



# Industry specific effects on innovation performance in China



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## ABSTRACT

This research aims to understand how industrial characteristics in Chinese industrial sectors are related to and affect innovation activities. Using Heckman's two-step procedure, this study contributes to examine firms' innovation determinants with a framework that clearly distinguishes between the two steps of innovation model: innovation propensity (probability of being innovative) and innovation performance (patents and innovation sales). In particular, the moderating effects of industrial characteristics on the relationships between R&D intensity, financial incentives and innovation performance are discussed. The findings show that different industrial characteristics generate different impacts on innovation propensity and innovation performance. Firms in capital intensive industries and relative monopoly industries are more likely to innovate. The findings also show that Direct Government Subsidy does not contribute significantly to improve economical innovation performance of firms and Indirect Government Subsidy on innovative economic performance is easier to be influenced by industry characteristics, which have important potential policy implications to guide innovation activities for Chinese policy makers as well as for Chinese firms.

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## 1. Introduction

Increasing dynamic and complex external environment forces firms to innovate and mitigation competition for survival (Lodh, Nandy, & Chen, 2014). China, one of the leading rapidly-growing emerging economies, has been evolving from “imitation” to “innovation” (Dang & Motohashi, 2015; Lin, Chen, & Lo, 2013). Innovation capabilities and performance in China have attracted attentions of scholars from many countries and regions all over the world. According to previous research, some of the innovation differentials among firms can be explained by differences in firms' contexts. One of the contexts in which firm's innovation takes place is provided by the industry in which firms operate (Tavassoli, 2015). Other performance variations are contributed by differences in characteristics and strategies of firms. Although considerable research efforts have been made to test whether the firm specific or industry factors more explain performance, the empirical findings are still inconclusive. Also, previous studies concern industrial characteristics have mainly focused on developed economies, characterized by well-established institutional environments, mature market-based competition and large pools of qualified knowledge workers (Frank, Cortimiglia, Ribeiro, & de Oliveira, 2016; Guan, Cai, & Cao, 2015). We thus in this paper respond to the lack of understanding of industry-level innovation determinants in China.

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The large empirical literature concern the determinants of performance variations among firms have been conducted from the fields of industrial organization economics (IO) and resource-based views of the firm (RBV). From the perspective of IO, the structural characteristics of an industry influence the behavior of its component firms, which inevitably determines firm performance (Hawawini, Subramanian, & Verdin, 2003). In the early days, the effects of structural characteristics of particular industries on performance were more dominant than firm effects (Henderson & Mitchell, 1997; Stimpert & Duhaime, 1997). Nevertheless, the majority of recent studies have provided evidence of a more important firm-specific effect (Chen & Lin, 2010; Hawawini et al., 2003), this is in line with RBV. Different from IO insistence on making industry structure the main reason to explain variations in firm performance, RBV scholars focus increasingly on the heterogeneity of enterprise resources. However, few literatures have examined the link between industry characteristic and firm innovation behaviors. According to the theory of industry organization economics (IO), characteristics of an industry structure affect the conduct of firms (Guan et al., 2015). Considering that firms' innovation performance is strongly influenced by the determinants of innovation propensity and intensity, we thus assume that industry characteristic has an impact on firm's ability to benefit from innovation activities.

This paper shows the innovative behaviors of firms are affected by the industrial characteristics in China. In particular, it contributes to distinguish between determinants for innovation propensity and innovation performance. Further, the moderating effects of industrial characteristics on the relationships between R&D intensity, financial incentives and innovation performance are discussed. The analysis in the paper is important for the government in China to promote R&D activities and improve innovation performance. In line with the existing literature, we also examine the firm-level effect (e.g. firm age, firm size, R&D intensity and financial incentives) on the innovation performance. Thus, our paper not only contributes to the existing literature by providing a Chinese influence of industrial characteristics on firm's innovation process, but also has some implications for China's policy makers to improve the efficiency of financial incentives.

The study is organized as follows. Section 2 introduces the background and sets out the theoretical framing and the hypothesis. Section 3 outlines the data sources and analytical framework. Section 4 describes the variables and reports our empirical results, and Section 5 presents our conclusions and discussion.

## 2. Theoretical and conceptual background

### 2.1. Firm's innovation propensity and performance

There is a flourishing research-based literature on the firm innovation activity determinants. Various factors in micro, meso and macro level, such as firm size, capabilities, national support for research and development (R&D), market structures and geography, have found to be critical factors driving R&D input and influencing innovation performance (Doh & Kim, 2014; Frank et al., 2016; Tavassoli, 2015). However, the effects of potential factors on innovation propensity (probability of being innovative) may be different from that on innovation performance (patents and innovation sales) (Tavassoli, 2015). The ratio of firms that have invested in R&D is relatively low in China (Feng & Ke, 2016). It is necessary to explore the determinants of innovation propensity. Also, there is likely to exist a "selection bias" (this will be discussed in Section 3) for many values of dependent variables in terms of innovation performance (patents and innovation sales) are not randomly missed (Heckman, 1979). We thus use Heckman's two-step procedure in this study to examine the effects of innovation determinants on the innovation propensity and innovation performance in a single model.

A variety of measurement methods over different innovation output indicators have been proposed (Bronzini & Piselli, 2016; Frank et al., 2016; Guan & Ma, 2003; Tavassoli, 2015). Patents and financial data associated with sales of new product are most common proxies for innovation performance. In prior studies, patent data have been traditionally used as a proxy for technological innovation output and new knowledge (Chen & Guan, 2011; Jaffe, Trajtenberg, & Henderson, 1993). Using patents as a proxy for innovation output has both advantages and disadvantages. On the one hand, it is well known that not all inventions are patentable and patented, and the patented inventions differ greatly in quality (Griliches, 1990). On the other hand, patents are more objective and reasonable compared with other proxies, for they are less exposed to personal or subjective considerations (Acs, Anselin, & Varga, 2002; Bronzini & Piselli, 2016). Moreover, the major purpose for a firm to engage in the innovative activities is to enhance their economic return through product or process innovation. Therefore, innovation should to a greater extent meet and attract more customers' demand and obtain more economic profits (Chen & Guan, 2011). Financial data associated with sales of new product are considered to be a good indicator of economic innovation performance (Guan & Yam, 2015), because it can directly reflect the contribution of innovation output to economic growth of China (Zhang, 2015).

In this study, we use the number of applied patents and granted patents to proxy for technological innovation performance of the firms. New product sales are used as a proxy for economical innovation performance.

### 2.2. Industrial characteristics and firm innovation

As to what determine the firm-level performance variations, much evidence in the literature points towards industry-level differences. Kotha and Nair (1995) observed a high impact of industrial characteristics on firm performance in Japan. Lin et al. (2013) employed data from enterprises in China and find that industry influences tend to be more important than firm factors in the long-term competitive advantages of firms. Spanos and Lioukas (2001) suggested that industry and firm specific effects are both important but explain different dimensions of performance. The main purpose of this paper is to investigate how the innovative behaviors of firms are affected by the industrial characteristics. The industry structure is considered to be an important

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