



# The value of Chinese patents: An empirical investigation of citation lags



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## ABSTRACT

China has been experiencing a substantial growth in patent applications. But is this increase accompanied by a similar increase in patent value? To assess this question, we examine the citation lag of Chinese patents as a proxy of patent value in comparison with patents from the US, Europe, Japan, and Korea. Our empirical analysis comprises a unique data set of 60,000 patents with priority years between 2000 and 2010. Utilizing Cox regressions, our results show that Chinese patents suffer from a large citation lag in comparison to international patents, indicating a lower value. This is especially true for patents filed domestically. However, we find empirical support for an increasing patent value in more recent patents. China shows a strong dynamic in the field of patenting and our results suggest that the gap between Chinese patents and international patents might narrow down in the near future.

## 1. Introduction

Formerly labeled as the “world’s factory” (Ma, Lee, & Chen, 2009), China tries to shift its economic model from a production-oriented to a knowledge-based economy (Hu & Mathews, 2008). China’s objective of becoming a leading nation in terms of innovation is reflected in the number of Chinese patent applications, which constitute an important protection mechanism for inventions and are one of, if not *the* most frequently utilized proxy to measure innovation in innovation research. Patent applications by Chinese entities have exploded in recent years: In 2015, Chinese applicants filed 1,010,448 patent applications; 90.8% more than US applicants and 122.1% more than Japanese applicants. Only 15 years ago, Chinese applicants filed 2.6% of the patents they filed in 2015. While applications by Chinese applicants have grown 38-fold since then, applications by US applicants doubled, and applications by Japanese applicants decreased by 7.3% (WIPO, 2017). These numbers illustrate the remarkable and explosive growth in Chinese patenting.

Naturally, an increase in patent quantity raises questions regarding patent value.<sup>1</sup> Both constructs are important when evaluating the development of innovation in China, in particular its meaningfulness (e.g., Fisch, Block, & Sandner, 2016; Li, 2012). For example, a mere quantitative increase in patent applications may raise concerns about whether China is actually catching up with other developed economies in terms of innovation, or whether the impressive application numbers hide the fact that China’s catch-up is rather superficial. However, while there are various studies that assess the increase in Chinese patent applications and its antecedents, comparatively little is known about the corresponding development of patent value and its determinants.

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<sup>1</sup> The terms *patent value* and *patent quality* are often used interchangeably as a proxy for the (economic) significance of a patent (e.g., Harhoff, Scherer, & Vopel, 2003; Li, 2012). We thus use the terms synonymously throughout this study.

We use the citation lag to assess the patent value of Chinese patents, which is the time elapsed between the publication of the application and the first forward citation it receives (Gay, Le Bas, Patel, & Touach, 2005; Marco, 2007). Our empirical analysis is based on an international dataset of 60,000 patent applications. We use survival time analysis (Cox regressions) to analyze the hazard ratio of a patent receiving a forward citation. A longer period of time until the first forward citation establishes a longer citation lag, signifying lower patent value. Our results show that Chinese patents have the longest citation lag by far, indicating an overall low value of Chinese patents in comparison with other countries. This is particularly true for patents filed domestically (i.e., patents filed in China by Chinese applicants). However, our results indicate that patent value has been increasing in recent years.

This study contributes to the increasing and current literature on innovation in China. Previous studies have empirically analyzed the explosive increase in patenting by Chinese entities and its antecedents (e.g., Fisch, 2016; Hu & Mathews, 2008; Li, 2012). Overall, these studies identify stark increases in China's national innovative capacity, for example through increases in technology transfer, subsidies, and strategic alliances (e.g., Chen & Kenney, 2007; Fang, 2011; Hu & Mathews, 2008; Li, 2012). In spite of this, little attention has been drawn to the value of Chinese patents, which is often assumed to be comparatively low (e.g., Dang & Motohashi, 2015; Liu, Cao, & Song, 2014; Thoma, 2013). While a few studies assess the value of Chinese patents, this study is the first to use citation lags as an indicator of patent value. By extending research on innovation in China by an analysis of citation lags in recent years, we hope to add a further and more nuanced layer of discussion to China's endeavor of becoming a leading innovative nation.

This study is structured as follows: In Section 2 we describe our conceptual framework. This includes a review of related literature and the development of hypotheses. Section 3 details our data and empirical model. Section 4 presents the empirical results, which are discussed and concluded in Section 5.

## 2. Conceptual framework and hypotheses

### 2.1. Patent value and citation lag

There is no universally accepted definition of patent value (e.g., Graf, 2007; Squicciarini, Dernis, & Criscuolo, 2013; Trajtenberg, 1990; Valentini, 2012). In addition to the multitude of definitions of patent value, there is a large body of research on how to measure it. For example, Tong and Frame (1994) find patent claims, which define the extent of rights claimed by the patent, to be a possible indicator of patent value. Alternatively, Harhoff et al. (2003) measure the value of a patent by using the size of the patent family (i.e., the number of national or regional patent offices in which a patent is filed), among other proxies. Another possible measurement of patent value is patent renewal data (Bessen, 2008; Lanjouw, Pakes, & Putnam, 1998) or grant lags (i.e., the time elapsed between the filing date of the application and the date of the grant of the patent). Also, Harhoff and Wagner (2009) argue that if applicants document their patent applications well, formulate the patent claims clearly, and work closely with the patent office, it is an indication that they themselves consider their patents valuable. Similar conclusions were reached by Règebeau and Rockett (2010). Trajtenberg, Henderson, and Jaffe (1997) created a generality index, which is based on forward citations and has been used frequently since (e.g., Galasso, Schankerman, & Serrano, 2011; Henderson, Jaffe, & Trajtenberg, 1998). Trajtenberg et al. (1997) also proposed an originality index that relates to the breadth of technological fields of a patent. A third index of patent value is the index of patent radicalness proposed by Shane (2001). This index counts the number of IPC classes in which the patents cited by the respective patent are classified.

In spite of this variety in measuring patent value, forward citations are the most frequently used proxy (e.g., Gambardella, Harhoff, & Verspagen, 2008; Harhoff et al., 2003). Forward citations refer to the number of times a patent has been cited by subsequent patents, indicating that these newer patents are technologically built upon the cited (previously filed) patent. Hence, a larger number of citations indicate a more valuable patent. Trajtenberg (1990) found that forward citations outperform simple patent counts as a proxy for the value of a patent. Citations have since been used and validated frequently (e.g., Albert, Avery, Narin, & McAllister, 1991; Gambardella et al., 2008; Hagedoorn & Clodt, 2003; Harhoff et al., 2003). However, using forward citations has drawbacks. For example, the patent examiner ultimately decides which and how many citations are included in a patent. More importantly, forward citations suffer from right truncation (i.e., newer patents have a lower propensity to receive numerous citations) (Mowery & Ziedonis, 2002). To avoid this problem, most studies use the forward citations a patent received within 5 years after the publication of the application. Also, the patent application is only published 18 months after filing. Thus, researchers typically award 6.5 years to a patent application to collect citations. This leads to a potential loss of data, as the observations in the last 6.5 years have to be excluded to establish comparability. This is a particularly important limitation when examining highly dynamic economies such as China, in which patent filing activity has exploded in recent years. Leaving out the last 6.5 years of development might lead to biased conclusions or a lack of identifying interesting results.

Against this background, we use the closely related measure of the citation lag, which is the time elapsed between the publication of the application and the first forward citation it receives (Gay et al., 2005; Marco, 2007). Thus, the citation lag is very similar to forward citations but circumvents the loss of the most recent data points. Also, Cox regressions can be employed that are explicitly able to deal with right truncation. For example, Gay et al. (2005) identified a link between number of forward citations and the citation lag. The authors noted that a technologically important patent is cited more quickly. Furthermore, a patent that receives its first citation during the first year after being granted receives a higher number of forward citations overall. Put differently, the advent of the first citation is a good predictor for all citations accumulated in a 5-year window. In contrast, a patent that receives its first forward citation a long time after being granted receives a lower total number of forward citations. Thus, a shorter citation lag can be associated with a higher patent value, while a longer citation lag can be associated with a lower patent value. Of course, using citation lag as a proxy of patent value also has drawbacks, which we outline at the end of the study.

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