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# Assessing the impact of patenting activity on business model innovation: the case of the bike industry

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## Abstract

The study examines the impact of patenting activity on business model innovation (BMI) from an international perspective. By considering the specific case of the bike industry under a patent-based analysis, the work preliminary contributes to the literature on BMs and their incremental innovation in the R&D management field.

## Keywords

Business model innovation, patent-based innovation, R&D management, incremental innovation, bike industry

## Main text

### 1. Introduction

In the past twenty years, business models innovation (BMI) has been a prominent topic in business sciences (Zott et al., 2011; Velu and Jacob, 2016; Wirtz and Daiser, 2018). Within this field, R&D investments and strategies have often emerged as crucial issues, including the roles of Open Innovation and the management of IP. In particular, a long tradition exists in investigating the impact of patents on firms' innovation (Verhoeven et al., 2016; Gans et al., 2017), with specific emphasis on those that operate in an international perspective (Picci, 2010; Alkemade et al., 2015; Fabrizio et al., 2017). Consequently, abundant research regards the definition of the boundaries of what can be defined as a patent-based advantage that is firm-specific, relatively non-tradable, and

capable to reshape a firm's business model generating value over time (Chih-Yi and Bou-Wen, 2021; Harrigan et al., 2017, Markman et al., 2004; Wei et al., 2018).

With regard to what determines an impact on BMI, scholars have analysed several determinants, such as strategic alliances (Chesbrough and Schwartz, 2007; Ritala and Sainio, 2014; Velu, 2015), organizational structures, and culture (Bocken and Geradts, 2020; Hock et al. (2016); Latilla et al., 2021), resources (Bicen and Johnson, 2015; Halme and Korpela, 2014; Mezger, 2014), sustainability (Evans et al., 2017; Hall and Wagner, 2012; Linder and Williander, 2017), and digitalization (Rachinger et al., 2018; Soluk et al., 2021; Tesch and Brillinger, 2017). However, relatively low attention has been paid to the role that patents and IP protection may play in BMI (Slowak and Regenfelder, 2017; Yun et al., 2016; Feng et al., 2021; Holgersson and Granstrand, 2021).

The aim of this work is therefore to provide a contribution to this field. More precisely, as suggested by Wirtz and Daiser (2018), in order to directly address this issue through an exploratory approach and an industry-based case study, we decided to consider the role of patenting activities in BMI for a single industry: i.e., the bike industry. We decided to choose this particular industry because of a number of distinctive characteristics.

First, the bike industry is an extremely consolidated industry, in the sense that it cannot be considered new, but is characterised by intense activity in terms of trademark, design, and patenting (EUIPO, 2019). As a matter of fact, it has been always distinguished by a vivid patenting activity and a strong patent-based international competition from its inception (WIPO, 2021). Second, in recent times, the topic of innovation in the bike industry and BMI have received increasing interest in the academic world, despite being still relatively unexplored (Gao and Li, 2020; Zhao et al., 2020; Turon and Kubik, 2021; Han et al., 2022). Third, the industry has always been characterized by an assiduous innovation purpose, facing new technological trajectories according to the shifting of the technology paradigm under a disruptive and incremental perspective (Ruan et al., 2014; Yun et al., 2021).

Within this framework, our work will try to answer the following research question: *what is the impact of patenting activities on business model innovation in the bike industry, at the international level?*

## 2. Methodology

According to the framework proposed by Yu et al. (2016) for patent-based industry analysis, we decided to use patent data to discuss BMI and deal with the research question. In particular, we built a dataset, related to the 2002-2020 period, from the Orbit Intelligence database, which combines different data sources. Obtained data belong to IPC classes and sub-classes referring to the bicycle industry, namely B62-H, B62-J, B62-K, B62-L, B62-M, using the keywords "bike\*" and "bicycle\*" to refine the results. The search algorithm has been defined as follows:

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((bike*) or (bicycle*))//TI/AB/CLMS/DESC/ODES/OBJ/ADB/ICLM AND (B62H or B62J or B62K or B62L or B62M)/IPC AND (PDA >= 2001)
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We obtained more than 56.000 patents granted in more than 60 countries. We built a data-based count of patent applications for every country we considered, considering for each sub-classes the following variable: number of patent grants, patent applicant name, patent applicant origin country.

According to Katila (2000), there is no one commonly accepted way to measure innovation through patents. However, together with a preliminary analysis on the patenting activities by year, both aggregated and by subclasses, and the analysis of the patent families by players, we considered the citation of patent counts in order to get a measure of the qualitative differences in innovation within the bike industry on an international basis (Albert et al., 1991). Within this framework, if patents belonging to a certain class are cited by other subsequent patents, it means that the innovative purpose of that patent has an impact on subsequent developmental efforts (Trajtenberg, 1990).

### 3. Results

Starting from a preliminary analysis of the descriptive statistics, we can observe how in the bike industry the number of patents granted in the period 2002-2020 has grown. We moved from an annual average of 1.500 patents granted in the first years of the century to a peak of more than 5.100 patents granted in 2017. Only in recent times the bike industry experienced a contraction. This is a trend which is not in line with the general course of the whole patenting activity on a global basis. In fact, after a contraction in 2019, all over the world, IP protection efforts increased in 2020, pushed by the great Asian economies (WIPO, 2021).

As we can see in Figure 1, the most active countries in terms of patenting activities in the bike industry are China, with more than 11.600 patents granted between 2001 and 2020, followed by the US (6.150), Germany (5.602), Japan (4.659), and Taiwan (4.525). While in the case of the US and Germany, the number of patents has remained stable over the years, there was a relevant growth in China, with a peak of 3.591 patents granted in 2017. This first analysis helps us to define the dimensions and trends of the international competition in a globalized market.

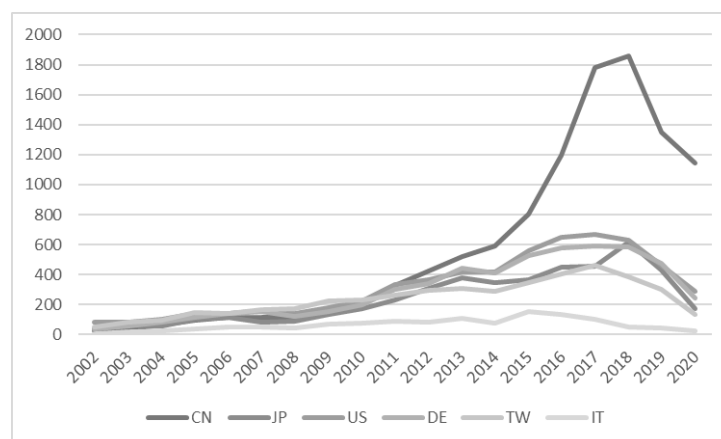


FIGURE 1: BIKE INDUSTRY (2002-2020) – INTERNATIONAL TREND, PATENTS GRANTED BY COUNTRY.

According to the classification proposed in WIPO (2021), we also analysed the IPC subclasses with a stronger propensity to patenting activity. As we can observe in Figure 2, it emerged that the subclasses with the higher level of patents granted is B62K, which is related to cycles, frames, and similar, with more than 28% of the inventions protected on the total amount considered. Within this IPC sub-class, we found a particular innovating propensity for foldable bikes, frames, and steering devices. Another dynamic sub-class is the one of cycle saddles or seats and related accessories (B62J). Relevant levels of innovation may be found for saddles and their single components (frames, seat posts, hulls), with particular interest for their synergic interactions.

Furthermore, we observed particular relevance for lighting devices as much as complementary accessories for the support of smartphones, maps, water bottles, etc.

In terms of patenting activities, similar outputs may be found in sub-class B62M, where we find electric and pedal-assisted bikes, as much as their batteries, actuators, and transmission systems specially adapted for such cycles. It is interesting to observe how these different trends have changed over time according to the need of the market and the expansion of sub-sectors. It clearly emerges that a key aspect in patenting activities for the bike industry is the diversification and the complementarity around the standard bike frames.

In conclusion, we can consider also sub-class B62H for the 10% of the patents granted and B62L for 5%. The first sub-field includes all those inventions related to the supporting devices as much as the appliance to prevent the theft of bikes. On the other hand, the second sub-field encompasses brakes and braking mechanisms or systems.

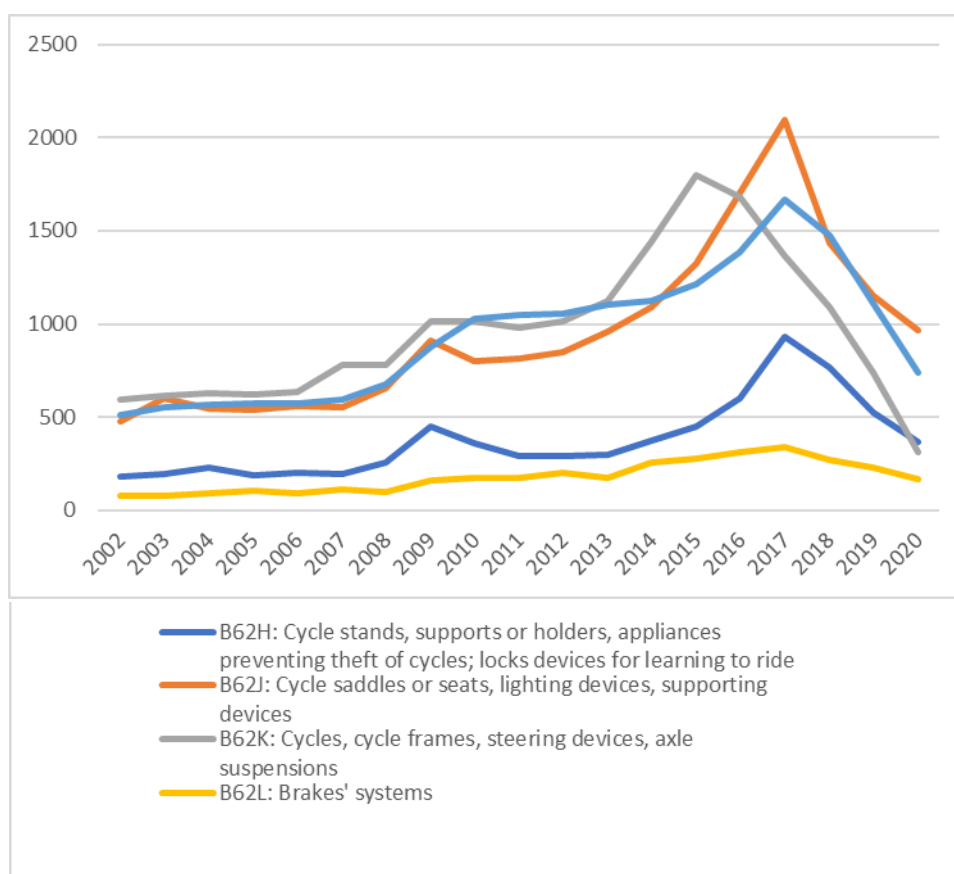


Figure 1: Bike industry (2002-2020) – Patents granted by IPC B62 Sub-classes

Considering the more active firms in terms of patenting activities on a global basis, we can see that the 10 top players own 13% of the overall patents granted in the industry. According to data provided in Figure 3, the most active firm is Shimano, with 2.261 patents granted in the bike industry in the past 20 years, and with a portfolio of more than 7.000 patents. Shimano is followed by Honda Motor (with 1.287 patents granted), Yamaha Motor (574), and Bosch (493). These elements assume particular relevance for our research because within the bike industry we see not only well-known names but also great multinationals that operate in the sector of components and vehicle productions. By looking at their IP portfolio, we can observe that those patents are mainly

linked to the e-bike’s sub-sector. In fact, they consider not only traditional fields of application but also batteries, electric motors, and advanced sensors.

Within this framework, the main competitors of Shimano are SRAM (US) with 377 patents granted, and Campagnolo (IT) with 290. The two companies are both producers of bicycles’ components that in order to deal with the market need for innovation narrowed the typology of patents granted over the year, specializing themselves in specific sub-sectors of the bike industry. SRAM has readapted its R&D efforts to produce mountain bike components, while Campagnolo specialized in racing bike components. This is a common trend that we observed in several companies all over the world. The international competition in the sector has led the companies to readapt their business models through innovation, specializing themselves in a particular sub-sector of the bike industry.

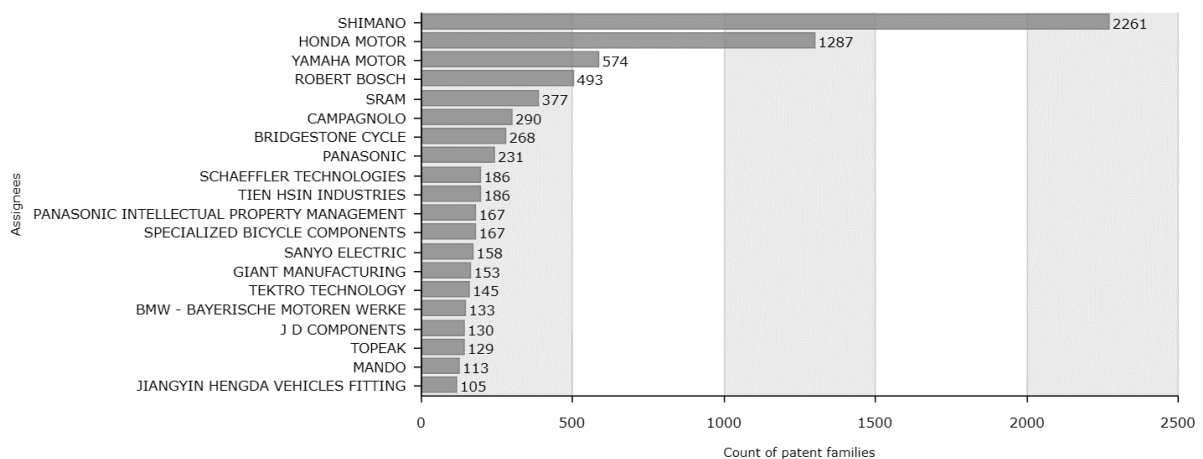


FIGURE 3: BIKE INDUSTRY (2002-2020) – PATENTS GRANTED BY COUNTRY ON THE GLOBAL MARKET

Starting from this preliminary analysis, we will move to focus on a patent citation analysis in order to better deal with the research question. To understand how firms innovate their BMs with patents, we preliminary set up a citation-weighted patent count to distinguish between the different players in the bike industry. As we can see in Figure 4, a strong network emerges among the firms with a high patenting propensity that we discussed in the previous paragraphs and smaller firms that actively cites their inventions in subsequent patents.

On a preliminary focus, there are three may aspects that can be underlined from Figure 4. First, these citations revealed that patenting activities play a key role in the development of subsequent innovations in the bike industry (Han et al., 2020). Second, the patenting activities are not determined only by self-citations but also by cross-citations. In particular, it emerged a high self-citation focus when it comes to considering big industrial players (e.g., Shimano, SRAM, Campagnolo), while it emerges a higher cross-citation focus when we consider smaller firms (Karvonen and Kässi, 2011). Third, according to Wu et al. (2006), we can assume that a similar codified knowledge flow of patent citation goes hand-in-hand with more tacit aspects of knowledge flows, related to a more diffuse interconnection and path-dependency among the assets and the knowledge of the firms.

Players dependency by citations

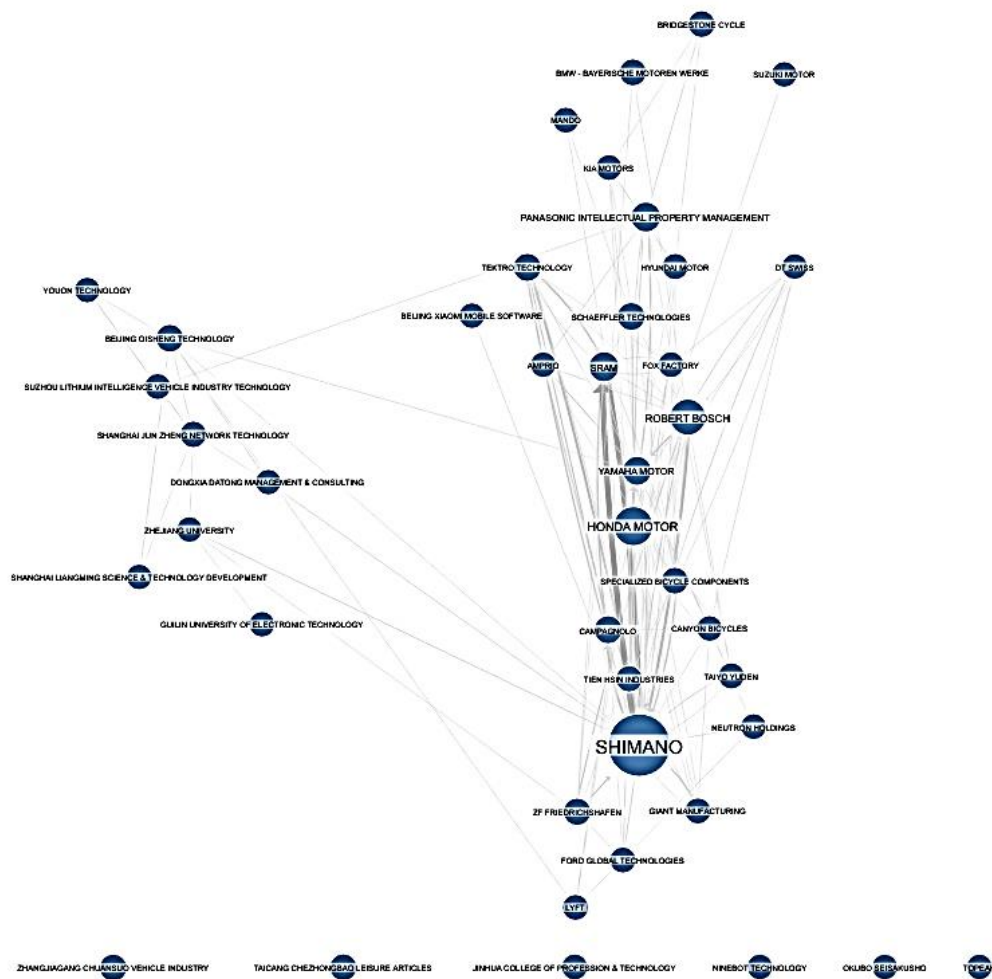


FIGURE 4: BIKE INDUSTRY (2002-2020) – PATENTS’ DEPENDENCY BY CITATIONS.

If we consider the bike industry and the patents’ dependency among its different players, we can observe what Mitchell (1989) and Katila (2000) defined as a patent-based incremental improvement in which the market leadership is determined by continuous technological innovation and a transition to traditional business models to implemented ones. This perspective directly link the changes in the bike industry to the theory of incremental innovation developed by Ettlie et al. (1984) and to the way in which it shapes the business model theory (Souto, 2015; Tang et al., 2016; Han et al., 2020, Benzidia et al., 2021).

Even if the research process is not concluded yet, there are still some preliminary conclusions that may be underlined.

**4. Preliminary conclusions**

The preliminary stages of the patent-based analysis on the bike industry led to a few insights to preliminarily address the research question. First of all, with regard to patented inventions, it seems that firms readapted their business model in order to address market trends and to cope with the international competition (Bashir and Verma, 2016; Velu and Jacob, 2016; Wirtz and Daiser, 2018).



In this process, a key role seems to be played by innovation, measured by the patenting activities, the patenting trends, and the patent's cross dependency by citations (Albert et al., 1991; Yu et al., (2016); Trajtenberg, 1990). Within this framework, we observed that patents, and therefore innovation, have an impact on the BM of the firms in the bike industry. In fact, they are able to incrementally transform an industry over time on an international basis, leading firms to change their BM, to deal with new sectors through R&D management, and to incrementally innovate and specialize themselves in specific sub-fields with distinctive patents always more cross-dependent in an international framework. This preliminary investigation will be enriched with further insights from patent citation's analysis in terms of the relationship between the different innovating drives of the firms. An avenue for future research may be related to integrating the analysis with multiple case studies from the bike sector to empirically investigate the impact on BMI.

The work also aims to contribute to the literature on BMI in an international context and R&D Management by combining these two different approaches under the lens of investigation of patents to assess the level of competitive advantage in the firms in the bike industry (Wirtz and Daiser, 2018; Slovak and Regenfelder, 2017; Holgersson and Granstrand, 2021). By integrating these two different frameworks, our research is relevant not only to the academic debate on these topics. In fact, our findings are relevant to business owners and managers with regard to the firm's innovation strategy in the bike industry. A deeper understanding of the relationship between BMI and the patents' role may contribute to a more effective approach in the R&D management activities of the firms. In addition, also in terms of public policies, important implications emerge. Since patenting activities have an impact on BMI and R&D activities, this work can lead policy makers to implement specific actions in order to stimulate this innovative process.

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