Ph.D. Dissertation

Innovation and Knowledge Networks of Small Firms

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Summary

The relationship between innovation and networks is one of the most frequently discussed issues in the recent economics and managerial science journals. In the knowledge-based economy, most of the economic agents do not go it alone in conducting innovative activities but get linked with several sources of knowledge. Benefits from being networked seem significant not only for established large firms but also for young and R&D-intensive firms. This is because new technology-based firms are strongly motivated to complement their relatively scarce resources by establishing knowledge networks and have more to learn technical skills from other economic organizations. Although considerable empirical effort has been invested in the examination of knowledge networks that small firms establish in the US and Europe, little attempt has been made to quantitatively investigate the determinants, organizational features, and impact of the knowledge linkages of small firms in Japan. Based on quantitative analyses, this study attempted to fill this gap. The empirical findings of each chapter can be summarized as follows.

Chapter 1 examined who engages in R&D cooperation and whether cooperative R&D-active firms improve R&D productivity through knowledge networks than cooperative R&D-inactive firms. The main results can be summarized as follows. Firm size, technical resources represented as patents, and organizational resources represented as cooperative arrangements in production are found to facilitate firms to engage in collaboration in R&D while commercial resources represented as export discourage firms from collaborating in R&D with others, which contradicts our prediction. Firm age and financial resources represented as operating profit have no impact on R&D cooperation. Cooperative R&D-active firms

record higher R&D productivity represented as the rate of return to R&D than cooperative R&D-inactive firms, which remains unchanged across sectors and firm sizes. This suggests the possibility that cooperative R&D provides participants with greater opportunities to learn technical skills from others and acts as the important channel of knowledge transfer among firms and other organizations such as universities. However, since we employed survey data that excluded firms with fewer than 50 employees from the sample, it is difficult to assert that R&D cooperation acts as an efficient conduit of knowledge transfer for small firms as well.

Consequently, in Chapter 2, we compiled a dataset that included small R&D-performing firms that did not have complementary assets and assessed the contribution of cooperative research to improvement in patent productivity. The results of switching regression show that small, dedicated research firms (SDRFs) that engage in cooperative research significantly improve knowledge resources embodied in R&D personnel. Furthermore, among cooperative research-active SDRFs, SDRFs that establish knowledge linkages with higher education institutes show greater research efficiency than SDRFs that collaborate exclusively with the private sector. This implies that cooperative research provides SDRFs with a great opportunity to improve the quality and usage of knowledge resources, and the effect is more apparent in collaboration with public knowledge.

Although we found that knowledge networks, including industry-university (I-U) collaboration, improve the efficiency of the innovative process of small firms, mere participation or establishment of knowledge linkage is not necessarily accompanied by improved research efficiency. We would like to know more about the circumstances under which R&D cooperation works well and how the determinants of organizational success differ across the phases of innovation. Therefore, Chapter 3 examined the organizational characteristics of successful innovative networks among small firms, called the "cross industry groups." The investigation of the comprehensive survey data revealed a shift in the network structure corresponding to the phases of the innovation process. Cohesive networks, represented by dense

communication and a high level of commitment among network constituencies, promote small firms to initiate collaborative product development. In contrast, sparse networks that place less value on strong ties and more value on establishing contact with external sources of knowledge such as public research institutes are preferred for achieving technical success in innovation, i.e., the completion of a development project and the placement of new products on the market. Further, it was shown that small firms in innovative networks are offered the opportunity to learn technical skills from others and to improve their own innovative capacity.

The empirical findings in Chapter 3 showed that small firm networks that achieved technical success in innovation establish contact with public research institutes as the source of knowledge. However, it is still unclear how small firms exploit public knowledge. In other words, through which channel does public knowledge spill over into small firms and what determines the channel employed? Thus, based on a faculty-level dataset, Chapter 4 examined the characteristics of knowledge interaction between universities and small firms. The results of statistical analysis present a contrasting picture regarding the characteristics of knowledge interaction according to the size of the industrial partner. On the one hand, based on direct personal connections, such as donation, universities are linked with large firms in a wide range of areas through highly interactive spillover channels, such as joint research. On the other hand, through intermediaries of liaison offices, universities are linked with small firms, through less interactive spillover channels, such as technical consultation. It was also found that faculty-specific characteristics, such as research potential of scientists, significantly affected the type of channel of knowledge transfer and the type of industrial partners.

The last chapter evaluated the effect of regional innovation policy to foster small firm innovation and localized knowledge flow. Science parks and business incubation centers are expected to encourage the birth of new firms and promote the survival and growth of new technology-based firms (NTBFs). Chapter 5 investigated the value-added contributions of science parks. First, on-park NTBFs are likely to

establish knowledge linkages, represented as joint research, with local universities and research institutes. Second, on-park NTBFs exhibit higher employment growth than off-park NTBFs, while the source of growth is concentrated in a few firms. Third, R&D output is not influenced by whether NTBFs are located in science parks. Fourth, on-park firm managers tend to wish to go public in the future. Fifth, no significant difference was found between science parks and other types of property-based initiative with regard to the degree of encouragement given tenants to establish linkage with local universities and research institutes.