



# China as number one? Evidence from China's most recent patenting surge<sup>☆</sup>



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## ABSTRACT

China overtook the U.S. in 2011 to become the country filing the largest number of patent applications. Has China's patenting ascendancy been propelled by Chinese firms' increasing technological sophistication or their much greater propensity to seek patents? Using a unique and never before used data set, where the State Intellectual Property Office (SIPO) patent records have been matched to their applicant firms by SIPO, we differentiate the two potential explanations by estimating a patent production function and by relating a firm's patents in force to its labor productivity. Our main findings are: 1) while the patenting surge has been an across-the-board phenomenon, most of the growth has come from the extensive margin of growth – firms that were not actively applying for patents in the past; 2) the correlation between patents and R & D and that between patents and labor productivity have become weaker, particularly for utility models and for the extensive margin of growth. These results suggest that non-innovation related motives for acquiring patents may have played an important role in the patenting surge.

## 1. Introduction

China's explosive patenting growth reached a milestone in 2011, when the number of patent applications filed with the State Intellectual Property Office (SIPO) overtook that of the U.S. Patent and Trademark Office (USPTO), making SIPO the busiest patent office in the world. Of the over half a million applications SIPO received, eighty percent were resident applications, which had been growing at 30 percent a year from 2001 to 2011. To put things in perspective, for Japan, South Korea and the U.S., the patent growth rate had been much lower at –2.8, 6.5 and 3.4 percent respectively during the same time. To the extent that patents have often been used as an indicator of technology innovation, the extraordinary growth of patenting at SIPO raises the question whether it is driven by commensurate technological progress in China.

If patents measure innovation output, a measure of inputs to the

innovation process is R & D expenditures. China's R & D spending had more than kept pace with her rapid growth of GDP – R & D as a share of GDP increased from 1.4 in 2007 to 1.8 percent in 2011, which was not far from the OECD average.<sup>1</sup> However, patents had been growing even faster. The number of invention patents granted to resident, non-individual applicants per 10 million dollars of R & D expenditure (in 2011 purchasing power parity prices) was 3 for China and 2 for the U.S. in 2007. In four years, the ratio for China rose to 6.3, and that for the U.S. increased more modestly to 2.4. While not impossible, it would seem unlikely that this large and widening disparity in patents to R & D ratio can be explained by the difference in the productivity of R & D of the two countries.<sup>2</sup>

The objective of this research is to investigate both the contributions of innovation and non-innovation related forces to China's patenting surge. By the latter we mean those that influence the propensity to apply for patents when the underlying rate of innovation

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<sup>1</sup> Even this acceleration of R & D intensity at the aggregate level may belie the even more rapid growth in R & D in certain sectors of the Chinese economy, such as telecommunications equipment.

<sup>2</sup> We use the number of patents granted to non-individual applicants in 2011 as the numerator and R & D expenditures incurred in 2008 as the denominator. The R & D expenditures are measured in 2011 prices that have been adjusted for purchasing power parity – we obtained the figures by multiplying GDP in 2011 PPP prices by the R & D to GDP ratio. We build in a three-year lag between patent grant and R & D spending. The GDP and R & D to GDP ratio data are obtained from World Development Indicators. (<http://data.worldbank.org/indicator/all>).

has not changed. The conventional role of patents lies in preventing copying and pre-empting unauthorized entry, the need for which rises when new technologies are created, thus implying a tight connection between innovation and patenting. However, it has been widely recognized that modern corporate warfare is not only conducted in product markets but also in the court of law, where ruling in favor of one party over the ownership of intellectual property could inflict significant damages on the other. This has increasingly been the case with Chinese firms as well.

What makes the Chinese experience unique has been the role that the government plays in encouraging the acquisition of intellectual property as part of its push for raising the level of technology innovation in the Chinese economy. For instance, the 12th Five-Year Plan of Science and Technology Development, which covers the five-year period from 2011 to 2015, set an explicit target for patents: it aimed to increase the number of SIPO invention patents in force per 10,000 people from 1.7 in 2010 to 3.3 in 2015. To execute plans such as this, Chinese government at various levels has introduced incentives to promote patent applications.

Our analysis uses a novel data set, in which SIPO patents have been matched to Chinese industrial firms at the firm level. This database spans the population of China's large and medium size industrial enterprises, which account for the majority of R&D conducted in Chinese industry. The match-merging of the patent database and the large and medium size industrial enterprise census database has been the result of an on-going collaboration between China's National Bureau of Statistics and SIPO, which started in 2007. Although the time span of the data is relatively short, it covers a time during which the most dramatic increase in SIPO patents took place. The current research is the first attempt to use this database to understand China's patenting surge.

Our key empirical strategy is to relate patents that a firm generates to a measure of the firm's R&D effort in a patent production function. We also regress the firm's labor productivity on the number of patents, the legal force of which the firm has paid patent renewal fees to maintain. The implicit assumption is that patents being an intermediate output of innovation should be correlated with a firm's deliberate efforts to produce new and better technologies. And the patents should eventually help the firm improve its economic performance. In the absence of more direct measures of patent quality such as patent citations or contributions of patents to total factor productivity growth, we use the correlation between patents and R&D spending and labor productivity to infer the significance of SIPO patents and how it has evolved over time.

Our results point to a notable trend of weakened association between patents and R&D and between patents and labor productivity in China's large and medium size enterprises from 2007 to 2011. This trend is particularly conspicuous for utility models, which require no substantive examination at the patent office for them to be granted, and for firms and regions that had patented relatively less in the past, i.e., the extensive margin of growth. Similar results are obtained with the labor productivity regressions. That the increasing disjointness between patents and R&D is most evident in the extensive margin of growth, which accounts for the bulk of the patenting surge, is consistent with the hypothesis that non-innovation related forces may have played an important part in the patenting surge.

The contribution of our research lies in uncovering a series of novel and interesting facts that inform the broad literature on the role of intellectual property rights in economic development (Fink and Maskus eds, 2005; Maskus, 2012). China has made significant technological progress, partly incentivised by the patent system and reflected in the patent statistics. But the rapid intellectual property rights has taken place in what is still a developing country. And how those patents that have been motivated by non-innovation related forces will affect the rate and direction of future technology innovation in China remains to be seen - and more research is certainly needed to

have a better understanding of these non-innovation related forces. It is not inconceivable that in the not so distant future China may have to deal with some of the challenges that developed countries have been wrestling with their patent systems (Jaffe and Lerner, 2004).

The rest of the paper is organized as follows. Section 2 provides an assessment of the state of knowledge regarding China's patenting surge. The next section introduces the firm-level database. We outline key features of China's most recent patenting surge in Section 4. The patent production function is specified and the estimation results are discussed in Section 5. We then explore the patents-productivity linkage in the following section. Section 7 concludes.

## 2. China's Great Leap Forward in patenting

### 2.1. An international comparison

China's extraordinary patenting surge is depicted in Fig. 1, where we plot the number of resident patent applications filed at four national patent offices, China, Japan, South Korea and the U.S. By this measure, China overtook the U.S. and Japan in 2009 and 2010 respectively. From 1985 to 2012, domestic patent applications at USPTO had been increasing at an annual rate of 5.5 percent - inviting much commentary and analysis of what is called the U.S. patent explosion (Kortum and Lerner, 1999; Jaffe and Lerner, 2004; Hall, 2004). In contrast, resident patent applications at SIPO registered an annual growth rate of 20 percent, with significant acceleration in the most recent years. The period our data span saw the most dramatic increase: the number of resident applications almost tripled from 153,060 in 2007 to 415,829 in 2011.

Resident patent applications at the Japan Patent Office had been rising from the mid 1980s to the late 1990s (Sakakibara and Branstetter, 2009), but started declining after that, with the number of applications filed in 2012 similar to that for 1985. South Korea, a country that has made the transition from imitation to innovation (Kim, 1997), started in the mid 1980s with a similar number of resident patent applications as China, but only grew its patent applications at a lower rate of 16 per cent per annum. If resident patent applications at SIPO had followed similar growth patterns as those at the USPTO and South Korea's patent office up until 2005, they clearly embarked on a much faster growth trajectory after that.

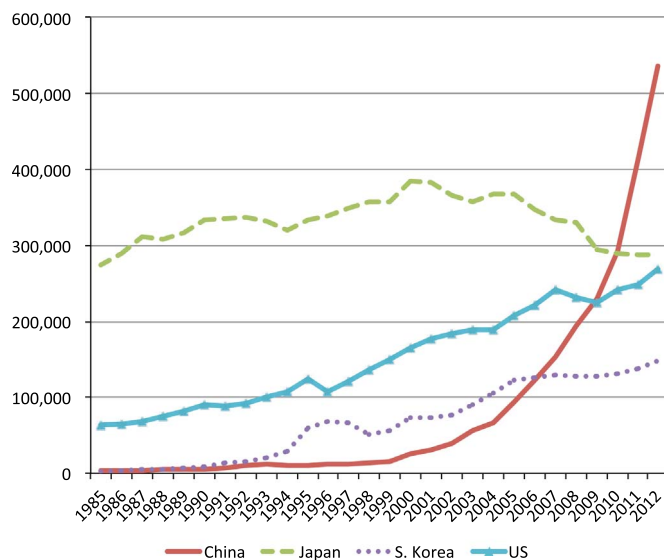


Fig. 1. Resident patent applications at national patent offices: 1985–2012.

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