Regional Science and Urban Economics 40 (2010) 73–78

Contents lists available at ScienceDirect

Regional Science and Urban Economics

journal homepage: www.elsevier.com/locate/regec

Vertical disintegration in Marshallian industrial districts☆

Octávio Figueiredo [a,b], Paulo Guimarães [c,b], Douglas Woodward [c,*]

[a] Universidade do Porto, Portugal
[b] CEMPRE, Portugal
[c] University of South Carolina, United States

ARTICLE INFO

Article history:
Received 14 April 2009
Received in revised form 12 October 2009
Accepted 12 October 2009
Available online 21 October 2009

JEL classification:
R12
R39
L25

Keywords:
Vertical disintegration
Agglomeration economies
Industrial districts

ABSTRACT

This paper uses a novel approach and detailed plant-level Portuguese data to reexamine the Marshallian hypothesis that specialization and the vertical disintegration of firms should be greater in areas where an industry concentrates. Our measure of firm specialization and vertical disintegration employs a Herfindhal index constructed with occupational shares for all workers within the firm. Controlling for firm size and sector of activity, we find that vertical disintegration is higher in areas where industries agglomerate. Sensitivity tests reveal that this positive relation is remarkably robust across different specifications.

1. Introduction

How does the regional scale and concentration of industries affect the specialization of firm activities? Interest in this question dates back to Smith (1776), who asserted that occupational specialization (or the division of labor) within the firm is "limited by the extent of the market." While Smith argued that a larger volume of trade would lead to greater specialization within the firm, Alfred Marshall observed that a similar phenomenon took place within regions; that is, a larger volume of industry output within a region (localization) would lead to specialization across firms (Marshall, 1890). In short, industrial localization implies vertical disintegration and more specialized suppliers. The Marshallian hypothesis underlies a large body of theoretical work, including the contributions to the "new economic geography," long-run economic growth, and international trade (for example, Rivera-Batiz, 1988; Krugman, 1991; Venables, 1996; Rodríguez-Clare, 1996; Hanson, 1996). Echoing Marshall, theoretical research emphasizes that firm specialization follows from industry-specific external economies.

It is surprising, then, that there is so little empirical evidence backing this long-standing hypothesis.[1] To be sure, there is an extensive literature on industrial districts dating to the 1980s and 1990s, primarily based on case studies illustrating the presence of specialized suppliers and firm vertical disintegration in particular areas and industries (for surveys see Piore and Sabel, 1984; Markusen, 1996). Whether these cases have a wider relevance remains an open question for systematic empirical work in regional science.

To date, Holmes (1999) and Li and Lu (2009) represent the only systematic statistical studies to directly address the Marshallian vertical disintegration hypothesis. The former study found a positive correlation between localization of an industry and firm vertical disintegration for the U.S. manufacturing sector. To measure localization, Holmes (1999) used 1987 employment data at the establishment-level. In turn, vertical disintegration was measured using a Purchased Input Intensity (PII) index (the ratio of purchased inputs to sales), an approach derived from Adelman's (1955) index of firm vertical disintegration. Yet the lack of establishment-level data for the PII index forced the use of aggregated localization variables. The spatial level of aggregation for the industries used in this study varies considerably. For more than 50% of the industries the spatial breakdown has ten or less areas.[2] More recently, Li and Lu (2009) followed Holmes's (1999) analysis using 2002 data for 31 province-level regions in China. Essentially, this study extends Holmes (1999), confirming his main result with firm-level information for the PII.[3]

☆ An earlier version of this paper was presented at the 2008 North American Meetings of the Regional Science Association International, Urban Economics Sessions.

* Corresponding author.
E-mail address: woodward@moore.sc.edu (D. Woodward).

[1] See Rosenthal and Strange (2004).

[2] Holmes (1999) notes that these areas can be counties, metropolitan statistical areas, states, or even larger units. For example, the creamery butter industry is partitioned into only two areas: the state of Wisconsin and the rest of the United States.

[3] Ono (2007) and Holl (2008) have also recently provided indirect tests of the Marshallian hypothesis. These studies find evidence that firms in areas of agglomeration are more likely to subcontract both services and production activities.

0166-0462/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.regsciurbeco.2009.10.002

Beyond the use of aggregate data to assess localization and vertical disintegration, another problem in Holmes (1999) (not addressed in the recent extension by Li and Lu, 2009) is the use of Adelman's (1955) index to measure firm vertical disintegration. As recognized by Holmes (1999), this index has significant theoretical limitations. Above all, the measure is sensitive to the firm's position in the production process. Everything else constant, the farther downstream a firm is in the production process, the lower the value for the Adelman's (1955) index.

In this paper we use a novel measure and establishment (plant) data for Portugal to evaluate the proposition that the vertical disintegration of firms should be greater in areas where an industry concentrates. Our approach addresses two essential problems associated with Holmes's (1999) empirical analysis. First, because we have access to detailed establishment data for all regions and industries, we are able to use the plant as the unit of observation. Second, we also know the occupation of every employee in each establishment. This allows us to compute an alternative, improved measure of vertical disintegration based on the occupational specialization within the establishment. Using narrowly defined spatial units consisting of 278 small localities in Portugal, we apply the measure to panel data for 2002–2006. After controlling for firm size and sector, we find that firms' vertical disintegration is approximately 2% higher in areas where industries agglomerate.

The paper proceeds as follows. Next we review measures of firm vertical disintegration and motivate our approach to account for firm specialization. In Section 3, we discuss the measurement of localization of an industry. Section 4 presents our main findings and implements several sensitivity tests, while Section 5 concludes the paper.

2. Measuring vertical disintegration

The most commonly used measure of firm vertical disintegration is Adelman's (1955) index: the ratio of value added to sales (see Davies and Morris, 1995 for a survey). Limitations, however, have been pointed out over the years by Barnes (1955), Eckard (1979) and Maddigan (1981). The main problem is the sensitivity to the stage of the production process, which is well illustrated in Holmes (1999). Consider the following scenario. There are three firms, each one undertaking one of the three stages of a sequential production process. Additionally, suppose that all firms contribute the same amount of value added to the final product. Now, even though all the three firms are vertically integrated to the same extent, because the value of sales increases as we move through the production chain, Adelman's (1955) value-added-to-sales index will result in a series of decreasing values. Another problem that arises in implementing this measure is the dearth of available micro-level data sets. Most countries and regions do not release data on the value of inter-firm transactions.

This paper takes a different tack, constructing an establishment-level, occupational measure for vertical disintegration. The analysis is based on a comprehensive Portuguese manufacturing employer-employee data set, the *Quadros do Pessoal*.[4] The data set includes precise information on plant location, firm start-up date, plant sector of activity, actual employment, and characteristics of the workforce. Of particular interest for our purposes is the detailed information on the occupation of the entire workforce for each plant. Every worker is coded using the Portuguese National Classification of Occupations (CNP), which follows the current International Standard Classification of Occupations (ISCO).[5] This allows us to construct an establishment-level measure of vertical integration based on occupational specialization within the establishment. The *Quadros do Pessoal* includes exceptionally rich employer–employee linked data. To the best of our knowledge similar micro-level information is available for just a few other European countries.[6] For the United States and most other countries, occupational characteristics of the workforce seem to be available only at the regional and sectoral level. In this case, it is not possible to draw inferences about the level of specialization within establishments.

If we compare two equally sized establishments in the same industry we would expect the establishment that undertakes more stages of production (the more integrated) to have a more diversified mix of occupations. Thus, to measure establishment vertical disintegration we propose a Herfindhal index constructed with the shares of workers on each occupation. That is,

$$H_i = \sum_{z=1}^{Zi} \left(\frac{x_{zi}}{x_i}\right)^2, \tag{1}$$

where x_{zi} denotes establishment's i employment in occupation z, x_i stands for total employment in establishment i, and Z_i is establishment's i total number of occupations.

To gain insight into the validity of our proposed measure we can apply this same logic to manufacturing sectors as a whole. Because subsectors tend to correspond to different production stages of sectors, if a correspondence exists between the occupations and the different phases of the productive process, then we would expect an increase in the Herfindhal index of occupations (calculated at the industry level) as we move from a broader to a finer definition of an industry. Table 1 shows the results of such exercise, by computing average Herfindhal indexes for different levels of aggregation of the manufacturing sectors. The information is for the most recent available year in our data set (2006). We make use of the Portuguese Standard Industrial Classification system (CAE rev.2) at the two-digit (22 industries), three-digit (100 industries) and five-digit (316 industries) levels.[7] Occupations are coded according to the Portuguese CNP classification at six-digits, the more detailed level of disaggregation. At this level, we have 1731 different groups of occupations in the manufacturing sector as a whole for 2006. To offer more insight into the level of detail provided in the Portuguese occupational data, Table 2 gives a list of the twenty most representative occupations, in descending order of importance, for the Fabric Mills Industry (CAE 172) in 2006.

As can be seen in Table 1, the average Herfindhal index behaves as expected when we move from a broader to a finer definition of industries. Yet, comparing the Herfindhal in this manner can be misleading because the average gives equal importance to all sectors within each level of the Standard Industrial Classification system. Hence, we also compared the Herfindhal of each subindustry with its parent in the industry.[8] We found that 79 out of the 98 three-digit Herfindhal indexes (for which the data distinguish the two from the three-digit levels) are larger than their two-digit counterparts (81%). These numbers are 246 out of 285 (86%) for the five-versus-three-digit comparison.

Since we propose a new measure of vertical disintegration, it is important to consider its properties carefully. It may be argued that the results discussed so far are driven by chance or by some peculiarity of the data. To address this concern, we implemented a simple permutation test. The test builds on the idea that if the mix of occupations is the same in the sector and the subsectors, then differences in Herfindhals may be attributed to chance. Hence, to test

[4] This survey collects information for all the establishments operating in Portugal, except family businesses without wage-earning employees.

[5] The ISCO is a tool for organizing jobs into a clearly defined set of groups according to the tasks and duties undertaken by each worker in the job.

[6] Besides Portugal, Norway, Denmark, Sweden and Finland have some of the best regional micro-level data available. Other countries, such as Germany and France, also have employer–employee linked data sets, including employee occupational information, but data are accessible for only a subset of firms.

[7] These are the numbers of industries we observe for this particular year.

[8] It should be noted here that for two industries the Portuguese Standard Industrial Classification system does not distinguish the three from the two-digit levels. The same occurs for 31 industries when we move from five to three-digit. In these cases, by definition, the Herfindhal for the industry is identical to that of the subindustry.