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Influences of production and R&D agglomeration on productivity: Evidence from Chinese electronics firms

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ABSTRACT

As China adopts a government-supported agglomeration model to develop high-tech industries, it is crucial to examine whether the spatial concentration of manufacturing and R&D activities enhance firm-level productivity. Based on a panel dataset of Chinese electronics firms from 2005 to 2007, the calculated Ellison–Glaeser (EG) index indicates that both production and R&D activities are highly spatially concentrated. Crucially, we find that production agglomeration has a positive relationship with firms' productivity, especially for smaller firms. In contrast, R&D agglomeration seems to negatively relate with productivity. It implies that the possible congestion effect and/or free rider problems erode the benefit derived from knowledge spillovers.

1. Introduction

The "New Economic Geography" revitalized by Krugman (1991, 1998) was a new genre of research since the 1990s. Previous studies, such as Glaeser, Kallal, Scheinkman, and Shleifer (1992), Rosenthal and Strange (2001), Iammarino and McCann (2006), and Ellison, Glaeser, and Kerr (2010), have investigated this issue of why there is an increasing tendency of spatial agglomeration on production activity. The causes of agglomeration firms are that geographical concentration can generate externalities through the advantages of a thick labor market, backward and forward linkages, and information spillover. They categorize the agglomeration effects into localization economies (intra-industry economies of scale from firm clustering) and urbanization economies (positive inter-industry externalities and scale effects associated with city size within a region). By benefiting from the aforementioned positive externalities, firms located within a relatively concentrated area are expected to have higher productivity. Consequently, a growing number of studies try to examine the impact of agglomeration on firm productivity, but reach inconsistent results, e.g., Ciccone and Hall (1996), Henderson (2003), Lall, Shalizi, and Diechmann (2004), and Lee, Jang, and Hong (2010).

Clarifying the relationship between agglomeration and productivity is particularly relevant to China, a country with a huge geographical area. Specifically, unlike the market-oriented formation of Silicon Valley and Route 128 in the U.S., the Chinese government uses various policies to promote the development and agglomeration of high-tech industries. One distinct strategy is establishing national Science & Technology Industrial Parks (STIPs, which internationally are referred to as science parks) which

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attract clusters of innovative firms and promoting technological capacity (Jongwanich, Kohpaiboon, & Yang, 2013). The policy-directed agglomeration of high-tech industries in the transition context of China challenges the application of "New Economic Geography" theory based on Western experiences. If increased geographic concentration does not result in more productivity, it implies that the policy-directed agglomeration not only causes resource misallocation, but also worsens the coastal–inland region inequality problem in China.

In addition to the industrial agglomeration, the spatial agglomeration of R&D activity is an increasing prevalence in China. Is the spatial agglomeration of production associated with a higher or lower geographical concentration of R&D, especially for R&D-intensive industries? Geographic proximity helps the transmission of tacit knowledge, because non-codified knowledge is vague and requires face-to-face interactions, which means that the marginal cost of transmitting tacit information across regions increases with distance (Krugman, 1998). Both localization and urbanization economies suggest that location may be one of the primary factors that conditions innovation and technical advances. The localization economies, also known as Marshall–Arrow–Romer externalities defined in Glaeser et al. (1992), predict that industrial agglomeration may increase innovation by providing industry-specific complementary assets and activities as well as through knowledge spillovers. Moreover, the urbanization economies also claim that a larger urban market can generate ideas and innovations, and lead to the creation of a market for specialized knowledge through the externality effect among various industries and institutes. Nevertheless, the possible positive feedback on innovation brought about by agglomeration is limited arising from the congestion and competition effects (Baptista & Swann, 1998). As a cluster grows, congestion costs might eventually offset the benefits to firms. Specifically, if geographical proximity positively affects imitative capacity as far as the firms' agglomeration increases the technological knowledge spillovers from firms with positive R&D expenditures to neighboring firms, Bagella and Becchetti's (1999) theoretical model shows that aggregate R&D effort is likely to be lower for firms agglomerated in industrial districts than for isolated firms. The linkages between production and R&D agglomerations remain empirical investigation.

More specifically, few studies have demonstrated the extent to which R&D agglomeration influences firm performance. If R&D arises within the same cluster and firms enjoy the advantages of knowledge spillovers and intensive exchanges of knowledge with other R&D actors (a similar concept to the regional innovation system (RIS)), one might expect the agglomeration of R&D to have a positive impact on firm productivity (Chang & Oxley, 2009). However, firms are likely to only enjoy the benefits of clustering when they have limited localization of R&D interchange with their neighbors, and overcrowding within the pool will eventually outweigh these benefits (Sher & Yang, 2005). Instead of examining the impact of R&D on firm productivity, this study explores another question that whether and how R&D agglomeration affects firm productivity in an R&D-intensive and technologically dynamic industry. Clarifying this issue is crucial to China's R&D policy. As mentioned previously, Chinese high-tech firms are directed to cluster in STIPs, leading their R&D to be highly concentrated geographically. For example, R&D spent by STIP firms to total business R&D accounted for respectively 49.08% in 2005 and 58.98% in 2008 (Jongwanich et al., 2013). The highly R&D agglomeration might encounter the congestion problem indicated in Baptista and Swann (1998), thereby resulting in a negative R&D spillover and lowering firm productivity.

This paper analyzes the dynamics of the spatial agglomeration of production and R&D, as well as the impacts of firm-level productivity on China's electronics industry. It aims to provide the following distinct empirical evidence to this line of research. First, this study adopts the spatial agglomeration index developed by Ellison and Glaeser (1997), the so-called EG index, to measure the degree and trend of spatial agglomeration and dispersion in terms of production and R&D within the electronics industry. Then, we examine the relationship between production agglomeration and R&D agglomeration. Second and more crucially, we establish an econometric model to quantify both effects of production and R&D agglomeration on firm productivity.

The remainder of this paper is organized as follows. Section 2 provides a summary review of the empirical literature on the impact of production and R&D agglomeration on firm-level productivity, with a particular focus on studies related to Chinese firms. Section 3 first introduces the data and then demonstrates the dynamics of spatial agglomeration in terms of production and R&D in China's electronics industry. The empirical specifications and estimation results are explained and discussed in Section 4. The final section presents the conclusions and policy implications.

2. The linkage between agglomeration and productivity, and literature review

2.1. Agglomeration and productivity

2.1.1. Agglomeration and its potential impact on productivity

Why industrial agglomeration, the geographical clustering of a group of companies which are related in specific production, may positively matter to firm productivity? It is mainly contributed by the positive network effect of industrial agglomeration that can lower the transaction cost, thereby promoting productivity. As discussed in Krugman (1991), industrial agglomeration has three main advantages. First, it provides a thick labor market which is full of various professional and technical workers. It enables firms to hire specialized workers to produce distinct product, thereby promoting productivity. Second, firms located in concentrated region are close to their upstream and downstream firms, enabling them to appropriate the effects of backward and forward linkages. Third, information spillover in spatially concentrated regions can induce a positive externality on the firms' productivity.[1]

[1] Fan and Scott (2003) further broke down the types of externalities into five main issues.