Sources of Private and Public R&D Spillovers: Technological, Geographic and Relational Proximity

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Extended Abstract

Japan's total factor productivity growth has been declining since the mid 1980s (e.g. Fukao and Kwon, 2011). At the same time, R&D expenditures as a percentage of GDP have been steadily increasing to reach 3.1% in 2008. The discrepancy between the trends in R&D expenditures and TFP suggests that the returns to R&D have been declining. One possible explanation for this phenomenon may be a decline in R&D spillovers, as loosening of traditional stable supplier relationships, relocation of increasingly sophisticated manufacturing plants abroad and the accompanied changing patterns of R&D agglomeration may have reduced the size and effectiveness of the relevant pool of R&D spillovers across firms.

Previous studies have suggested that both technological proximity and geographic proximity attenuate the effectiveness of R&D spillovers (Jaffe et al, 1993; Adams and Jaffe, 1996, Crespi et al, 2007; Goto and Suzuki, 1989; Aldieri and Cincera, 2009), while proximity appears less crucial for the most proximate technologies (Orlando, 2004). These studies have typically relied on single industry empirical settings (Adams and Jaffe, 1996) or smaller samples of publicly listed firms (Orlando, 2004). The scope of these studies also has been limited in a number of ways. First, the focus has been on intra-firm (Adams and Jaffe, 1996) or inter-firm spillovers, while studies have abstracted from the role of public research. A different research stream focusing on the role of knowledge spillovers from public research conducted at universities and research institutes has however suggested the importance of such spillovers and an explicit role of proximity (e.g. Jaffe, 1989; Adams, 1990; Anselin et al, 1997; Furman et al, 2006). Second, the role of spillovers through supplier and client linkages has not received due attention. Here a separate literature on the role of spillovers from foreign direct investments to local firms has concluded that 'vertical' spillovers through buyer-supplier relationships often is the key channel through with spillovers occur (e.g. Haskel et al, 2007; Görg and Strobl, 2001; Javorcik, 2004; Kugler, 2006). While knowledge and technology transfer in these relationships is often purposeful and embedded in intermediates, the full value tends not to be fully reflected in the price of such intermediates, leading to ‘pecuniary spillovers’ (Hall et al, 2010). Compared with ‘horizontal’ spillovers within narrowly defined industries, the absence of market rivalry provides greater incentives for productivity and growth enhancing knowledge exchange and spillovers (e.g. Bloom et al., 2010). Since suppliers and clients may be active in a variety of industries, these 'relational' spillovers are yet a different dimension of heterogeneity in spillover pools. In particular in the

context of Japanese firms, stable supplier relationships, for instance those within vertical business groups, have been associated with knowledge sharing and technology spillovers (Suzuki, 1993; Branstetter, 2000),

In this paper, we bring together these various sources of spillovers, which until know have not been examined simultaneously, in an analysis of TFP growth in a unique and extensive panel of Japanese manufacturing plants, 1983-2007. Simultaneous estimation of the three potential moderators of private R&D spillovers (technological, geographic, and relational proximity) as well as public R&D spillovers allows for more precise estimates and an assessment of their relative importance. We matched plant level data from the Census of Manufacturers with information on R&D expenditures form the yearly (comprehensive) Survey of R&D Activities in Japan. The Census data cover all manufacturing factories with four or more employees, while the R&D survey covers virtually all R&D spending firms in Japan. We could match on average more than 90 percent of total R&D expenditures in the manufacturing sector to the manufacturing plants. This resulted in an unbalanced panel of more than 240,000 plants observed for maximum of 25 years and a median of 12 years.

We first calculated TFP levels of each plant using the index number method, following Good et al (1997). We then employ panel data analysis to regress TFP on firm R&D, the various R&D spillover measures, and a set of control variables. We calculate R&D stocks and R&D spillover pools at the plant level by taking into account the product focus of firms' R&D, the industry of the plants, and the location of other plants. R&D stocks, measured at the parent firm level in the R&D surveys, are separated by major sector of application to arrive at R&D stocks of the firm with relevance for specific plants, utilizing a question in the R&D survey concerning the focus of R&D. At the plant level, firm level R&D stocks are then distinguished in R&D in the same product field and R&D in other fields (e.g. Adams and Jaffe, 1996). We distinguish three levels of geographic proximity, the town ('machi') level, the city level and the prefectural level, while we define technologically proximate R&D stocks as R&D stocks related to plants in the same R&D field. Hence, we seek to differentiate spillover pools by geographic proximity *and* technological proximity, as well as by geographic proximity *and* relational proximity. To measure relational proximity, we use detailed data on the 10 largest suppliers and customers of each firm collected by Tokyo Shoko Research. Public R&D pools are derive from the R&D surveys as well and are also differentiated by location of the institute or university and the technological field of R&D with varying relevance for specific industries. In the analysis we take into account the potential complementarities between external knowledge spillovers and firms' own R&D

stocks stemming from enhancement of firms' absorptive capacity (Cohen and Levinthal, 1990) to benefit from spillovers (e.g. Lokshin et al, 2008: Cassiman and Veugelers, 2006; Aldieri and Cincera, 2009; Acs et al., 1994). Our preliminary and partial findings confirm a robust impact of relevant firm-level R&D stocks, mitigate by the number of the firms' plants drawing on this R&D (Adams and Jaffe, 1996). We also find a significant, but ten times smaller, impact of firm R&D stocks in other fields. Positive spillovers effects from R&D by firms with plants in the same industry extend from the city level to the prefectural level, but this is not the case for R&D stocks in other industries.

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