China has gained more attention in the past few years. One of the main observations is the increase in patent applications and granted patents both at the national patent office and at international patent offices such as the USPTO. This increase in the output of technology presents an interesting base for exploring if and how China is interacting in the global market for technologies. Utilizing data from USPTO patent reassignment dataset, this analysis maps international flows of patent ownership transfer between China and other countries. Data from the US patent reassignment database have been subject to several filters resulting in 1176 patents granted between 2000-2017 that have been traded internationally between China and another country in small bundles. The analyse explores, first, at the macro level, which countries China interacts the most with and the main role China plays in this international market for patents. Secondly, it explores the type of technologies involved in these transfers.

The results suggest that China has a specific role in supplying certain types of technologies to the international market for patents. It also hints that although most flows occur between China and the United States, the top partners are present across different continents. The analysis is of explorative nature and aims at identifying relevant key aspects of Chinese implication in the global markets for technology that shall be pursued in future research.

Keywords: China, Markets for Technology, cross-border patent transactions
Abstract

China has gained more attention in the past few years. One of the main observations is the increase in patent applications and granted patents both at the national patent office and at international patent offices such as the USPTO. This increase in the output of technology presents an interesting base for exploring if and how China is interacting in the global market for technologies. Utilizing data from USPTO patent reassignment dataset, this analysis explores the national and international interactions of Chinese based firms in the Market for Patents between 1980-2017. The data from the US patent reassignment database have been subject to several filters resulting in 4555 granted patents that have been acquired by a Chinese assignee. The analyses explore, first, at the macro level, which countries China interacts the most with and the main role China plays in this international market for patents. Secondly, focusing on China, this study explores the geographical distribution of transactions between three regional levels – Mainland China, Hong Kong and Taiwan. The results suggest that China has a specific role in importing certain types of technologies to the international market for patents. The analysis is of explorative nature and aims at identifying relevant key aspects of Chinese implication in the global markets for technology that could be pursued in future research.

Key Words: Patent assignments, markets for technology, markets for patents, China
1. Introduction

The transfer of technology is increasingly seen as a major driver of entrepreneurship and innovation [1][2][3]. Markets for technology have played a major role in the transfer of codified knowledge for over a century. Indeed, [4] identified a growing trend for trading inventions already in the nineteenth and the early twentieth centuries. Inventors started to trade their technological information to arm-length buyers. Firms, therefore, developed new strategies to incorporate invention into its processes and developed a new set of capabilities to adapt external knowledge. One of the early institutions to regulate and promote the technology market was the Patent System. Not only it protected the inventor by providing rights to its idea, it also facilitated the diffusion of knowledge due to the detailed description of the technology each inventor was entitled to provide. Although this market declined during the 1920s [4] it has regained momentum in late twentieth century [1].

In the past decades, several scholars have since attempted to estimate the size of markets for technology [5][6], while others focused on pointing issues regarding imperfections in these markets [1][7][8]. Simultaneously, markets for technology (MFT) have been subject to several studies, mainly at the micro level (cf. [9][10][11][12]). Other authors have focused on the describing the different channels in the MFT. A specific stream of the literature focused on patents and how they facilitate technology transfer (cf. [4][13][14]).

However, with the increase in globalization in the product market and the internationalization of Research and Development (R&D) [15], the markets for technology expanded and transcended National boundaries. In the recent years, developing countries, in particular, have increased their technology and knowledge output, leading to an increase in technology that can potentially be traded. One such country is China, which, among other emerging economies, has experienced impressive growth in technological innovations over the past decades. Literature in Globalization and Global Value Chain identified a shift from manufacturing to R&D within multinationals subsidiaries. Part of it is due to Chinese “Market for technology” policy aimed at increasing inbound foreign direct investment from western multinationals. [16] identified that the main emphasis of policy is on the spillover effects of MNE’s. As a result, Chinese based companies in diverse sectors have focused on acquiring technology either from external sources or by upgrading their technological capacity. Evidence shows that China has more than fifteen thousand patents granted in the 2002-2010 period, from which 3.07% were traded [17].

In this paper, the aim is to focus deeper on the position and role China takes in the Global market for patents. Ultimately, this research attempts to understand what is the role of China as an acquirer of technology in the Global Markets for Technology.

Previous research has emphasized an increase in the volume of Chinese patent applications and filed patents [18]. The increase in the volume of technology in the form of "intellectual property" offers the opportunity to track the transactions of such technologies.

This paper will hence utilize patent data to determine the volume of patent transactions that are acquired by a Chinese company or technology holder. The aim is to map the technology flows geographically and differentiating the flow between three main Chinese geographical regions (i.e. mainland China, Hong Kong and Taiwan) and incoming flows from Foreign countries. This explorative analysis attempts to highlight relevant sectors, technology market structure and volume of incoming transactions over the period 1980-2018. The findings of this explorative analysis may open the path to an in-depth analysis of the Chinese role in the Global MFT.
The remainder of the paper will be structured as follows: First, the specific case of China and the Chinese markets for technology is introduced. After that, a comprehensive review of the theoretical contributions is made. In the third part, data are introduced and basic results of the descriptive analysis are displayed. The final section discusses the different findings and concludes the research with a summary of the main findings.

2. Literature review

2.1. Markets for Technology

This paper follows the definition proposed by [1]:

"market for technology refers to transactions for the use, diffusion and creation of technology. This includes transactions involving full technology packages (patents and other intellectual property and know-how) and patent licensing. It also includes transactions involving knowledge that is not patentable or not patented (e.g., software, or the many nonpatented designs and innovations)" (p.3).

The authors excluded, however, other forms of technology exchange such as joint ventures, mergers and acquisitions and the mobility of Human capital as they relate rather to the market for firms and labor market respectively.

The importance for technology markets lies in the fact that it may shape firms strategies as they seek to develop innovations for competitiveness. How firms decide to incorporate or trade knowledge is of high relevance at both the firm, national and international level. At the micro level, literature in the topic has focused mostly on the supply of technology, searching for the reasons and motivations leading firms to license or sell their technology. [19], for instance, argues that a firm holding a technology can profit from it either by embedding it in a final product, or by trading it. [9] explains that licensing creates competitors. Firms with downstream operations shall compare the revenue from licensing with the rent-dissipation effect by enabling competition through licensing. In their paper, they highlight the relationship between the product market and the market for technologies. This line of research focuses also on factors enhancing licensing, such as the presence of fragmented product markets [20] and the presence of technology specialists [21]. Another line of research studied the demand side. Where the three main areas of analysis include the “Not invented here” (NIH) syndrome, where firms may prefer technologies developed within the firm; the complementarity [11] vs substitutions [12] of in-house and external R&D, and absorptive capacity [22]. Researchers also sought for limitations and factors hampering the growth and expansion of markets for technology. However, literature is rather scarce when it comes to study markets for technology at the meso level. [23] suggests aiming research at understanding interdependence between product- and technology-market competitions and explore the dynamics of industry structure associated with technology trade. Indeed, as [24] highlight, previous papers focus mainly on the definition of players in the market or the activity of capital markets. They therefore proposed a dynamic perspective for investigating the structure of a patent transaction network. There is still, however, a gap in the literature as they recognize that it is still uncertain which interaction structures affect patent transactions.
2.2. Geography of Technology trade and Market imperfections

The market for technology presents different characteristics from other types of markets. According to [25][26], three conditions need to be met in order for a market to operate efficiently:

- **Market thickness**: buyers and sellers may operate with many potential transactors.
- **Market safety**: conditions in the market allow players to reveal preferences without undermining bargaining power.
- **Lack of congestion**: The players in the market have access to alternatives before trading.

Several studies have highlighted that markets for technology fail to meet the above conditions. Some of the major issues include the presence of information asymmetries between sellers and buyers, difficulty to assess the market value of technologies, fear of high search costs and possible opportunistic behavior [23].

Several authors concluded that markets for technology are far from efficient and present several frictions [1][27][7].

This poses a threat to global markets for technology, as geographical distance and language barriers emphasize asymmetric knowledge problems already present in the market [28].

2.3. Evidence of the importance of Patents in the MFT

In the previous literature, the importance of patents in the MFT has been covered both implicitly and explicitly.

Implicitly, changes in the US patent law in the nineteenth century allowed the development of a market for technology [4]. The increase in patent protection increase licensing propensity [13]. Several researchers have focused on the motives to patent and provided additional evidence on the importance of patents in technology transactions [29][30][31][32].

Explicit studies showed that trade in patents stimulates innovation and the overall welfare by enhancing innovation activity, knowledge diffusion and improving the geographic spread of technology [4][33][27]. With patent trade, a piece of knowledge is able to reach places where it may be best used [1][14]. Moreover, Patents seem to reduce search cost within MFT [34].

Nevertheless, certain authors raised concerns about patents that have been acquired for strategic or opportunistic reasons. In particular, the presence of patent trolls as non-practicioning entities may create an adverse effect due to their practice of engaging in litigation or extracting excessive licensing fees from manufacturing firms [35][36].

Empirical works on the role of patents in MFT focused on transactions (licensing agreements, transfers or sales). However, data on such transactions is still scarce and difficult to exploit. Only recently some researchers have attempted to analyze datasets on patent reassignments [37][38][17] and patent auctions [39][40][36].

Of the two data mentioned above, patent reassignments offer more promising records to conduct the present analysis. Some of the main findings are therefore described in this section. When [37] first analyzed patent reassignments data, he identified individual private inventors and small innova-
tors to be the most active sellers of patents, as opposed to government agencies and large innovators. He also showed that younger, more original and highly cited patents have a higher likelihood to be traded. [38] later found that small firms sell and acquire more patents than large firms do, where large firms do not seem to acquire an excessive concentration of patent rights through the market for patents.

2.4. China in the Markets for Technology

Although Chinese legislation regarding Intellectual Property Rights (IPR) protection traces back to the 19th century, it is only recently, in 1984, that modern patent law was adopted. This law was further reformed in 2001 during the Chinese inclusion in the World Trade Organization [41]. Since the enforcement of new patent legislation in 1985, patent applications by both Chinese and foreign inventors have grown [42]. Using Chinese patents applied at the domestic patent office have been accepted as an indicator of the internal structure of innovative activities in an economy with relatively low technological capabilities [43]. However, it seems that this indicator is partly driven by National Policy as opposed to the classical function of IPR protection. Alternatively, another indicator commonly used is the number of Chinese applications on international patent offices. Although they are relatively biased towards large companies able to compete globally, it represents the reality [43] and it is a better indicator of the presence of China in the global markets for technology.

A recent study has discussed the flow of knowledge between Developing and Developed nations and identified that knowledge flows from China are occurring more frequently [45]. Inter-city patent rights transfers in China has been rising, with the number of city-pairs increasing rapidly [46]. Such continued growth in the inter-city, and by extension, inter-provincial trade in technology is a driver of regional technological innovation and industrial development [47].

3. Methods and Data Collection

Main data used in this analysis are derived on the one hand from the USPTO patent assignment dataset. An assignment tracks a transfer of patent right at the USPTO in the Patent Assignment database. An assignment is, hence, a transfer, by a seller to a buyer, of the rights, title and interest in one or more granted patents or patent applications. Disclosure of patent transactions is not required; however, it provides additional legal protection in the case patent owners face litigation. The structure of the data provides the name of the assignor (seller), assignee (buyer), the date the assignment was recorded at the patent office. Furthermore, the dataset provides a categorization of conveyance type “assignment of assignors’ interest” which allows distinguishing from other administrative events or Mergers and Acquisitions (M&A) that lie outside of the scope of this analysis. After matching inventors and assignees with the original patent assignments data, several steps were taken to filter the data. After filters and data pre-processing, only incoming utility patents to a Chinese based organization were retained. Moreover, mergers and acquisitions and other administrative conveyance types were excluded as well. Finally, a constructed variable in the USPTO assignment dataset allowed discarding transactions made between inventors and their employees (known as first assignments). The final dataset contains 2 787 patent transactions including 4 555 different utility patents between 1980 and 2018.
4. Data Analysis

5. Discussion and Conclusion
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