific production externality that declines with distance. FG firms need to buy inputs from an IG producer. IG firms receive FG in order to pay for the inputs (labor and land) they use in production. We assume "iceberg transport costs".

Output per unit of land of a FG firm located at $r$ is given by

$$x(r) = g^F(z^F(r))f^F(n^F(r), c^I(r)),$$

where $nF(r)$ is the number of workers per unit of land hired by the firm, $c^I(r)$ the units of intermediate input per unit of land, and $z^F(r)$ denotes the productivity of a firm at location $r$. Productivity is determined by employment in the FG sector at other locations discounted by distance, namely

$$z^F(r) = \delta^F \int_{-S}^{S} e^{-\frac{\omega}{\omega}} n^F(s) \theta(s) ds,$$

where $\theta(s)$ is the fraction of land at location $r$ used for FG production. Technology in the IG sector is similar, except that the only two factors used in production are land and labor. Productivity is also determined by an industry specific production externality.

Agents derive utility out of consuming the FG. They work for a firm at some location $r$ and command a real wage $w(r)$ in units of FGs. Markets are assumed to be competitive so firms earn zero profit; there is competition for production locations between industries. If the relative price of IGs at location $r$, $p(r)$, is above (below) a certain threshold, the location will be used for IG (FG) production. If the relative price is equal both goods are produced. The threshold is determined by the relative productivity of both industries at that point in space.

In order for a particular area to specialize, agglomeration effects have to be stronger than the gain from being close to the market of that product (in the model, regions that produce the alternative good). For small transport costs, the productivity gain from agglomeration may dominate the gain resulting from closer customers. For high transport costs, the productivity gain does not dominate at the center of the cluster, and so a new cluster of firms producing the other good appears. Hence, the theory suggests that lower transport costs imply more specialization (negative relationship).

Concentration depends on densities of production in areas specializing in the production of different goods. IGs are needed to produce FGs, and FGs are needed to pay workers that produce IGs. Both goods use land as an input in production. As transport costs decrease, areas that are in the periphery will have better access to the markets at the center and so will produce more than before per unit of land. The extra production will imply higher productivity via the production externality. Hence, lower transport costs result in less concentration of employment in the industry. Given this, areas producing the other good will also produce relatively less at the center of the agglomeration and more in areas near regions producing the
original good. This catching up of the periphery will be amplified by the production externality. Hence, lower transport costs in general result in less concentration (positive relationship).

There are rare cases in which responses in concentration are different from the case explained above. It may be the case that as transport costs decrease and regions become more specialized, productivity in some clusters of firms will increase enough to yield an increase in concentration. This happens when transport costs decrease sufficiently to completely eliminate some clusters of firms in the industry, thereby increasing concentration in the remaining clusters.

Figure 1: Model predictions, concentration and specialization as a function of transport costs

Construction of an equilibrium requires solving for prices given both productivity functions, and then for the productivity functions that are consistent with these prices. This is a functional fixed point problem that can be solved numerically for different values of transport costs (kappa). For Figure 1 we separated the continuum of regions into four countries, N=4, and calculated average Gini indexes for 100,000 different sets of random borders. Concentration measures can be directly obtained from the densities of production at each location, so borders do not play a crucial role. Figure 1 plots the result of the model fixing real wages (population in the region may vary), or population in the region. The results are very similar for both cases. Figure 1 shows how specialization increases and concentration decreases as transport costs fall. There is one exception as transport costs decrease from $\kappa = 0.1$ to $\kappa = 0.09$. In this case a cluster of IG firms disappears, therefore increasing concentration in the remaining clusters.
3. Previous literature

A large majority of the models in the literature (see Krugman 1991B, Krugman, Venables 1995) find a U-shaped relationship between transport costs and specialization and concentration, with the later two developing in parallel. An exception is a model in Fujita, Krugman and Venables (1999, p 388ff), with three regions and two industries. Decreasing trade cost result in deconcentration (of population) and increasing specialization. Even though their results seems similar to our results, it is important to stress the models differences. We study changes in trade costs both between countries and between regions in a country, their model does it only between countries. On top of this, our setup allows for a richer set of distributions of economic activity. Finally, the source of congestion costs and agglomeration effects is different.

4. Measuring specialization and concentration in empirical research

Specialization of a country is defined as a distributional indicator on its industry shares. In parallel, (regional) concentration is a distributional measure on the country shares in an individual industry. In line with the literature our preferred indicator is the Gini coefficient.

We use two data sets to calculate specialization and concentration. The first is a data set of 50 US states and 10 industries; the second is for 14 European states disaggregated into 23 industries. Both are available for the period from 1987 to 1996. The value added is used as an activity variable in both sets. The relative richness of the US data according to the number of geographic units versus the greater disaggregation of the European data set in the industry dimension is an advantage, as we would like to learn whether the model prediction of diverging trends for specialization and concentration is replicated in empirical data under rather different circumstances and institutional settings.

5. Empirical evidence and robustness

For the US the average specialization of the states increased – as measured by the Gini index - from 0.1075 in 1987 to 0.1100 in 1996, or by 2.3%. For concentration of industries on the other hand the Gini declined from 0.2966 to 0.2892 or by 2.5%. Thus, specialization increased and concentration decreased for the US as predicted by the model.

For the European Union the average specialization of the member countries rises from 0.2001 to 0.2115 or by 5.7%. The average concentration of industries decreased from 0.2994 to 0.2962 or by -1.0%.

\[1\] For a more thorough description of the data see Aiginger, Leitner (2002).

\[2\] The rising trend in specialization in Europe is statistically significant (as indicated by a significantly positive time dummy for the Ginis), as is the decreasing concentration in the US. The shortness of the time series prevents the declining trend for concentration in the EU and the increasing specialization in the US to be not significant see Aiginger, Davies (2000) and in Wieser (2003) which use more disaggregated data and data sets including a longer span in the nineties.
The results reported in general do not depend on the distributional indicator chosen, nor on the
degree of disaggregation (see Wieser, 2003, or Aiginger, Davies 2000). As for the chosen activity
variables, the results are robust apart from one exception. Specialization of US states
decreased in the last ten years if specialization is measured by employment. The reason for this
is the extreme jump in productivity in the electronic sector (embedded in a broadly defined
electrical and electronic products aggregate).

Figure 2: Concentration and specialization trends in the US and Europe

A pattern of increasing specialization and wave shaped concentration has been reported by
Midelfart-Knarvik et al. (2000) for Europe. Decreasing regional concentration is reported for the
EU (Hallet, 2000). For the US it is well established that regional concentration had reached a
peak in the early twenties in the US (Krugman, 1991A, Kim, 1995). Most studies do not investigate
concentration and specialization separately. To our knowledge no previous paper has studied
simultaneously the patterns of specialization and concentration for Europe and the US.
6. Conclusions

We have presented the implication of the model in Rossi-Hansberg (2003) that under rather general circumstances, decreasing transport costs will lead to an increase in specialization and a decrease in regional concentration. The driving force for the first effect is that lower transport costs amplify the advantage of the sector specific production externalities. For the second lower transport costs shift production to regions far away from main markets since exporting to distant locations is less costly.

Two data sets, one for the US states and the other for EU members, show that specialization and concentration do not develop in parallel empirically. The kind of divergence is roughly in line with the model prediction.

We do not claim this empirical evidence as proof of the theory, since the empirical data are influenced by variables not modeled and, above all, by institutional facts such as the integration process of the EU and NAFTA. Furthermore, our evidence refers to a rather short period, and changes are rather small. However, the evidence confirms that specialization and concentration should be considered as phenomena which can and will diverge.

References:


