【Grant-in-Aid for Scientific Research (S)】

Empirical Study on General Purpose Technologies: Generation, Diffusion, and Impact

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Purpose and Background of the Research

●Outline of the Research

This research analyzes the creation, diffusion, and impact of general purpose technologies (GPTs). The aim is to provide empirical answers to the following questions: (1) How are versatile technologies (knowledge) created? (2) How do they spread? (3) What impact do they have on the macroeconomy, employment, and corporate competitiveness? GPTs are technologies that are used for a wide range of purposes, such as steam engines, semiconductors, and artificial intelligence. They are used in a wide range of fields and make a significant contribution to improving economic productivity. Until now, GPTs research has been centered on qualitative case studies of famous examples. While the findings of each case have been accumulated, the empirical regularities common to GPTs have not been identified. In addition, although there is a definition of GPTs, it has not been sufficiently operationalized, and the technologies analyzed in case studies have been subjectively judged as to whether they are truly GPTs. In addition, because GPTs have been broadly defined in the same way as steam engines or lasers, the fact that some technologies are more versatile than others (specialized technologies) has been ignored. Therefore, in this study, we will quantitatively measure the degree of versatility of technology using bibliographic information from patents and academic papers, and conduct quantitative empirical research on the above three points, rather than just qualitative case studies. In addition, in this study, we will analyze these three points not only at the cross-industry level, but also at the company level. This will make it possible to clarify the process of de-maturity, in which companies return to the stage of re-growth, and the role of research and development in promoting the horizontal expansion of business. The following figure is an image of the overall structure of this study.

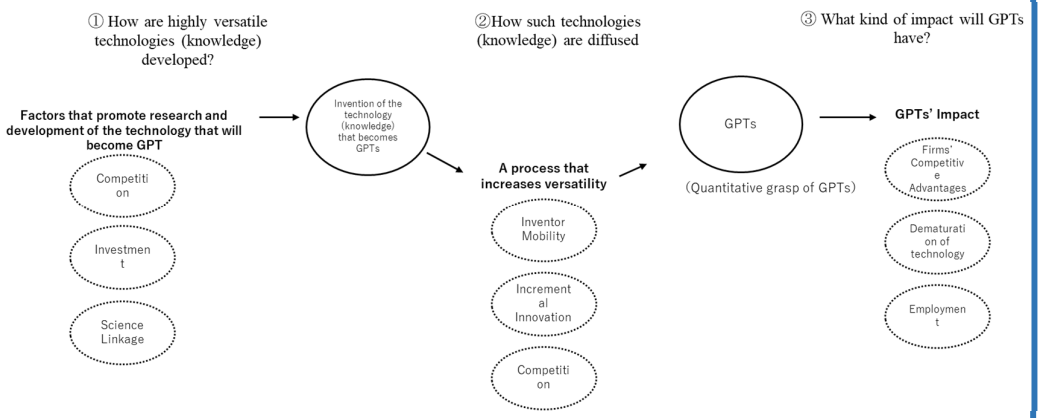

Figure 1. Research Image

●Quantitative grasp of general-purpose technologies

Conventional research on GPTs has not been systematic or quantitative in its identification of what constitutes a GPT, and has generally analyzed technologies that are thought to be versatile. Examples of this include steam engines, electricity, and lasers. In contrast, this research uses patent data to quantitatively measure versatility. Specifically, (1) the top 1% of patents with the highest number of citations are extracted and normalized by the average citation rate, and (2) the concentration of citations is measured using HHI based on IPC classification, and patents with low HHI are judged to be highly versatile technologies. The originality of this research is that it can distinguish differences in versatility even within the same technological field, and it can analyze the characteristics of GPTs in more detail.

● Three-Level Analysis

This research measures highly versatile technologies at three levels: (1) cross-industry, (2) industry, and (3) company, analyzing their creation, diffusion, and impact. While previous GPT studies focused on cross-industry aspects, industry- and company-level analyses remain unexplored. Comparing (1) widely adopted cross-industry technologies with (2) those limited to specific industries can clarify the characteristics of GPTs. We emphasize spin-outs as a key diffusion process. (3) Company-level analysis (consolidated accounting level) will reveal how R&D fosters new business areas and drives firms beyond maturity.

Expected Research Achievements

This study examines the creation and diffusion of General-Purpose Technologies (GPTs) through four key processes across cross-industry, industry, and company levels.

Measuring GPTs

Using patent and paper data, we will quantitatively assess GPTs' versatility. By leveraging patent families and analyzing international diffusion, our evaluation remains independent of specific countries. We will identify key inventors and organizations using Derwent Innovation and Web of Science.

Inventors & Organizations Behind GPTs

We will analyze the characteristics of inventors and companies driving GPTs, focusing on R&D investments and cumulative innovations. A key question is whether GPT inventors themselves contribute to subsequent improvements or if this role shifts to other firms or inventors.

Enhancing Versatility & Application Development

Using patent citation data and inventor migration patterns, we will investigate how GPTs spread across companies and regions. We will assess whether the original inventor or new firms drive application development, considering labor mobility, market entry barriers, business life cycles, and competitive dynamics.

Impact of GPTs

At the macro level, we will empirically evaluate GPTs' contributions to economic growth. At the micro level, we will assess their impact on corporate employment, competitiveness, and the dynamics between new entrants and incumbents. Additionally, we will explore how Japan's demographic challenges influence technology adoption. By integrating these four processes, we aim to uncover the mechanisms driving GPT creation and diffusion.

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