DISCUSSION PAPER SERIES

Discussion paper No. 200

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November 2019

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Trademarks as an indicator of regional innovation: Evidence from Japanese prefectures

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Acknowledgments: We thank participants at the 1st BETA (Bureau d'économie théorique et appliquée) workshop in Strasbourg (October 2018) for constructive comments on an earlier version of the manuscript. The authors acknowledge the support of Grant-in-Aid for Scientific Research (C) (No. 18K01639), Japan Society for the Promotion of Science.

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Abstract

Regional science has long been concerned with measuring the spatial distribution of innovation activity. While patents are frequently used as an indicator of regional innovation, we introduce trademarks as an additional indicator. Specifically, we explore the spatial distribution of trademark applications using a detailed and comprehensive dataset of 47 Japanese prefectures from 1999 to 2012. In addition to mapping differences in trademarks across regions, we identify correlates at the regional level that provide initial insights into potential determinants of regional innovation. For example, regional trademark activity is positively associated with regional entrepreneurship and with strong private service and finance sectors. Overall, our results reveal associations unique to trademarks that patent-based measures of innovation cannot uncover. With these results, we contribute to research in regional science and to the evolving literature on trademarks of this discipline.

Keywords: Trademarks; regional innovation; Japan; prefectures; spatial distribution; patents.

JEL: L80; O34; O53; R12.

1. Introduction

Regional science has long been concerned with measuring the spatial distribution of innovation activity. Indicators used include various innovation input and output measures such as R&D expenditures (Männasoo et al., 2018), high-tech firm density (De Silva and McComb, 2012), innovative entrepreneurship (Fritsch and Storey, 2014; Huggins et al., 2018), and venture capital activity (e.g., Ferrary and Granovetter, 2009; Florida and Kenney, 1988). In addition, a significant number of studies have used intellectual property (IP)-based measures and mostly relying on patent data (e.g., Acs et al., 2002; Fritsch and Slavtchev, 2011; Porter, 2003).

Our study introduces trademarks as an indicator of regional innovation activity. Patents and trademarks grasp different aspects of innovation activity. While patents protect firms' technological assets, trademarks relate to marketing assets and convey commercialization efforts (e.g., Block et al., 2014; Flikkema et al., 2014; Mendonça et al., 2004). Due to these differences, exploring the spatial distribution of trademarks in addition to patents enables a more comprehensive assessment of regional innovation, which is crucial to both theory and practice. Thus, in this study, we explore the spatial distribution of trademarks across regions to provide a more nuanced perspective of regional innovation activity.

We use a comprehensive dataset of 47 Japanese prefectures covering the period from 1999 to 2012. Based on this dataset, we assess the spatial distribution of trademarks in Japan and how it relates to regional level characteristics. IP rights have historically played and still play a crucial role in the Japanese economy (Reiffenstein, 2009). For example, the Japan Patent Office (JPO) had received the highest number of patent applications in the world from the 1970s until 2005 (Nagaoka et al., 2010). In addition to mapping differences in trademarks across Japanese prefectures, we use regression analysis to identify correlates of trademarks and provide initial insights into the potential determinants of regional trademark activity.

We find that regional trademark activity is positively associated with regional entrepreneurship and income levels. Moreover, regional trademark activity levels are stronger in regions characterized by strong private service and finance sectors while they are lower in regions with a strong high-tech manufacturing sector. Our results also reveal that the associations detected are unique to trademarks and most importantly cannot be found with patent-based measures of innovation.

With these results, we contribute to research in regional science by introducing trademarks as a measure for assessing the spatial distribution of innovation activity (e.g., Acs et al., 2002; Fritsch and Slavtchev, 2011; Porter, 2003). In addition, we contribute to the evolving literature on trademarks (e.g., Castaldi and Giarratana, 2018; Flikkema et al., 2014; Flikkema et al., 2019; Mendonça et al., 2004), which has primarily focused on trademarks as a firm-level measure of innovation activity.

The paper is structured as follows. Section 2 introduces trademarks as an indicator of regional innovation and describes the Japanese trademark system. Section 3 describes our data, variables, and method. Section 4 outlines our descriptive and multivariate results regarding differences in trademarking across Japanese regions and interprets our findings. Section 5 concludes the study and outlines avenues for future research.

2. Theoretical and empirical foundations

2.1 Trademarks as an indicator of regional innovation

Trademarks are an established proxy of innovation activity. For example, Jensen and Webster (2009) document significant correlations between trademarks and other established innovation proxies such as survey-based measures of innovation, R&D expenditures, and patents. Similarly, Flikkema et al. (2014) establish an empirical relation between trademarks and innovation activities and Greenhalgh and Rogers (2012) argue that trademarks may even be a more "comprehensive indicator of innovation than patents" (p. 52).

Related studies frequently describe trademarks as particularly well suited to grasping aspects of innovation that other measures (e.g., patents) fail to capture. While patents protect firms' technological assets, trademarks relate to marketing assets and convey commercialization efforts (e.g., Block et al., 2014; Mendonça et al., 2004; Flikkema et al., 2019). Additionally, patents are more suitable for capturing innovation in R&D-intensive and technology-oriented industries. In contrast, trademarks are an indicator of innovation in less technology-oriented industries such as advertising-intensive, creative, and service-related industries (e.g., Amara et al., 2008; Castaldi, 2018). The role of trademarks as a measure of innovation in service industries is particularly salient and has been documented in various studies (e.g., Castaldi and Giarratana, 2018; Flikkema et al., 2014; Hipp and Grupp, 2005). Moreover, patents and trademarks refer to different stages of the innovation process. Trademarks are crucial in later phases of the innovation process, which concern market entry and commercialization (e.g., Flikkema et al., 2014; Seip et al., 2018).[1]

Prior research in regional science has traditionally drawn on patents as an indicator of regional innovation activity (e.g., Acs et al., 2002; Fritsch and Slavtchev, 2011; Porter, 2003). We argue that aggregated counts of trademarks may be a similarly informative measure when assessing innovation activity at a regional level. Specifically, the use of aggregated trademark counts may grasp aspects of regional innovation that patent-based measures fail to account for. So far, the few studies using trademarks as a measure at an aggregate level assess their utilization across different industrial sectors (e.g., Flikkema et al., 2014; Jensen and Webster, 2009; Mendonça et al., 2004). Other studies use trademark data aggregated at a national level and

[1] This argument does not hold for start-up firms, which may already use trademarks in early innovation phases to signal their marketing and commercialization capabilities to external finance providers (Block et al., 2014).

outline correlations with income per capita (Fink et al., 2005), GDP, and population size (Mangàni, 2007).

2.2 Trademarks in Japan

We assess trademarks as an indicator of regional innovation activity in Japan. Japan is divided into 47 prefectures, such as Tokyo and Osaka, which form the first level of jurisdiction and administrative division. Japan is traditionally characterized by the largest number of small and medium-sized enterprises (SMEs) in the world and by a number of industrial clusters (Yamawaki, 2002). Also, assembly and parts manufacturers tend to be located in the same area of Japan to pursue efficient production under a subcontracting system (Asanuma, 1989; van Kooij, 1991). For example, automobile and motorcycle clusters have formed in the areas of Nagoya and Hamamatsu, respectively (Echeverri-Carroll, 1996; Yamamura et al., 2005). Such clusters have made Japanese firms such as Toyota and Honda global market leaders.

Meanwhile, the Japanese government has shifted its innovation policy toward promoting innovation at the regional level since the end of the 1990s. Before then, the government had placed a great emphasis on national innovation systems until then (Goto, 2000; Kitagawa, 2005, 2007; Okamuro et al., 2019). The Basic Act on Science and Technology enacted in November 1995 clarifies that a local governments have a responsibility to formulate policies to advance science and technology in the government's administrative area. Furthermore, the Ministry of Economy, Trade, and Industry (METI) initiated an Industrial Cluster Policy in 2001. The Industrial Cluster Policy aims to enhance Japan's competitiveness through industrial clusters formed by local SMEs and through new ventures utilizing seeds from universities and other research institutions. In cooperation with the METI, the Knowledge Cluster Policy was launched in 2002 by the Ministry of Education, Culture, Sports, Science, and Technology

(MEXT). Since Japanese firms became less internationally competitive in information technology (IT) industries under their in-house innovation strategies, the Japanese system of innovation has transformed into a dynamic and network-based system characterized by active external collaboration with various parties (Motohashi, 2005).

In addition to providing a fruitful setting for studying regional differences, Japan is a particularly attractive case for research on trademarks. First, Japan has adopted a regional collective trademark system since April 2006. The purpose of the collective trademark system is to foster the growth of regional brands and to convey the uniqueness of certain regional products by distinguishing them from products originating from other geographical regions. In practice, various trademarks are derived from the names of geographical regions and from products specific to those regions. Therefore, for some Japanese trademarks, regional names are used by combining them with specific product names. This fact suggests that trademarks should serve as important marketing tools in Japanese regions.

Second, IP rights have historically played a crucial role in Japan (Reiffenstein, 2009). The JPO had received the most patent applications in the world since the 1970s until 2005, when the multiple claim system was introduced in Japan (Goto and Motohashi, 2007; Nagaoka et al., 2010). This partly occurred because the Japanese patent system has emphasized technological diffusion rather than inventor protection under the first-to-file rule of priority (Cohen et al., 2002; Goto and Odagiri, 1997; Ordover, 1991). The propensity to trademark in Japan is also high. According to JPO Status Report 2019, Japan ranked third in the world in terms of the number of applications following China and the US in 2017.[2]

[2] The number of trademark applications in Japan amounted to 184,483 in 2018.

3. Data and variables

3.1 Data

We obtain trademarks and patents for all 47 Japanese prefectures for 1999 to 2012. Data on trademarks were obtained from the *Trademark Database* complied by the MEXT's National Institute of Science and Technology Policy (NISTEP). It covers all trademarks that were registered by the JPO and were applied between 1999 and 2012. Data on patent applications were drawn from the *IIP Patent Database* compiled by the JPO's Institute of Intellectual Property (IIP). This source covers all patents applied to the JPO from 1964. We, therefore, use the period running from 1999 to 2012 to compare trademarks and patents as indicators of regional innovation. We count the number of trademarks and patents submitted to the JPO at the prefecture-level based on the addresses of the applicants.

We then merged this dataset with data on various regional economic indicators taken from various sources. First, we collected data on population density and on the number of scientists within each prefecture from the Ministry of Internal Affairs and Communications' (MIC's) *National Census*.[3] To obtain data on per-capita income, on the number of employees, on export/import ratios, and on industry compositions for each prefecture, we use the *Regional-level Japan Industrial Productivity (R-JIP) Database* compiled by the Research Institute of Economy, Trade, and Industry (RIETI). Data on the number of headquarters and establishments were obtained from the MIC's *Establishment and Enterprise Census* and the *Economic Census* (for 2009 onward). Information on the number of universities in each prefecture was taken from the MEXT's *School Basic Survey.*

[3] The *National Census*, *Establishment and Enterprise Census*, and *Economic Census* are not surveyed every year. For years for which data were not obtainable, we used the values of surveys conducted immediately prior to those years.

3.2. Variables

3.2.1 IP measures: trademarks and patents

To uncover differences in regional trademarking behavior, we measure the number of trademark registrations by prefecture based on the addresses of applicants. We use the date of the respective trademark application as our date of reference. According to the JPO, trademarks include characters, figures, symbols, three-dimensional shapes and combinations thereof. The Trademark Act has been partially revised in Japan several times. Principal revisions include the introduction of the service mark registration system in 1991. Product names with regional names have been allowed as trademarks under the regional collective trademark system enacted in April 2006.[4]

While trademarks are at the core of this study, we are interested in the additional explanatory power of trademarks over patents. Therefore, like other studies on trademarks, we use patents as a control variable. To assess potential differences and complementarities with the more established indicator of innovation (e.g., Acs and Audretsch, 1989; Nagaoka et al., 2010; Pavitt, 1985), we count the number of patent applications submitted by prefecture based on the addresses of applicants.

3.2.2 Regio-economic characteristics

We examine a range of region-economic characteristics to identify correlates of trademark applications submitted across regions. Our variables include population density (population per square kilometer), per capita income (in thousands of yen), the number of employees, the number of headquarters, entrepreneurship rates, government expenditures, the number of universities, the number of scientists, as well as import and export ratios for each prefecture. These

[4] In Japan, the trademark system for retail or wholesale services was introduced on April 1st, 2007, and a mark used for retail or wholesale services can be registered as a service mark. A unique feature for trademarks in Japan is that of *nidan-heiki* (double parallel writing in Japanese and Latin), which distinguishes between company and product names using the same characters but different pronunciations.

variables capture various aspects for the demand and supply sides of products and services as well as economic and scientific infrastructures of each prefecture.

3.2.3 Industry composition

In addition to regio-economic characteristics, we examine the effects of regional industry compositions on trademarks and patents. Data on real value added by industry sector for each prefecture are used to measure industry compositions based on classifications of the *R-JIP Database*. In our data, we distinguish between nongovernmental and governmental service sectors. Industries of the manufacturing sector are classified into high- and low-tech manufacturing sectors using the Organisation for Economic Co-operation and Development's (OECD) classification (2011).

Table 1 describes the definitions and data sources of the variables.

- Please insert Table 1 here -

4. Empirical results

4.1 Regional differences in trademarking across Japanese prefectures

We first assess the spatial distribution of trademarks across Japan descriptively by ranking all 47 prefectures according to the number of trademarks (aggregated from 1999 to 2012) as is shown in Table 2. To provide additional information on each prefecture, Table 2 also displays the aggregate number of patent applications, population, and per capita income for each prefecture.

- Please insert Table 2 here -

Overall, large differences across regions emerge with regard to the number of trademarks. Unsurprisingly, the most densely populated metropolitan areas (e.g., Tokyo, Osaka) present the highest number of trademark registrations. According to the MIC's System of Social and Demographic Statistics (SSDS), while the share of primary industry in terms of the labor force is quite low in these metropolitan areas, the share of tertiary industry is the highest among prefectures in Japan. More rural and less populated areas (e.g., Tottori, Akita) show considerably fewer trademarks (less than 2,000). In such prefectures, while the share of the primary industry is high, that of the tertiary industry is low. The number of trademarks per prefecture is highly skewed and shows a considerable degree of variance. While 525,371 trademarks were registered by applicants from Tokyo between 1999 and 2012, applicants from Tottori registered 1,522 trademarks (= 0.3%). The variance in trademark registrations is similar to the variance in patent applications with applicants from Tokyo filing 2,329,846 patent applications while applicants from Aomori filed 2,967 (= 0.1%). Overall, the results also show a positive association between trademarks, patents, population, and income.

Further illustrating the spatial distribution of trademarksacross Japan, Figure 1 presents a map of the 47 Japanese prefectures according to their ranking in terms of overall trademarks registered from 1999 until 2012. Prefectures with a high number of trademark registrations are colored green while prefectures with fewer trademark registrations are colored red. Figure 2 displays the spatial distribution of patent applications in the same manner.

Figure 1 shows that the number of trademark registrations is particularly high in central Japan while areas of southern and northern Japan show lower numbers of trademark registrations. For example, the number of trademarks is particularly low for Kyushu, Japan's southernmost island, and for the northern region of the main island. While central Japan (including Tokyo and Osaka) is characterized by secondary and tertiary industries, rural areas, such as

Akita and Miyazaki, are characterized by primary industry. While Figures 1 and 2 appear similar overall, some differences in the spatial distributions of trademarks and patents emerge when comparing them. For example, regions with the lowest number of trademark registrations (i.e., Shimane, Akita, and Tottori) are not those with the lowest number of patent applications (i.e., Okinawa, Oita, and Aomori). Further differences in the spatial distribution of trademarks and patents emerge for selected prefectures, revealing larger discrepancies in rankings according to trademarks and patents. For example, Yamaguchi prefecture ranks 36^{th} in terms of trademarks while it ranks 19^{th} in patents. This strong tendency toward patenting in this prefecture may be attributable to the fact that it includes many headquarters of firms in high-tech manufacturing sectors such as the heavy and chemical industries. In contrast, Okinawa prefecture ranks 27^{th} in terms of trademarks while it ranks 45^{th} in terms of patents. Okinawa prefecture ranked 47^{th} and 2^{nd} in terms of its shares in the labor force of secondary and tertiary industries, respectively, as of 2010. In practice, this prefecture is dominated by the service sector, including the tourism industry.

- Please insert Figures 1 and 2 here -

4.2 Causes of regional differences in trademarking across Japanese prefectures

4.2.1 Empirical approach

The descriptive results show differences in the distribution of trademarks and patents across Japan. To explore the causes of these regional differences empirically, we apply an ordinary least squares (OLS) regression framework to identify correlates of the regional number of trademark registrations in a more robust, multivariate way. The results of our main analysis are displayed in Table 3.

The number of trademark registrations (per prefecture and per year) serves as our dependent variable. Correlations are displayed in Table A1 (Appendix). To account for the nested data structure of different yearly observations for each prefecture, standard errors are clustered by prefecture. Several variables are included in logged form to account for strong skewness in the data.

We include the number of patent applications (per prefecture and per year) as a control variable. Importantly, this enables us to isolate correlates of trademark registrations irrespective of the number of patent applications. Then, we separately consider a set of regional economic characteristics (Model 1) and industry structures (Model 2) that might correlate with trademark activity.

4.2.2 Results

The results regarding the region-economic determinants of trademarks (Table 3, Model 1) show that a larger number of registered trademarks positively correlates with a higher population density level ($p < .10$), higher per capita income ($p < .01$), and a higher entrepreneurship rate ($p < .05$). In contrast, a larger number of trademarks negatively correlates with a higher export ratio.

Results on the influence of a different regional industrial configuration (Table 3, Model 2) show that a larger number of trademarks negatively correlates with higher value-added in the agricultural ($< .05$), wholesale ($p < .10$), government services ($p < .05$), and high-tech manufacturing sectors ($p < .01$). In contrast, we find a positive correlation between trademark registrations and higher value-added finance ($p < .01$) and private services ($p < .05$).

- Please insert Table 3 here –

4.2.3 Interpretations of the main findings

We find that trademark activity is associated with a strong private service sector. This suggests that trademarks can be used to capture *service innovation* in the private sector, which is in line with recent firm-level trademark research (Castaldi, 2018; Castaldi and Giarratana, 2018). This is an important finding for the field of regional science, where most studies on service innovation are either conducted at the firm level using questionnaire-based measures (Love et al., 2010) or rely on qualitative empirical data (Liu et al., 2019). We show that trademarks can be used as an indicator of regional levels of service innovation. This finding opens up the possibility of conducting quantitative research on regional processes of transformation from primarily manufacturing industry-oriented regions to regions those characterized by knowledge-intensive business services (KIBS) (Liu et al., 2019). Prior research shows that KIBS play an important role in the transformation of regional and national innovation systems (Muller and Zenker, 2001; Pinto et al., 2015). Trademark-based measures of regional innovation seem to be well-suited to developing a deeper understanding of why and under what conditions KIBS have a profound effect on regional development and prosperity.

We also find that trademarks are associated with a strong finance sector. Innovation research conducted at firm and regional levels has struggled to find quantitative measures of innovation for the financial sector. Our results imply that trademarks can be used as a proxy for measuring innovation in the banking and finance sector. Similar to KIBS, the financial sector can be seen as an integral part of a regional and national innovation system. The venture capital (VC) industry, in particular, has been described as a driving force of innovation and innovative entrepreneurship (Block et al., 2017; Kortum and Lerner, 2000; Peneder, 2010). Trademark-based measures of innovation could be used to dig deeper into the heterogeneity of the financial sector and to understand how innovative products and services of the financial sector impact regional systems of innovation (Ferrary and Granovetter, 2009; Wood, 2009).

4.2.4 Additional analyses and robustness checks

In a first additional analysis, we use the number of patent applications (per year and per prefecture) as a dependent variable to further illustrate differences in the spatial distribution of trademarks and patents. The results are displayed in Table 4.

With regard to regional economic characteristics, the results show that a larger number of patent applications is positively correlated with higher population densities ($p < .10$), a larger number of corporate headquarters ($p < .01$), a larger number of scientists ($p < .01$), and a higher export ratio. In contrast, a larger number of patent applications is negatively correlated with a higher entrepreneurship rate ($p < .10$). Thus, the results show a stronger technological research orientation for patents (number of scientists) and indicate that startups do not find patents as attractive as more established firms (entrepreneurship rate). With regard to the industrial configuration, the results show a positive correlation between higher numbers of patent applications and higher value-added in the high-tech ($p < .01$) and low-tech ($p < .05$) manufacturing sectors, underlining the overall importance of patents for manufacturing industries. In contrast, patents negatively correlate with higher value-added in agriculture ($p < .01$) and mining ($p < .01$), for which patents to not seem to be of crucial importance.

- Please insert Table 4 here -

In a second additional analysis, we distinguish trademarks that refer to products, trademarks that refer to services, and trademarks that refer to both products and services. When registering a trademark, the applicant has to indicate the product or service classes (i.e., categories) the trademark will be used in once it is registered. These classes are based on the WIPO's international trademark classification system ("Nice classification") (e.g., Block et al., 2014; Flikkema et al., 2019; Sandner and Block, 2011). The Nice classification was established in 1957 and distinguishes 34 classes referring to products and 11 classes referring to services (WIPO, 2019). Measures based on Nice classes are frequently used as an indicator of diversification in prior trademark research (e.g., Block et al., 2014; Castaldi and Giarrantana, 2018; Mendonca et al., 2004; Sandner and Block, 2011).

Following Flikkema et al. (2019), we use the Nice classes to distinguish trademarks that refer to products (i.e., only contain product Nice classes), trademarks that refer to services (i.e., only contain service Nice classes), and mixed trademarks (i.e., contain both product and service Nice classes). The underlying assumption is that trademarks filed in only product or service classes are related to product and service innovations. Applying this approach to the regional level, we aggregate product trademarks, service trademarks, and mixed trademarks for each prefecture in Japan from 1999 until 2012. We then perform regression analyses for each trademark type. The results are displayed in Table 5. Model 1 uses the number of product trademarks as the dependent variable. Model 1a includes our regio-economic characteristics, while Model 1b includes our industry variables. Model 2 uses the number of service trademarks as the dependent variable and Model 3 uses the number of trademarks that contain product as well as service classes as the dependent variable.

The results provide more nuanced insights on trademarks as a measure of product and service innovation. For example, the results described in Table 5 reveal a positive and significant correlation between the number of universities and the number of service trademarks and mixed trademarks. This result complements the main analysis (Model 3), which reports an insignificant effect that can largely be attributed to insignificant relation between universities and product trademarks. Similarly, the relationship between regional income per capita and product trademarks seems to be less pronounced than the relationship beteen income and service as well as mixed trademarks. Regarding industry composition, the results reveal a positive and significant relation between real estate and service trademarks. This result, which underlines the importance of a specific trademark type in the real estate sector, is overlaid in the main model (Table 3), since the overall effect is insignificant. Further, Table 5 reveals that the positive association between trademarks and the private service sector is especially pronounced for service and mixed trademarks. Finally, Table 5 shows that the negative effect between trademarks and government services is mainly due to the negative association between government services and product trademarks.

- Please insert Table 5 here -

As a robustness check, we reestimate our main models using trademark registration dates instead of applications dates. Trademark applications are examined by the respective trademark office. Like patents, they are rejected if they fail to meet certain criteria (e.g., they must differ from existing trademarks, they must be used in commerce). While the trademark application process is less time-consuming, less complex, and less expensive than the patent application process (e.g., Castaldi, 2018; Mendonça et al., 2004), this examination process introduces a time lag to our trademark data that might potentially bias our findings. Since trademarks can only be used once they are registered, the registration date (instead of the application date) might be a more suitable measure from an economic resources point of view. Overall, the results presented in Table 6 (Models 1a and 1b) underline the robustness of our main findings.[5]

As a final robustness check, we reestimate our main models using the number of granted patents instead of the number of patents applications. The number of patent grants is a fre-

[5] Note that our dataset only contains trademarks that were eventually registered. Information on trademark applications that were rejected is not available.

quently used indicator of patent quality because patents need to undergo an examination process and are rejected if they fail to meet certain criteria for patentability, such as novelty and unobviousness. Since the patent application process introduces a considerable time lag, we use the year of application as the point of reference for each granted patent (Trajtenberg, 1990). In our sample, the average number of patent applications per prefecture per year is 7,227 and the average number of granted patents is 3,150 (= 44%). Prior research attributes the low rate of patents grants to strict examination standards at the JPO (Nagaoka, 2009) and low application fees, which lead to a high number of low quality applications that eventually get rejected (van Pottelsberghe de la Potterie and François, 2009). The results are displayed in Table 6 (Models 2a and 2b). The results underline the robustness of our main findings. No major differences emerge.

- Please insert Table 6 here -

5. Conclusions and avenues for further research

We show that regional trademark activity is positively associated with regional entrepreneurship and income levels. Moreover, regional trademark activity is higher in regions with strong private service and finance sectors, while it is lower in regions with a strong high-tech manufacturing sector. Our results also reveal that the associations detected are unique to trademarks and, most importantly, cannot be found with patent-based measures of innovation. To summarize, using trademarks as an indicator of regional innovation seems to capture unique and important aspects of regional innovation systems.

With these findings, our paper contributes to two streams of literature. First, we introduce trademarks to the literature on the spatial distribution of innovation activity (e.g., Acs et al., 2002; Fritsch and Slavtchev, 2011; Moreno et al., 2005; Porter, 2003). While this literature has a tradition of capturing regional innovation activity with a number of indicators such as regional R&D expenses and the number of patent applications, trademarks have not yet been utilized. We show that trademarks may be suitable for capturing nuances of regional innovation that cannot be captured by more traditional proxies such as innovation activity in the financial or private service sectors. Therefore, trademarks provide an important addition to the portfolio of measures used to grasp innovation activity in regional sciences. Second, our findings contribute to the evolving literature on trademarks (e.g., Block et al., 2014; Mendonça et al., 2004; Castaldi and Giarratana, 2018; Flikkema et al., 2014). This literature has established trademarks as a measure of non-technological forms of innovation, such as service innovation, and has thoroughly investigated the role of trademarks at the firm level. However, empirical research dedicated to uncovering regional differences within a country that uses trademark data is scarce. We contribute to this research by assessing differences across Japanese regions using trademark data. Similar to firm-level studies, the use of trademark data enables us to provide novel insights that future research can build on.

Our exploratory research opens up several avenues for future research. Future studies could build upon and expand on the set of variables we use to gain more nuanced insight into the spatial distribution of trademarks. With regard to regional economic characteristics, for example, future research could consider variables related to entrepreneurial finance or R&D inputs. Prior research suggests that entrepreneurial finance providers such as VCs interpret trademarks as an indication of the marketing capabilities of innovative start-ups (Block et al., 2014). With regard to the regional industrial configuration, future research could delve deeper into which aspects of the service sector are responsible for the larger number of trademark applications observed. The service sector is heterogeneous and includes a wide range of firms differing in degrees of innovation, scalability and knowledge intensity. As an example, there could be significant differences between B2B and B2C service firms. While Japan provides a rich context for studying regional differences, future research might also use trademarks to assess regional differences in other regional settings such as the US or EU. Due to its fragmentation into several relatively small countries, the latter would provide for an interesting context in which trademarks may not only measure innovation but also the internationalization ambitions of firms (e.g., Barroso et al., 2019). Unfortunately, information on international trademark applications according to the WIPO's Madrid Agreement for the International Registration of Marks is not included in our trademark dataset and is not available from NISTEP. The database includes information on whether international priority was claimed on a trademark filed at the JPO (i.e., trademarks that were initially filed in foreign countries). However, this only applies to 138 of all trademarks filed by applicants located in Japan between 1999 and 2012 so that a meaningful analysis at the regional level is not possible.

Studying trademarks would also allow for new insights related to impactful innovation and entrepreneurship activity in reference to already well-researched innovation contexts such as the US. As trademarks more beyond technological innovation and encompass 'softer' forms of innovation such as business models and service innovation, they may play an important role in detecting hot spots and clusters of truly impactful entrepreneurship such as the Silicon Valley area (Guzman and Stern; 2005; Henrekson and Sanandaji, 2019). Finally, future research could in more detail investigate the differences between trademarks and patents as an indicator of regional innovation. A better understanding of the differences and commonalities between both IP-based measures would inform theory and practice on the circumstances under which each indicator should be used to measure regional innovation activity.

References

Acs, Z., Audretsch, D.B. (1989). Patents as a measure of innovative activity. Kyklos, 42(2), 171–180.

Acs, Z., Anselin, L., Varga, A. (2002). Patents and innovation counts as measures of regional production of new knowledge. Research Policy, 31(7), 1069–1085.

Amara, N., Landry, R., Traoré, N. (2008). Managing the protection of innovations in knowledge-intensive business services. Research Policy, 37(9), 1530–1547.

Asanuma, B. (1989). Manufacturer-supplier relationships in Japan and the concept of relation-specific skill. Journal of the Japanese and International Economies, 3(1), 1–30.

Barroso, A., Giarratana, M.S., Pasquini, M. (2019). Product portfolio performance in new foreign markets: The EU trademark dual system. Research Policy, 48(1), 11–21.

Block, J., Fisch, C., Van Praag, M. (2017). The Schumpeterian entrepreneur: A review of the empirical evidence on the antecedents, behaviour and consequences of innovative entrepreneurship. Industry and Innovation, 24(1), 61–95.

Block, J., De Vries, G., Schumann, J.H., Sandner, P. (2014). Trademarks and venture capital valuation. Journal of Business Venturing, 29(4), 525–542.

Castaldi, C. (2018). To trademark or not to trademark: The case of the creative and cultural industries. Research Policy, 47(3), 606–616.

Castaldi, C., Giarratana, M.S. (2018). Diversification, branding, and performance of professional service firms. Journal of Service Research, 21(3), 353–364.

Cohen, W.M., Goto, A., Nagata, A., Nelson, R.R., Walsh, J.P. (2002). R&D spillovers, patents and the incentives to innovate in Japan and the United States. Research Policy, 31(8–9), 1349–1367.

De Silva, D.G., McComb, R.P. (2012). Geographic concentration and high tech firm survival. Regional Science and Urban Economics, 42(4), 691–701.

Echeverri-Carroll, E.L. (1996). Flexible production, electronic linkages, and large firms: Evidence from the automobile industry. The Annals of Regional Science, 30(1), 135–152.

Ferrary, M., Granovetter, M. (2009). The role of venture capital firms in Silicon Valley's complex innovation network. Economy and Society, 38(2), 326–359.

Fink, C., Javorcik, B.S., Spatareanu, M. (2005). Income-related biases in international trade: What do trademark registration data tell us? Review of World Economics, 141(1), 79–103.

Flikkema, M., De Man, A.-P., Castaldi, C. (2014). Are trademark counts a valid indicator of innovation? Results of an in-depth study of new BeNeLux trademarks filed by SMEs. Industry and Innovation, 21(4), 310–331.

Flikkema, M., Castaldi, C., De Man, A.-P., Seip, M. (2019). Trademarks' relatedness to product and service innovation: A branding strategy approach. Research Policy, 48, 1340–1353.

Florida, R.L., Kenney, M. (1988). Venture capital, high technology and regional development. Regional Studies, 22(1), 33–48.

Fritsch, M., Slavtchev, V. (2011). Determinants of the efficiency of regional innovation systems. Regional Studies, 45(7), 905–918.

Fritsch, M., Storey, D.J. (2014). Entrepreneurship in a regional context: Historical roots, recent developments and future challenges. Regional Studies, 48(6), 939–954.

Goto, A. (2000). Japan's national innovation system: current status and problems. Oxford Review of Economic Policy, 16(2), 103–113.

Goto, A., Motohashi, K. (2007). Construction of a Japanese patent database and a first look at Japanese patenting activities. Research Policy, 36(9), 1431–1442.

Goto, A., Odagiri, H. (1997). Innovation in Japan. Oxford University Press: Oxford.

Greenhalgh, C., Rogers, M. (2012). Trademarks and performance in services and manufacturing firms: Evidence of Schumpeterian competition through innovation. Australian Economic Review, 45(1), 50–76.

Guzman, J., Stern, S. (2015). Where is Silicon Valley? Science, 347(6222), 606–609.

Henrekson, M., Sanandaji, T. (2019). Measuring entrepreneurship: Do established metrics capture high-impact Schumpeterian entrepreneurship? Entrepreneurship Theory and Practice, forthcoming.

Hipp, C., Grupp, H. (2005). Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies. Research Policy, 34(4), 517–535.

Huggins, R., Waite, D., Munday, M. (2018). New directions in regional innovation policy: A network model for generating entrepreneurship and economic development. Regional Studies, 52(9), 1294–1304.

Jensen, P.H., Webster, E. (2009). Another look at the relationship between innovation proxies. Australian Economic Papers, 48(3), 252–269.

Kitagawa, F. (2005). Regionalization of innovation policies: The case of Japan. European Planning Studies, 13(4), 601–618.

Kitagawa, F. (2007). The regionalization of science and innovation governance in Japan? Regional Studies, 41(8), 1099–1114.

Kortum, S., Lerner, J. (2000). Assessing the contribution of venture capital to innovation. RAND Journal of Economics, 31(4), 674–692.

Liu, Y., Lattemann, C., Xing, Y., Dorawa, D. (2019). The emergence of collaborative partnerships between knowledge-intensive business service (KIBS) and product companies: The case of Bremen, Germany. Regional Studies, 53(3), 376–387.

Love, J.H., Roper, S., Hewitt-Dundas, N. (2010). Service innovation, embeddedness and business performance: Evidence from Northern Ireland. Regional Studies, 44(8), 983–1004.

Mangàni, A. (2007). Measuring variety and quality of products with trademarks. International Economic Journal, 21(4), 613–631.

Männasoo, K., Hein, H., Ruubel, R. (2018). The contributions of human capital, R&D spending and convergence to total factor productivity growth. Regional Studies, 52(12), 1598–1611.

Mendonça, S., Pereira, T.S., Godinho, M.M. (2004). Trademarks as an indicator of innovation and industrial change. Research Policy, 33(9), 1385–1404.

Moreno, R., Paci, R., Usai, S. (2005). Spatial spillovers and innovation activity in European regions. Environment and Planning A, 37(10), 1793–1812.

Motohashi, K. (2005). University–industry collaborations in Japan: The role of new technology-based firms in transforming the National Innovation System. Research Policy, 34(5), 583–594.

Muller, E., Zenker, A. (2001). Business services as actors of knowledge transformation: The role of KIBS in regional and national innovation systems. Research Policy, 30(9), 1501–1516.

Nagaoka, S. (2009). Reform of patent system in Japan and challenges. In: Nagaoka, S., Kondo, M., Flamm, K.,Wessner, C. (Eds.). 21st century innovation systems for Japan and the United States: lessons from a decade of change, Tokyo. Washington, D.C.: National Academies Press.

Nagaoka, S., Motohashi, K., Goto, A. (2010). Patent statistics as an innovation indicator. In: Hall, B.H., Rosenberg, N. (Eds.). Handbook of the Economics of Innovation, Vol. 2, pp. 1083–1127, North-Holland: Amsterdam.

Okamuro, H., Nishimura, J., Kitagawa, F. (2019). Multilevel policy governance and territorial adaptability: Evidence from Japanese SME innovation programmes. Regional Studies, 53(6), 803–814.

Ordover, J.A. (1991). A patent system for both diffusion and exclusion. Journal of Economic Perspectives, 5(1), 43–60.

OECD (2010). Measuring innovation: A new perspective. Available at: http://www.oecd.org/site/innovationstrategy/measuringinnovationanewperspective-onlineversion.htm. Last accessed: July 31st, 2019.

OECD (2011). Technology intensity definition: classification of manufacturing industries into categories based on R&D intensities. Available at: http://www.oecd.org/sti/ind/48350231.pdf. Last accessed: July 31st, 2019.

Pavitt, K. (1985). Patent statistics as indicators of innovative activities: Possibilities and problems. Scientometrics, 7(1–2), 77–99.

Peneder, M. (2010). The impact of venture capital on innovation behaviour and firm growth. Venture Capital, 12(2), 83–107.

Pinto, H., Fernandez-Esquinas, M., Uyarra, E. (2015). Universities and knowledge-intensive business services (KIBS) as sources of knowledge for innovative firms in peripheral regions. Regional Studies, 49(11), 1873–1891.

Porter, M. (2003). The economic performance of regions. Regional Studies, 37(6–7), 549–578.

Reiffenstein, T. (2009). Specialization, centralization, and the distribution of patent intermediaries in the USA and Japan. Regional Studies, 43(4), 571–588.

Seip, M., Castaldi, C., Flikkema, M., De Man, A.-P. (2018). The timing of trademark application in innovation processes. Technovation, 72, 34–45.

Trajtenberg, M. (1990). A penny for your quotes: patent citations and the value of innovations. RAND Journal of Economics, 21(1), 172–187.

Van Kooij, E. (1991). Japanese subcontracting at a crossroads. Small Business Economics, 3(2), 145–154.

Van Pottelsberghe de la Potterie, B., François, D. (2009). The cost factor in patent systems. Journal of Industry, Competition and Trade, 9(4), 329–355.

Wood, P. (2009). Service competitiveness and urban innovation policies in the UK: The implications of the ‘London paradox’. Regional Studies, 43(8), 1047–1059.

Yamamura, E., Sonobe, T., Otsuka, K. (2005). Time path in innovation, imitation, and growth: The case of the motorcycle industry in postwar Japan. Journal of Evolutionary Economics, 15(2), 169–186.

Yamawaki, H. (2002). The evolution and structure of industrial clusters in Japan. Small Business Economics, 18(1–3), 121–140.

Tables and figures

Table 1. Definitions of variables and data sources.

Variable	Definition	Data source(s)
IP measures		
Trademark registrations	Number of trademark registrations at the JPO in each prefecture (based on year of application).	NISTEP Trademark Database
Patent applications	Number of patent applications submitted to the JPO in each prefecture´(based on year of application).	IIP Patent Database
Regio-economic characteristics		
Population density	Population per square kilometer.	National Census
Income per capita	Per capita income (in thousands of yen) for each prefecture.	RIETI R-JIP Database
Employees	Number of employees (in thousands of individuals) in each prefecture.	RIETI R-JIP Database
Headquarters	Number of headquarters located in each prefecture.	EEC and Economic Census
Entrepreneurship rate	Number of new establishments in each prefecture.	EEC and Economic Census
Universities	Number of universities (national/municipal/private) located in each prefecture.	School Basic Survey
Scientists	Number of scientists in each prefecture.	National Census
Import ratio	Ratio of imports to total outputs for each prefecture.	RIETI R-JIP Database
Export ratio	Ratio of exports to total outputs for each prefecture.	RIETI R-JIP Database
Industry composition		
	Real value added by an industry in each prefecture.	RIETI R-JIP Database
Includes the following industries:	Agriculture, mining, construction, electricity, wholesale, finance, real estate, transportation, private services, government services, high-tech manufacturing, low-tech manufacturing	
Variables used in further analyses and robustness checks		
Product trademarks	Number of trademarks that only contain product Nice classes.	NISTEP Trademark Database
Service trademarks	Number of trademarks that only contain service Nice classes.	NISTEP Trademark Database
Mixed trademarks	Number of trademarks that only contain product and service Nice classes.	NISTEP Trademark Database
Trademark registrations (year of registration)	Number of trademark applcations that were eventually registered (based on year of registration).	NISTEP Trademark Database
Granted patents	Number of patents that were eventually granted (based on year of application)	NISTEP Trademark Database

Notes: N = 658 observations (prefecture-year level) for 47 prefectures for a 14-year period (1999–2012). JPO = Japan Patent Office. IIP = Institute of Intellectual Property, NISTEP = National Institute of Science and Technology Policy, RIETI = Research Institute of Economy, Trade, and Industry, EEC = Establishment and Enterprise Census.

Table 2. Ranking of Japanese prefectures according to the sum of trademarks between 1999 and 2012.

#	Prefecture	Trademark registrations [a]	Patent applications [a]	Population (in mil.) [b]	Per capita income (in mil. Yen) [b]
1	Tokyo	525,371	2,329,846	12.617	4.408
2	Osaka	149,185	745,641	8.824	3.022
3	Aichi	50,980	397,890	7.261	3.366
4	Kanagawa	46,634	313,107	8.794	3.205
5	Hyogo	35,541	104,965	5.578	2.743
6	Kyoto	29,996	129,810	2.640	2.889
7	Fukuoka	22,052	45,530	5.049	2.710
8	Saitama	19,695	77,147	7.069	2.937
9	Shizuoka	18,850	72,469	3.779	3.243
10	Chiba	17,290	44,060	6.070	2.964
…	…	…	…	…	…
38	Iwate	2,620	4,598	1.372	2.391
39	Miyazaki	2,615	4,322	1.150	2.223
40	Oita	2,541	2,971	1.207	2.579
41	Tokushima	2,524	6,756	0.805	2.751
42	Nagasaki	2,497	3,584	1.469	2.219
43	Aomori	2,472	2,967	1.423	2.346
44	Kochi	2,157	3,273	0.789	2.205
45	Shimane	1,939	5,441	0.738	2.405
46	Akita	1,868	3,510	1.135	2.389
47	Tottori	1,522	5,573	0.602	2.373
	Mean value	*23,595*	*101,173*	*2.714*	*2.733*

Notes: [a] = Trademarks and patents are summarized from 1999 until 2012. [b] = average of values from 1999 until 2012. 1 mil. Yen ≈ 13,001 USD (as of January 1st, 2012).

Table 3. Main analysis: OLS regression analysis to explore the determinants of the regional number of trademark registrations (log., per prefecture, per year) as the dependent variable.

Model	**(1)**	**(2)**
Variables	**Coef. (SE)**	**Coef. (SE)**
IP measure (control)		
Patent applications (log.)	0.414 (0.056)***	0.313 (0.063)***
Regio-economic characteristics		
Population density (log.)	0.134 (0.072)*	
Income per capita (log.)	1.105 (0.386)***	
Employees (log.)	-0.379 (0.405)	
Headquarters (log.)	0.209 (0.280)	
Entrepreneurship rate (log.)	0.573 (0.234)**	
Universities (log.)	0.177 (0.113)	
Scientists (log.)	-0.112 (0.072)	
Import ratio	1.891 (1.792)	
Export ratio	-7.832 (2.373)***	
Industry composition		
Agriculture (log.)		-0.074 (0.102)
Mining (log.)		0.054 (0.045)
Construction (log.)		0.006 (0.161)
Electricity (log.)		0.134 (0.084)
Wholesale (log.)		-0.253 (0.144)*
Finance (log.)		0.587 (0.200)***
Real estate (log.)		0.379 (0.248)
Transportation (log.)		-0.063 (0.283)
Private services (log.)		0.940 (0.359)**
Government services (log.)		-0.961 (0.400)**
High-tech manufacturing (log.)		-0.188 (0.039)***
Low-tech manufacturing (log.)		-0.064 (0.106)
Year dummies	Yes	Yes
Years	1999–2012	1999–2012
Observations (prefectures)	658 (47)	658 (47)
R^2 (adj.)	0.939	0.949

Notes: Pooled OLS regression (prefecture-year level). Standard errors are clustered at prefecture level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4. Additional analysis: OLS regression analysis to explore the determinants of the regional number of patent applications (log., per prefecture, per year) as the dependent variable.

Model	**(1)**	**(2)**
Variables	**Coef. (SE)**	**Coef. (SE)**
IP measure (control)		
Trademark registrations (log.)	0.727 (0.151)***	0.660 (0.176)***
Regio-economic characteristics		
Population density (log.)	0.155 (0.088)*	
Income per capita (log.)	0.564 (0.582)	
Employees (log.)	-0.581 (0.540)	
Headquarters (log.)	1.309 (0.402)***	
Entrepreneurship rate (log.)	-0.640 (0.333)*	
Universities (log.)	-0.019 (0.151)	
Scientists (log.)	0.260 (0.080)***	
Import ratio	-4.555 (2.776)	
Export ratio	15.043 (2.816)***	
Industry composition		
Agriculture (log.)		-0.393 (0.144)***
Mining (log.)		-0.137 (0.065)**
Construction (log.)		0.307 (0.216)
Electricity (log.)		-0.138 (0.189)
Wholesale (log.)		0.336 (0.290)
Finance (log.)		0.322 (0.291)
Real estate (log.)		-0.481 (0.319)
Transportation (log.)		0.014 (0.452)
Private services (log.)		-0.593 (0.632)
Government services (log.)		0.548 (0.467)
High-tech manufacturing (log.)		0.327 (0.062)***
Low-tech manufacturing (log.)		0.366 (0.151)**
Year dummies	Yes	Yes
Years	1999–2012	1999–2012
Observations (prefectures)	658 (47)	658 (47)
R^2 (adj.)	0.939	0.939

Notes: Pooled OLS regression (prefecture-year level). Standard errors are clustered at prefecture level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. Additional analysis: OLS regression analysis to explore the determinants of the regional number of product, service, or mixed trademark applications (per prefecture, per year) as the dependent variable.

Model	**(1a)**	**(1b)**	**(2a)**	**(2b)**	**(3a)**	**(3b)**
Dependent variable	**Product trademarks (log.)**	**Product trademarks (log.)**	**Service trademarks (log.)**	**Service trademarks (log.)**	**Mixed trademarks (log.)**	**Mixed trademarks (log.)**
Variables	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**
IP measure (control)						
Patent applications (log.)	0.462 (0.063)***	0.342 (0.073)***	0.260 (0.053)***	0.208 (0.052)***	0.308 (0.078)***	0.269 (0.091)***
Regio-economic characteristics						
Population density (log.)	0.140 (0.082)*		0.087 (0.045)*		0.172 (0.077)**	
Income per capita (log.)	0.931 (0.442)**		1.415 (0.390)***		1.663 (0.472)***	
Employees (log.)	-0.606 (0.451)		0.058 (0.321)		-0.286 (0.491)	
Headquarters (log.)	0.317 (0.306)		-0.021 (0.272)		0.189 (0.309)	
Entrepreneurship rate (log.)	0.609 (0.251)**		0.646 (0.230)***		0.565 (0.345)	
Universities (log.)	0.172 (0.130)		0.209 (0.078)***		0.286 (0.132)**	
Scientists (log.)	-0.149 (0.086)*		-0.037 (0.051)		-0.017 (0.070)	
Import ratio	2.880 (2.021)		-0.548 (1.178)		-0.877 (1.884)	
Export ratio	-7.074 (2.662)**		-6.774 (2.314)***		-8.690 (2.610)***	
Industry composition						
Agriculture (log.)		-0.075 (0.115)		-0.078 (0.070)		-0.191 (0.142)
Mining (log.)		0.070 (0.059)		0.018 (0.026)		0.012 (0.045)
Construction (log.)		0.004 (0.186)		0.032 (0.134)		-0.119 (0.226)
Electricity (log.)		0.157 (0.104)		0.017 (0.092)		0.010 (0.108)
Wholesale (log.)		-0.242 (0.174)		-0.168 (0.133)		-0.319 (0.201)
Finance (log.)		0.666 (0.248)**		0.328 (0.165)*		0.313 (0.251)
Real estate (log.)		0.358 (0.311)		0.419 (0.162)**		0.273 (0.272)
Transportation (log.)		-0.042 (0.316)		-0.136 (0.204)		0.065 (0.388)
Private services (log.)		0.845 (0.426)*		1.103 (0.249)***		1.439 (0.398)***
Government services (log.)		-1.073 (0.473)**		-0.534 (0.296)*		-0.627 (0.509)
High-tech manufacturing (log.)		-0.187 (0.048)***		-0.139 (0.041)***		-0.189 (0.055)***
Low-tech manufacturing (log.)		-0.115 (0.124)		0.010 (0.102)		0.074 (0.158)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Years	1999–2012	1999–2012	1999–2012	1999–2012	1999–2012	1999–2012
Observations (prefectures)	658 (47)	658 (47)	658 (47)	658 (47)	658 (47)	658 (47)
R^2 (adj.)	0.918	0.939	0.880	0.927	0.945	0.887

Notes: Pooled OLS regression (prefecture-year level). Standard errors are clustered at prefecture level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6. Robustness check: OLS regression analysis using the number of trademark registrations based on the year of registration (log., per prefecture, per year) as the dependent variable.

Model	**(1a)**	**(1b)**	**(2a)**	**(2b)**
Variables	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**	**Coef. (SE)**
IP measure (control)				
Patent applications (log.)	0.411 (0.058)***	0.313 (0.064)***	-	-
Granted patents (log.)	-	-	0.388 (0.047)***	0.301 (0.058)***
Regio-economic characteristics				
Population density (log.)	0.136 (0.074)*		0.151 (0.068)**	
Income per capita (log.)	1.133 (0.396)***		1.030 (0.391)**	
Employees (log.)	-0.367 (0.437)		-0.337 (0.395)	
Headquarters (log.)	0.205 (0.303)		0.212 (0.269)	
Entrepreneurship rate (log.)	0.573 (0.247)**		0.577 (0.229)**	
Universities (log.)	0.173 (0.116)		0.165 (0.110)	
Scientists (log.)	-0.111 (0.076)		-0.120 (0.072)	
Import ratio	2.011 (1.791)		1.904 (1.778)	
Export ratio	-8.132 (2.388)***		-7.847 (2.387)***	
Industry composition				
Agriculture (log.)		-0.067 (0.103)		-0.082 (0.102)
Mining (log.)		0.059 (0.045)		0.055 (0.044)
Construction (log.)		-0.022 (0.163)		0.016 (0.156)
Electricity (log.)		0.147 (0.086)*		0.128 (0.081)
Wholesale (log.)		-0.249 (0.147)*		-0.264 (0.144)*
Finance (log.)		0.578 (0.199)***		0.575 (0.212)***
Real estate (log.)		0.403 (0.251)		0.378 (0.243)
Transportation (log.)		-0.094 (0.285)		-0.094 (0.285)
Private services (log.)		0.979 (0.369)**		0.975 (0.348)***
Government services (log.)		-0.972 (0.408)**		-0.908 (0.390)**
High-tech manufacturing (log.)		-0.187 (0.040)***		-0.196 (0.038)***
Low-tech manufacturing (log.)		-0.074 (0.108)		-0.066 (0.106)
Year dummies	Yes	Yes	Yes	Yes
Years	2000–2012	2000–2012	1999–2012	1999–2012
Observations (prefectures)	611 (47)	611 (47)	658 (47)	658 (47)
R^2 (adj.)	0.941	0.951	0.939	0.950

Notes: Pooled OLS regression (prefecture-year level). Standard errors are clustered at prefecture level. *** p < 0.01, ** p < 0.05, * p < 0.1.

Figure 1. Japanese prefectures ranked by the total number of trademark applications between 1999 and 2012.

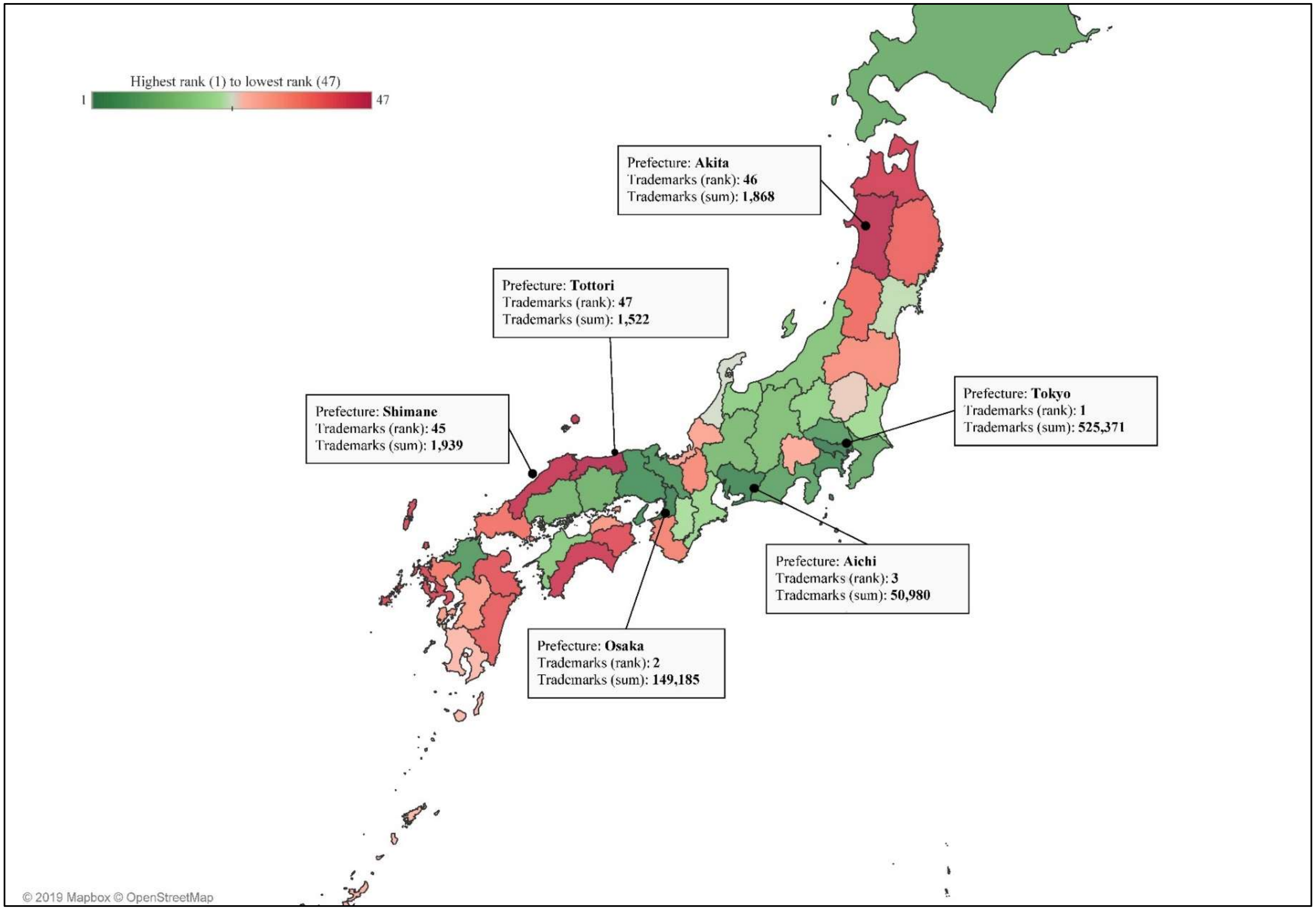
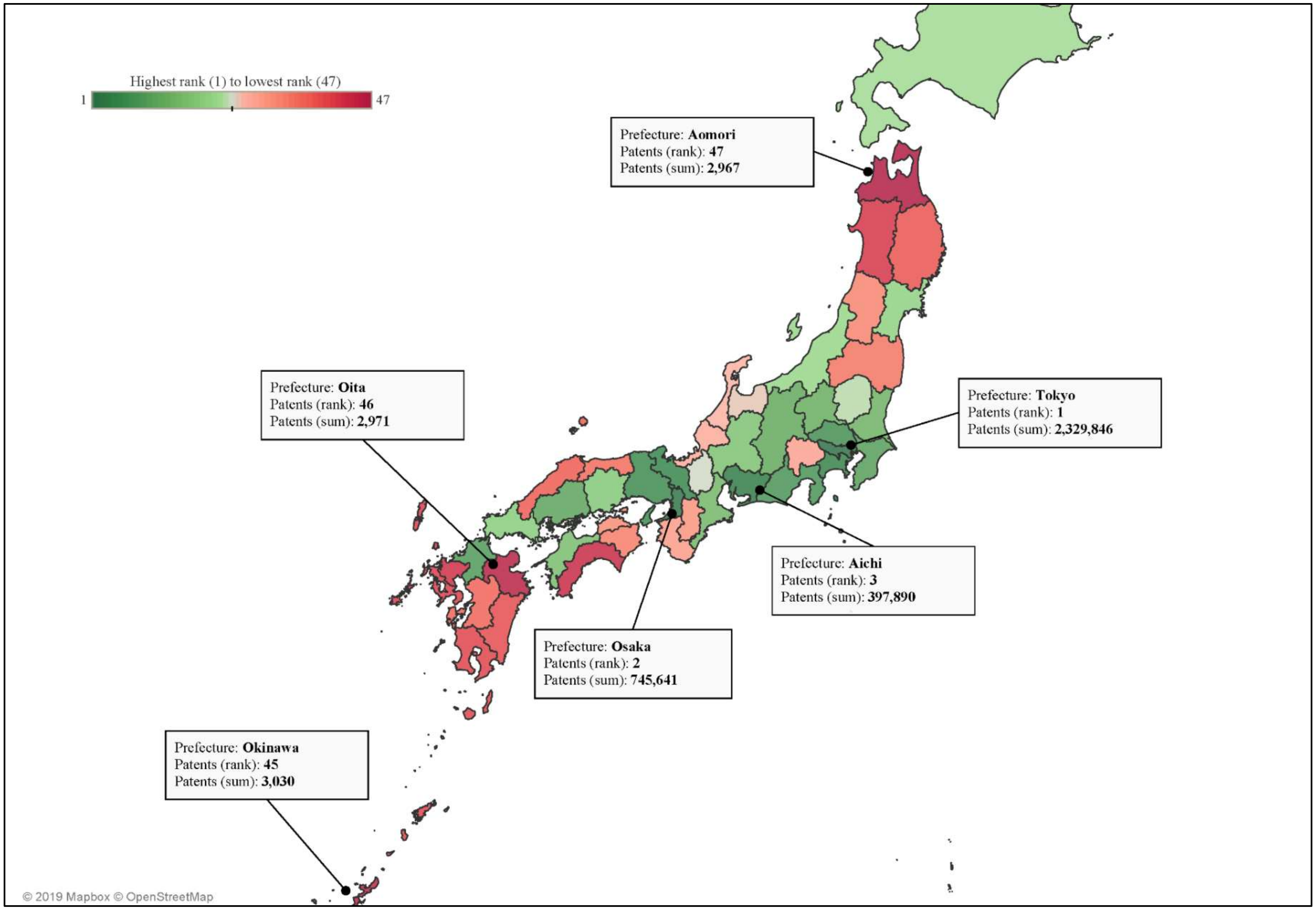


Figure 2. Japanese prefectures ranked by the total number of patent applications between 1999 and 2012.



Appendix

Table A1. Descriptive statistics and correlations.

#	Variable	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.	Trademark registrations (log.)	6.24	1.18										
2.	Patent applications (log.)	7.14	1.53	0.91*									
3.	Population density (log.)	5.81	0.98	0.81*	0.80*								
4.	Income per capita (log.)	7.90	0.14	0.69*	0.79*	0.61*							
5.	Employees (log.)	13.79	0.75	0.89*	0.86*	0.74*	0.63*						
6.	Headquarters (log.)	8.19	0.78	0.91*	0.85*	0.71*	0.61*	0.97*					
7.	Entrepreneurship rate (log.)	8.22	0.92	0.74*	0.74*	0.64*	0.50*	0.84*	0.76*				
8.	Universities (log.)	2.27	0.91	0.87*	0.80*	0.69*	0.57*	0.91*	0.90*	0.76*			
9.	Scientists (log.)	7.24	1.19	0.79*	0.85*	0.77*	0.72*	0.86*	0.79*	0.73*	0.77*		
10.	Import ratio	0.06	0.02	-0.25*	-0.30*	-0.37*	-0.10*	-0.25*	-0.23*	-0.32*	-0.22*	-0.27*	
11.	Export ratio	0.06	0.02	0.16*	0.24*	0.10	0.44*	0.13*	0.11*	-0.01	0.11*	0.22*	0.41*

#	Variable	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1.	Trademarks registrations (log.)	6.24	1.18													
2.	Patents applications (log.)	7.14	1.53	0.91*												
3.	Agriculture (log.)	11.79	0.63	-0.11*	-0.14*											
4.	Mining (log.)	8.73	1.02	0.22*	0.20*	0.51*										
5.	Construction (log.)	13.10	0.75	0.84*	0.83*	0.26*	0.47*									
6.	Electricity (log.)	12.26	0.77	0.80*	0.78*	0.13*	0.33*	0.85*								
7.	Wholesale (log.)	13.43	0.99	0.90*	0.86*	0.15*	0.39*	0.95*	0.83*							
8.	Finance (log.)	12.62	0.91	0.94*	0.91*	0.07	0.37*	0.93*	0.85*	0.97*						
9.	Real estate (log.)	11.50	0.92	0.91*	0.86*	0.12*	0.27*	0.92*	0.82*	0.96*	0.95*					
10.	Transportation (log.)	13.06	0.89	0.90*	0.84*	0.21*	0.35*	0.94*	0.86*	0.97*	0.95*	0.97*				
11.	Private services (log.)	14.28	0.84	0.92*	0.85*	0.15*	0.32*	0.93*	0.85*	0.97*	0.96*	0.98*	0.98*			
12.	Government services (log.)	13.62	0.64	0.86*	0.79*	0.27*	0.38*	0.94*	0.84*	0.95*	0.93*	0.95*	0.97*	0.98*		
13.	High-tech manufacturing (log.)	13.75	1.19	0.62*	0.68*	0.07	0.09	0.57*	0.61*	0.59*	0.64*	0.68*	0.64*	0.66*	0.59*	
14.	Low-tech manufacturing (log.)	13.49	0.91	0.83*	0.87*	0.16*	0.36*	0.87*	0.82*	0.88*	0.89*	0.89*	0.89*	0.86*	0.82*	0.72*

Notes: N = 658 observations (prefecture-year level) from 47 prefectures over 14 years (1999–2012). * $p < 0.01$.