Competition and Technological Similarity: The Case of a Chinese Robotics Firm[1]

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Synopsis

- To observe how a firm that is accumulating technologies changes its technological positioning when facing competition, this study compares the technology position of a Chinese robotics firm with that of a Japanese first-mover firm.
- As the Chinese firm increased its technological similarity with the Japanese firm through the accumulation of basic technologies, it has also begun to diversify technologies.
- Increasing similarity is assumed to be the foundation or precondition for technological differentiation.

How do firms position themselves technologically among competitors in the same market through technology accumulation? Many firms are working to develop technologies for further growth amid fierce competition. The value of a technology cannot be determined solely by itself but only relative to existing competitors; therefore, evaluating a firm's technologies requires focus not only on the quantity and quality of technologies but also on the technology position, referring to relative commonalities and differences from competitors.

To observe how the technology position of a firm that has begun to accumulate technologies progresses to competitive improvement, we compare the technology position of a Chinese industrial robotics firm, Siasun Robot & Automation (Siasun), with that of a first-mover firm in the same industry, Yaskawa Electric (Yaskawa) in Japan. The primary business of both firms is industrial robotics; however, Siasun also manufactures service robots and related products, and Yaskawa also manufactures servo motors, which are a core component of robots, inverters, and other industrial products. Although the sales of Siasun, which was founded in 2000, are still only one-tenth those of Yaskawa, which was founded in 1915 and launched its robotics business in the 1970s, Siasun has increased both sales and patent applications since the beginning of the 2010s. The cumulative number of patent applications used in this study is 8,307 for Yaskawa and 490 for Siasun.

In this study, technology position is a vector including the proportion of patent applications in each technology field based on the International Patent Classification (IPC), or a vector generated through natural language processing (NLP) of the title and abstract of patent application documents. Using these indicators, we calculate the cosine similarity of the two firms' technology positions in two ways.[2] Similarity is 1 if the vectors are in the same direction, and 0 if orthogonal.

[1] Discussion here is based on the primary findings of the following analysis:
Kimura, Koichiro, Hiroshi Matsui, Kazuyuki Motohashi, Shun Kaida, and Janthorn Sinthupundaja (2021) "Technology Development and Similarities," in Koichiro Kimura (ed.) *Impacts of Innovation on Firm Performance and Industrial Development in East Asia*, Bangkok: IDE-JETRO Bangkok.
Available at https://www.ide.go.jp/English/Publish/Reports/Brc/29.html.

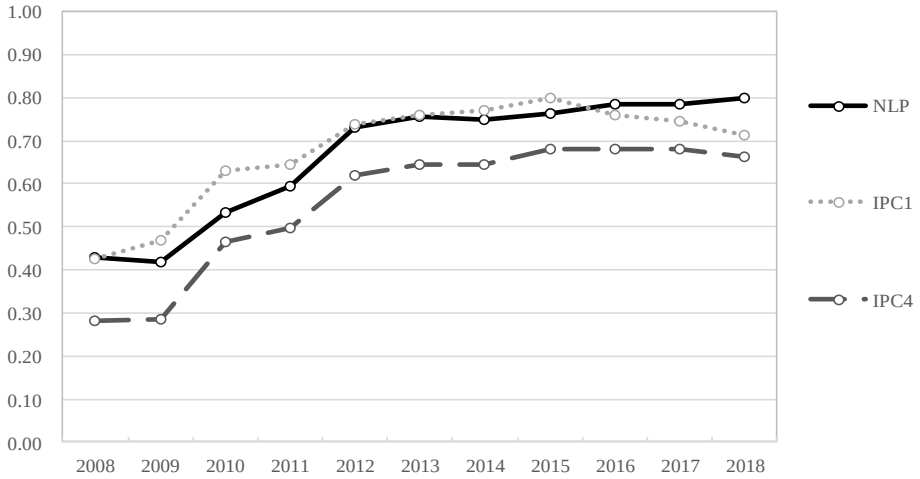
[2] Jaffe (1986) introduced this similarity equation to examine technology spillover between technologically similar industries. Firm A's technology position is $\mathbf{F}^A = (F_1^A \ldots F_n^A)$ composed of the value in each technological field k, F_k^A. The similarity between Firms A and B is $s^{AB} = similarity\,(\mathbf{F}^A, \mathbf{F}^B) = \mathbf{F}^A\mathbf{F}^{B'} / \sqrt{(\mathbf{F}^A\mathbf{F}^{A'})(\mathbf{F}^B\mathbf{F}^{B'})}$. In addition to this study, similarity has been often used to demonstrate technology spillover (Bloom et al., 2007; Forman and van Zeebroeck, 2019).

First, we demonstrate that the technology position of Siasun is moving closer to that of Yaskawa. Specifically, we calculate the similarity between Firms A's (Siasun) and B's (Yaskawa) cumulative patent applications up to each year t, $stock_{\leq t}$, vectorized by IPC or NLP:

$$s_t^{AB} = similarity\ (stock_{\leq t}^{A},\ stock_{\leq t}^{B}).$$

Figure 1 shows the similarities using IPC-based vectors at the broadest 1-digit level classification (IPC1) and the detailed 4-digit level (IPC4) and NLP-based vectors. The three trends indicate that Siasun is moving closer to Yaskawa in terms of technological fields, although the levels of similarity differ somewhat. The similarities have rapidly increased, as Siasun's number of patent applications has risen for basic robotics technologies, such as manipulators in B (Performing operations; transporting), controls in G (Physics), and servo motors and power supply in H (Electricity), as categorized in the IPC.

Figure 1: Similarities between Siasun and Yaskawa, 2008–2018



Source: Kimura et al. (2021).

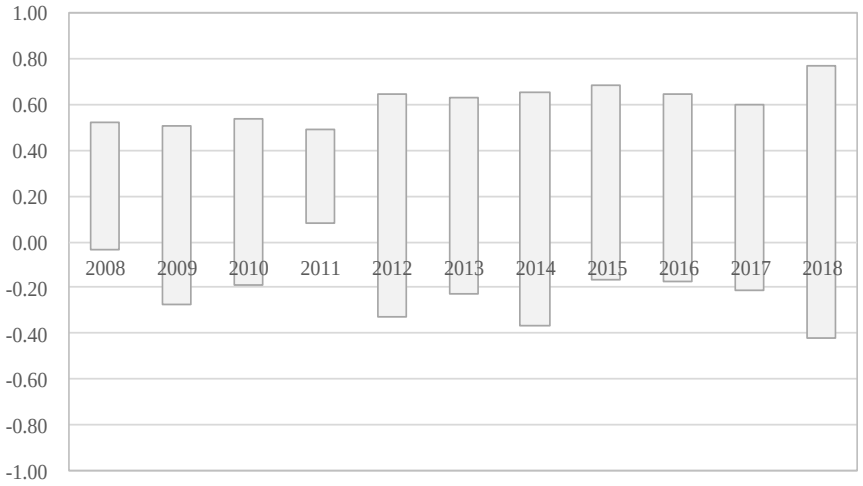
Notably, the trajectory in similarity largely stagnated following rapid increase because each firm has a differing and stable business portfolio. Thus, other than the initial rapid rise demonstrated, are any other features involved in the process of technology accumulation?

Further, we demonstrate that each new Siasun patent application is technologically diversifying in comparison with Yaskawa's cumulative patent applications each year. Specifically, we calculate the similarity between each new Firm A's (Siasun) patent application i in each year t, application_{it} and Firm B's (Yaskawa) cumulative patent applications up to each year t, $\text{stock}_{\leq t}$, vectorized by NLP:

$$s_{it}^{AB} = similarity\ (application_{it}^{A},\ stock_{\leq t}^{B}).$$

Figure 2 presents the maximum and minimum ranges of similarities of Siasun's patent applications in comparison with Yaskawa's cumulative patent applications each year. The larger ranges since 2012 indicate diversification of Siasun's technologies as the number of patent applications grows. Consequently, once Siasun's technology position approached that of Yaskawa's and the changes had largely diminished, its technologies began to diversify.

Figure 2: Ranges of Maximum and Minimum Similarities, 2008–2018



Source: Kimura et al. (2021).

A pattern of technology accumulation was found for the Chinese firm, indicating that as similarities increase with the accumulation of basic technologies, technological differentiation also rises. The acquisition of basic technologies for a product appears to be a foundation or precondition for the development of a variety of technologies and innovations that further enhance the product value to advance firm growth. Subsequently, technology position not only refers to the composition of technological fields but also the progress and diversity of technology development capability. As technological transformations are continuously occurring amid the Fourth Industrial Revolution, we also need to explicitly focus on how they are changing firms' patterns of technology accumulation in both advanced and emerging countries.

References

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