The micro-geographies of productivity growth: Evidence from the auto-related industries in Japan

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Since the 1990s, to many researchers and policy makers, promoting industrial clusters become a critical policy in realizing regional innovation and the resulting growth. Following its iconic success in Silicon Valley and the preceding policy launch in European countries, the Ministry of Economy, Trade and Industry (METI) in Japan promoted 19 cluster projects nationwide after establishing the Industry Cluster Project in 2001. There are many policy reports and related papers that present a comprehensive review and some successful experiences of cluster initiatives in Japan (e.g., Ishikura et al. 2003; METI 2009; Ganne and Lecler 2009). Despite this invaluable evidence on specific cases, there are some questions that remain. Where are the well- or poorly-functioning clusters located? What is the geographical extent of these clusters? What is the composition of related industries in these clusters?

The purpose of this study is to provide basic quantitative facts about the clusters representing productivity growth, in particular, focusing on transportation equipment and its related industries in Japan. For the concept of a cluster, we follow the definition provided by Porter (2003): *a geographically proximate group of interconnected companies, suppliers, service providers, and associated institutions in a particular field, linked by externalities of various types*. That is, we explicitly incorporate proximity in both geography and technology into an analytical framework.

The Japanese transportation equipment industry (including automobile, railway rolling stock, ship, and aircraft manufacturing) uses cutting-edge technologies and is expected to play an important role in developing the regions designated in the cluster projects. Because of the characteristics of vertical and hierarchical organizational structures, consistent clustered productivity growth is believed to be associated with extensive knowledge spillover among related industries.

We use data extracted from the Census of Manufactures provided by the METI. We arrange information for firms with no less than 30 employees. Our data cover the time period 1993–2012. For each firm, we collect detailed information such as production, value added, employment, fixed assets, and aggregate wages. The data also include information about the firm’s location and industrial classification. This extensive and detailed information about company aspects enables us to make the following analytical contributions.

First, we are able to relate the structure of the local clusters to company productivity. This approach is more consistent with endogenous growth theories than many studies based on the conventional employment approach since the seminal work of Glaeser et al. (1992).

Second, we capture each company's productivity growth by using the measurement of the Malmquist total factor productivity (TFP) index. The conventional methods, based on the Törnqvist TFP index or the Solow residual, presume the optimizing behavior of production. On the other hand, a desirable property of the Malmquist TFP index is that it is applicable without any ad hoc adjustment to the input data, even if the varying intensity of input usage conceals true productivity (Nemoto and Goto 2005). In this study, the Malmquist TFP index is decomposed into three components: technical change, efficiency change, and scale change. Among them, the technical change component measures the degree of the shift in the production frontier, which comes from technological progress and changes in various production circumstances. Focusing on the technical change component is suitable for analyzing the relationship between knowledge spillover in clusters and productivity growth accumulated through innovation. The large number of observations in our data sets allows us to apply an econometric approach for estimating the distance functions required for the Malmquist TFP index.

The measurement of the Malmquist TFP index and its decomposition are conducted for companies classified into transportation equipment manufacturing and related industries. As an indicator of technological proximity to the transportation machineries sector, we apply the *average propagation length* (APL) proposed by Dietzenbacher et al. (2005). APL is an index that expresses the average number of steps it takes to transmit a demand-pull (or cost-push) from one sector to another, which can be referred to as "economic distance." If extensive knowledge spillover is more likely to occur between technologically proximate industries, the adoption of APL will provide valuable information in the discussion of relationships affecting industrial productivity growth due to knowledge externalities. Each APL index between industries is derived by using the input–output table for Japan.

Third, based on the address information of the companies, the estimated results of the technical change component of the TFP index are visualized on maps using a geographic information system (GIS). This approach for detecting clusters allows us to uncover more realistic geographical areas and decaying patterns with distance rather than research relying on political borders or predetermined geographical units (Rosenthal and Strange 2005; Catini et al. 2015). Thus, we explore the spatial pattern of productivity growth, namely, whether the company's productivity growth forms clusters, and if so, the degree of the productivity growth relates to the proximity to diversified industries (Jacobs 1969) or its own-industry activity (Marshall 1920; Arrow 1962; Romer 1986). The findings would help infer the path of knowledge transfer that contributes to productive growth and establish effective regional policies.

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