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The idiosyncrasy and dynamism of technological innovation across industries: patent citation analysis

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Abstract

In general, the structural and behavioral patterns of technological innovation are idiosyncratic across industrial sectors and dynamic over time. Yet, despite voluminous amounts of previous research, patterns of innovation are hard to standardize or theorize. The objectives of this article are two-fold. One is to investigate distinctive and changing patterns of technological innovation across industries and observe dynamic trends over time. The other is to identify patterns of relationships among industries and examine the roles of respective industries. To this end, the U.S. Patent and Trademark Office (PTO) patent database was used and patent citation analysis applied. The idiosyncratic differences among industrial sectors are highlighted, especially between conventional manufacturing sectors and science-based sectors. We also found changing trends in technological knowledge flows across industries.

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Keywords: Pattern of innovation; Patent citation analysis; Industrial sector; Idiosyncrasy; Dynamism; Innovation; Technological innovation

1. Introduction

Although the amount of previous research on technological innovation is voluminous, the behavioral patterns of technological innovation are difficult to standardize or theorize. The difficulty may be attributable to the following factors:

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- The innovation pattern is idiosyncratic across industrial sectors. Since technological regimes and market conditions differ among sectors, the nature and effect of innovation are also differentiated [1–6].
- The innovation pattern is never stable and static but unstable and dynamic. It goes through an evolutionary process of change over time [7–9].
- The innovation process is pervasive and interactive between industrial sectors. Technological knowledge not only accumulates as stock within a specific industry but also flows among related industries. Therefore, the linkages and interdependencies among sectors are emphasized as the industrial structure becomes more diverse and complex [10,11].

This article investigates the idiosyncratic patterns of technological innovation across industries and examines dynamic trends over time. Specifically, three inquiries form the principal research themes of the current study.

- (a) If the patterns of technological innovation are dissimilar among industries, what are the main differences in terms of industry and/or technology characteristics?
- (b) If the patterns of innovation are unstable and dynamic, what are the differences or changing trends over time?
- (c) If industrial sectors are interconnected in a technological network, what is the overall shape of the network, and what are the roles of industries in the network?

This study uses patent data and applies patent citation analysis as the primary methodological approach. For a long time, the research arena of technological innovation has suffered from a lack of appropriate data; therefore most earlier studies utilized conceptual and/or qualitative approaches. Patents seem to be the one important exception. There are three primary reasons for using patent data:

- (a) Patents possess both technical and market attributes since they meet explicit criteria for originality, technical feasibility, and commercial worth [12].
- (b) Patents have advantages in terms of the availability of a database and variety of information.
- (c) Patents cover virtually every field of innovation in most developed countries and over long periods of time. In fact, a number of past studies employed patent analysis to examine the pattern or effect of technological innovation [13–18].

The remainder of this article is organized as follows. In Section 2, the theoretical background and operational methods of patent citation analysis are presented. In Section 3, the contents of the database and the process of manipulating the raw data are described. In Section 4, the scheme for classifying industrial sectors is discussed. In Section 5, proposed research themes are analyzed and related implications are provided. Here indexes are operationally defined to facilitate the analysis. We finish with concluding remarks and future research issues.

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