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Abstract
The catch-up process of emerging market economies is dependent on multiple factors, such as local governmental regulations but also global industry developments. We investigate how intellectual property (IP) protection standards affect this catch-up process. The alignment of these standards with the country’s level of innovation capabilities set the framework for the study. We use patent data from the United States Patent Office and compare the catch-up process of Brazil, India and Turkey based on the countries implementation of TRIPS regulations. We find that countries with a gradual implementation of IP protection standards gain a higher level of innovation capabilities compared to countries that immediately ratify the standards. These countries require more time to catch-up to global standards as a misalignment of IP protection and innovation capabilities is evident. Jelcodes:O34,Z0

ABSTRACT

The catch-up process of emerging market economies is dependent on multiple factors, such as local governmental regulations but also global industry developments. We investigate how intellectual property (IP) protection standards affect this catch-up process. The alignment of these standards with the country’s level of innovation capabilities set the framework for the study. We use patent data from the United States Patent Office and compare the catch-up process of Brazil, India and Turkey based on the countries implementation of TRIPS regulations. We find that countries with a gradual implementation of IP protection standards gain a higher level of innovation capabilities compared to countries that immediately ratify the standards. These countries require more time to catch-up to global standards as a misalignment of IP protection and innovation capabilities is evident.

Key words: Emerging market catch-up, Intellectual property protection, innovation capabilities
INTRODUCTION

For emerging market economies, it is crucial to upgrade their national innovation system to create higher value-added activities that enhance comparative competitive advantages (Mudambi, 2008; Porter, 1990). An upgraded innovation system can support the local innovation ecosystem to transform low value-added to high value-added capabilities that enables it to catch-up to and compete with innovation systems of advanced market economies (Abramovitz, 1986; Bell & Pavitt, 1993; Lorenzen & Mudambi, 2010). Earlier studies suggest that this catch-up is determined by the initial gap between the innovation systems of developed and emerging market economies (Abramovitz, 1986) and reflects a process which starts with imitation approaches and continues with knowledge generating practices (Autio, Sapienza, & Almeida, 2000; Kale & Little, 2008; Awate, Larsen & Mudambi, 2012).

In order to support an optimal upgrade of a national innovation system, governments can effectuate policies and regulations that increase the possibilities for domestic firms to develop innovation capabilities (Kale, 2010; Kumaraswamy, Mudambi, Saranga & Tripati, 2012; Quian, 2007). One possible governmental regulation is as an effective implementation of Intellectual Property (IP) protection laws which offers the possibility for (domestic and foreign) firms to innovate and develop innovation capabilities without the danger of fraud (Coriat & Orsenigo, 2011; Mansfield, 2000). This protection is especially important in an emerging market context with an economy that is highly dependent on innovation improvements of domestic firms and foreign activities, which would allow some degree of knowledge spillovers for domestic firms.

However, literature has also suggested that a higher IP protection standard can be detrimental to the national innovation system of emerging market economies, as it may result in a strong position of foreign firms in the domestic market and prevent domestic firms from acquiring
and improving their innovation capabilities. There is still a lack of consensus on the effect of IP standards on the catch-up performance of emerging market economies (Kale & Weild, 2008; Qian, 2007).

In order to contribute to this discussion of the impact of IP standards on the emerging market catch-up process, we study the evolution of national innovation capabilities along with the development of regulatory changes in emerging market economies (Kumaraswamy et al., 2012; Qian, 2007). Our focus is on the pharmaceutical industry, as it is at the heart of governmental regulations and closely connected to the country’s healthcare system, especially in an emerging market context. Moreover, the pharmaceutical industry of emerging market economies experienced many different phases of IP protection levels often starting with a lack and non-existing IP protection moving to a more efficient IP protection over time. This focus enables us to track different levels of innovation capabilities of emerging market economies in different periods of time.

In order to study different IP regulations in emerging countries, we investigate the process of emerging market economies becoming a signatory to the Trade Related Aspects of Intellectual Property Rights (TRIPS) (effective since 1995), enforced by the World Trade Organization (WTO). This agreement allows us to assess the impact of changes on IP regulations. Our specific interest is on a provision of the agreement that granted emerging market economies a special transition period. Due to their laggard position in terms of IP protection when ratifying TRIPS, emerging market economies were given a 10-year transition period to comply with regulations that ended on January 1, 2005. Interestingly, this transition period was handled in different ways by emerging market economies. For example India incrementally changed domestic IP standards and capitalized on the full transition period. In contrast Brazil and Turkey implemented the required IP regulations immediately without any transition period.
This difference provides us with a natural experiment to assess the impact of changing IP regulations on innovation capabilities of emerging market economies (Qian, 2007).

We contemplate that there needs to be an alignment/fit between local innovation capabilities and the IP regime in emerging market economies as it will allow them to upgrade their innovation capabilities optimally in order to catch-up to standards of mature market economies. To explain how emerging market economies can achieve this fit, we develop a cross-country framework that compares the level of domestic innovation capabilities and the progression of IP protection level. A network analysis and analysis of the national pharmaceutical industry allows us to use the framework as assessment for the catch-up process of Brazil, India and Turkey. In order to assess the emerging market catch-up process, we track the progression of national innovation capabilities of the pharmaceutical industry on the ability of knowledge sourcing and connectedness (Awate et al, 2012; Bierly & Chakrabarti, 1996; Kumaraswamy et al, 2012). The identification of the location and quantity of sourced knowledge, allows us to study how the domestic market transfers its innovation capabilities into outputs. The connectedness of the country shows the importance of the country in the global pharmaceutical market and the resulting expected innovation capabilities. The more connected the inventors of the country are, the higher the expected innovation capability through knowledge spillovers and learning from partners. We collected data from the United States Patent and Trademark Office (USPTO). In order to study different levels of IP protection, we track regulatory changes in each emerging market through secondary sources and primary sources.

The paper is organized as follows: After discussing theories around innovation capabilities with special focus on the pharmaceutical industry and IP regulations (especially in relation to TRIPS), we develop a framework for this paper. The framework will help us to design
hypotheses around the effect of IP regulations on innovation capabilities and the catch-up process of emerging market economies. Following this discussion we explain the applied methods of the research and outline the data. We finish the paper with a discussion and conclusion section.

THEORETICAL FRAMEWORK

Innovation Capabilities of Emerging Market Economies

The literature suggests that between discovery and application, there is a world of innovation, which shows the difference between invention or pre-knowledge and the ability to create value from it (Rosenberg, 1982; Teece, 1996). Innovations are new creations of economic significance, which include radically new creations as well as new combinations of existing elements (Asheim & Coenen, 2005).

A country’s innovation system is a set of relationships between entities or nodal points involved in such creation and combinations including firms, universities, government agencies (Freeman, 1987; Lundvall, 1992; Nelson, 1993). While some countries develop national systems of innovation (NSI), which they support through governmental policies, in others there is more a disorganized approach to generating innovations at the country level (Guennif & Ramani, 2012). However, to come up with innovations necessitates certain recombination capacities, through which actors within the national innovation system search and source knowledge bases. Therefore, whether countries choose to interfere with the innovation process deliberately or not, they have to make sure they provide necessary conditions to enable necessary knowledge flows from and within to the country’s innovation network. In this paper, we are interested in the process emerging countries develop such innovation capabilities at the national level.

IP Regulations at the National Level
Innovations require searching for and utilizing mostly tacit knowledge but this process is often prone to the problems asymmetric information causes. What is often called as the Arrow Paradox, constrains owners of innovations to disclose the tacit knowledge they possess without a minimum level of appropriability (Arrow, 1962; Teece, 1996). This is especially true for industries such as the pharmaceutical industry, as it is heavily dependent on patents and changes in patent legislation are key determinants of innovation activity (Di Masi, Hansen, & Grabowski, 2003; Morgan & Fai, 2007; Sattler, 2003).

Inventors seek intellectual property protection when the expected value of the patent exceeds the cost of the patent application and the cost of revealing the invention (Griliches, 1990) and patents introduce to firms an incentive to continue searching for innovations as, they offer a number of exclusivities to the patent holding firms (Jaffe et al. 1993). Laws governing the patent exclusivities through IP protection and effective implementation of those laws are very influential in type and location of innovative activities firms undertake, in addition to firms' capability endowments and cost calculations (Cantwell & Mudambi, 2005; Ceccagnoli & Rothaermel; 2008; Coriat & Orsenigo, 2011).

There are two types of patent protection in the pharmaceutical industry; a process patent allows obtaining a product through different methods, while product patents restrict all other processes and methods from producing the same pharmaceutical product (Li, 2008). A product patent ensures protection of the molecule itself and bans production and marketing of the same drug. Process patents only protect the process with which the molecule is developed, often allowing the production of cost-effective generics.

IP protection standards, for process and product patents, were established and applied in mature market economies for many years. However, emerging market economies experienced many different phases of IP protection levels over time (Waguespack et al, 2005). Most of the
emerging market economies did not have patent protection at all in the initial years of development of their domestic pharmaceutical industries, which enables the drug development process to be imitated and the drug to be marketed with a domestic brand without compensing the original owner of the innovation.

In the following years some of the emerging market economies started to provide only recognizing process patents, but still allowing the product to be imitated (Lanjouw & Cockburn, 2000). Only after the countries became signatories to the TRIPS agreement in 1995 and enforced rules and regulations for product patent protection were higher IP standards achieved (Li, 2008). This agreement made it compulsory for governments of these countries to accept regulations to bring IP protections to a consistent higher standard. TRIPS granted owners of innovations, whether foreign or domestic, special exclusive rights, which lead to an increasing importance of the generation of patents of any kind (Coriat et al. 2006; Kale, 2010).

**Framework: Level of IP Protection vs. Level of Innovation Capabilities**

Emerging countries compete to attract R&D investments to benefit from potential learning and spillover opportunities and they simultaneously seek an appropriate level of IP protection to implement (Luo, Sun, & Wang, 2011). However, determining a level of IP protection is not an easy decision for the emerging countries. While it has been widely accepted for developed economies that, better appropriability regime through higher IP protection leads to more innovation, there seems to be a lack of consensus on the effect of higher IP standards on the catch-up performance of emerging country innovation systems. (Kale & Wield, 2008: Qian, 2007). To understand the true effect of higher or lower standards, we need to simultaneously assess the relationship between country-specific factors and the IP regime in each country (Kyle & McGahan, 2012; Qian, 2007). This requires us to track the evolution of IP protection regime in the emerging countries along with developments in the domestic innovative
After having discussed innovation capabilities and IP protection we are now able to incorporate these two concepts in a framework to investigate the impact of regulatory changes on a country's innovation capabilities and the catch-up of emerging market economies. Our framework (see Figure 1) combines the level of domestic innovative capabilities of a country (see y-axis) and its level of IP protection standards (see x-axis), following prior studies (Dhalman & Ross-Larson, & Westphal, 1987; Kumaraswamy et al, 2012; Kyle & McGahan, 2012; Qian, 2007).

**X-Axis: Level of IP Protection**

Prior literature has emphasized the notion that recognizing patent production laws and effectively implementing these laws are not the same (Keupp, Beckenbauer, & Gassman, 2010). This separation is visible under the special provision of the TRIPS which allowed emerging market economies a 10-year transition period before fully complying with the IP protection standards. The aim of the transition period was to allow emerging market economies to gradually transition to a more rigorous IP regime (Kale, 2010; Li, 2008). Furthermore, Li (2008) suggests that the 10-year flexibility within the TRIPS Agreement, provided the opportunity for governments of emerging countries to design socially optimal patent regimes by striking a balance between dynamic gains and static losses.

To ratify TRIPS immediately or capitalize on the 10-year transition period for many emerging market economies was not a completely internal decision (Coriat & Orsenigo, 2005). IP protection, especially in the pharmaceutical industry, is often influenced not only by domestic but also by foreign pressures, especially in an emerging market context. The healthcare sector
in emerging market economies is often closely connected to the countries pharmaceutical industry and thus, of vast importance to the government (Abrol, 2004; Chin & Grossman, 1990; Deardorff, 1992; Li, 2008). Additionally, global changes and foreign pressures by multinational firms that are very protective of their IP, are pressuring the domestic government (Arrow, 1962; Cantwell & Mudambi, 2005; Ceccagnoli & Rothaermel; 2008; Coriat & Orsenigo, 2011; Teece, 1986). Thus, to comply with domestic and global pressures resulted often in on-going struggles between the local government and foreign actors to determine the level of IP protection in emerging market economies (Kale, 2010).

While MNEs and governments from mature market economies lobbied towards a fast ratification of the TRIPS agreement, domestic drug companies were against the idea of a quick ratification. They feared that their innovative capabilities were not at the level to compete with firms from developed market economies which were expected to enter the country more willingly with a functioning IP protection regime. Consequently, some government from emerging market economies decided to ratify the TRIPS agreement in their national assembly’s quickly, while others chose to wait until 2005 to offer a more gradual transition into higher IP protection standards (Li, 2008; Qian, 2007). This variation among different countries in their decision to ratify TRIPS provides us the possibility to assess the effect of changing IP standards in different countries.

Hence, we investigate the change of IP standards in emerging countries under three different phases on the X-axis of the framework: the period before TRIPS regulations where ratified in the country (pre-1995), the period during the TRIPS regulations were implemented (1995-2005) and the period after all TRIPS regulations were implemented (post-2005). The second phase was only possible as some emerging market countries were allowed a 10-year transition period to implement the regulations, due to their initial non-existence and late comer position
regarding IP regulation. In our framework a high IP protection implies that IP regulations are fully efficient and prosecuted in case of violation a medium level of IP protection implies that some IP regulations exist but prosecution is not very efficient and a low level of IP protection reflects no or hardly any IP regulations with no stringent prosecution in case of violation (Qian, 2007).

**Y-Axis: Level of National Innovation Capabilities**

Prior literature classifies technological capabilities within a national innovation system as process or output and innovative or generative ones depending on the quantity and quality of the innovation that they are empowered to generate (Bell & Pavit, 1993). For domestic pharmaceutical industries, both of these capabilities are important. Output capabilities are needed to produce least costly “generic” drugs that are biologically equivalent to the original patented product. Especially in developing and less developed countries, many people cannot afford basic health costs, so that generic drugs offer a low cost but effective alternative to original patented drugs (Lanjouw & Cockburn, 2000). Generic drugs that are reformulations and combinations of patented drugs also constitute a very important portion of the market share for drugs in total (Morgan & Fai, 2007). On the other hand, innovation capabilities are needed to come up with new molecules, which might turn into “blockbuster” drugs. However, while numbers are few, ‘blockbuster’ drugs account for the large majority of leading pharmaceutical firms’ sales (Morgan & Fai, 2007). Hence, since there are market opportunities for each capability, emerging countries are required to possess some of each capability within their national innovation systems.

Process/output capabilities of a national innovative system is considered as possessing basic and intermediate technological capabilities that are acquired through imitative learning (Chaturvedi & Chataway, & Wield, 2007; Kale & Little, 2008). This kind of capacity does not
require the ability to enhance the product, but instead focus on ability to produce the most cost effective way (Awate et al., 2012; Luo et al., 2012). On the other hand, innovative / generative capabilities are more complex and higher level of capabilities which are beyond smaller adaptations and adjustments of the product and, rather, describe firms’ ability to develop the ‘next generation’ of the product (Awate et al. 2012).

Similarly, Global Value Chain (GVC) literature classifies activities involved with products and services as higher-value added activities and lower value added activities. Higher value activities are those which require more tacit knowledge while lower value activities are more basic and often based on imitative learning (Mudambi, 2008). Upgrading from lower value added activities to higher value added activities, or moving up the technology ladder is crucial for emerging countries to close the competitive advantage gap between them and the developed countries (Porter, 2000). First, because higher value added activities, have greater profit margins than lower level activities and provides countries competitive slack since there are fewer costs involved with switching location of a lower level activity (Mudambi, 2008).

In addition, an economy cannot rely on only exogenous, imitative learning but should also pay attention to new knowledge creation, thus in-house learning (Asheim & Coenen, 2005; Nonaka & Reinmoller, 1998). The aim of such an upgraded innovation system is to support domestic firms to escape from middle income trap and catch-up to their counterparts in advanced market economies (Abramovitz, 1986; Awate et al., 2012; Bell & Pavitt, 1993; Mathews, Hu, & Wu, 2011). This process is called upgrading the innovation system, or catch-up and analyzed by an increasing number of recent studies (see Awate et al, 2012; Mathews et al., 2011; Mudambi, 2008; Lorenzen & Mudambi, 2013).

Similar to the phenomenon that the IP standards in emerging countries were undergoing different phases, emerging countries experienced different phases while upgrading their
capabilities from output ones to innovative ones (Dhalman et al, 1987; Kale et al, 2010; Kumaraswamy et al, 2012). For example, Kumaraswamy et al. (2012) developed a three stage model to outline the catch-up process of emerging market economies, which we will use as base for our own analysis. The first stage, termed transition period, focused the development of process capabilities by domestic firms through imitating products and processes, (also called reverse engineering) in the pharmaceutical industry (Luo et al, 2011). The second phase, the consolidation phase, requires the liberalization of the domestic market so that local firms compete with MNEs which resulted in a need for domestic firms to develop their capabilities to cope with newer and better products of MNEs. The final phase if successful, is the global integration phase where domestic firms have begun engaging in knowledge creation through global R&D connections.

Based on these different phases, we assess innovation capabilities of countries on the Y-axis, by levels of knowledge sourcing (Bierly & Chakrabarti, 1996; Gereffi, 1999) and connectedness involved with the different phases that national innovative systems are undergoing (Giuliani et al., 2005; Sturgeon, Van Biesebroeck, & Gereffi, 2008). That is; a high level of innovative capabilities indicate a broader & deeper knowledge sourcing as well as a high level of connectedness to the global innovative networks at the national innovation system (Awate et al. 2012). At this level, the national innovation system is considered to possess innovative/generative capabilities as in the case of global integration phase in Kumaraswamy et al, (2012). A medium level of innovative capabilities is achieved with less broad and less deep knowledge sourcing (Awate et al. 2012) as well as some level of global connectivity, so that the national innovation system is considered to possess some level of innovative/generative capability along with process/imitative capabilities. This is similar to the consolidation phase in Kumaraswamy et al. (2012). Finally, the low level of innovative capabilities are composed of narrow and shallow knowledge sourcing accompanied with very
few or no international connections, and such a national innovation system is considered to possess mainly process/imitative capabilities which is similar to the transition phase of emerging country catch up in Kumaraswamy et al. (2012).

**Movement within the Framework: Emerging Market Economy Catch-up**

The upgrade of the innovation capabilities occur when countries move from a lower level of innovative capabilities to higher one in the framework (Figure 1). Studies show that the shift from an imitation based national innovation system to an innovation generative one requires actors within the national innovation system to have access to broader and deeper knowledge bases (Bierly & Chakrabarti, 1996; Henderson & Cockburn, 1996). Similarly, the ability to create value from knowledge necessitates a wide angle in knowledge inflow: width of mouth, as innovation in large part requires the integration of diverse knowledge sets (Arrow, 1974), but, at the same time, the innovation requires the ability to choose among different alternatives (sharpness of angle).

The first type of knowledge inflow is ensured through knowledge sourcing. It has been suggested that during catch-up process emerging countries balance in-house and external knowledge sourcing (Asheim & Coenen, 2005; Bell & Pavitt, 1993). In-house knowledge sourcing is important since, complex innovations such as pharmaceutical molecules requires spatial concentration (Jaffe et al, 1993), generation of a innovatively capable national system requires some minimum level of knowledge stock or absorptive capacity residing within the emerging countries (Cohen & Levinthal, 1993; Giuliani, Pietrobelli, & Rabellotti, 2005). External knowledge sourcing is important as well, as ability to source knowledge from other knowledge bases and clusters will provide the emerging country innovation actors a good understanding of the current and complementary technological domains (Baptista & Swan, 1998; Brusoni et al, 2001; Isaksson, 2005).
On the other hand, as different parties (scientists, entrepreneurs, engineers, R&D managers) are involved in the development funnel leading to innovation (Cohen, Nelson & Walsh, 2002), innovation is now accepted as a collaborative process (Jones, Wuchty & Uzzi, 2008) between both co-located and distant pairs of actors involved (Brusoni & Pavetti, 2001; Zander & Sölvell, 2000). Complex innovations such as coming up with a new molecule in the pharmaceutical industry require a certain level of interaction with global knowledge bases, so that the domestic firms feel the need to collaborate and learn from developed country MNEs and other clusters (Kale, 2010; Kumaraswamy et al., 2012; Quian, 2007).

The external connections to clusters with firms that seek innovations are also important. For example, Gereffi (1999), introduces a story of catch-up through changing local clusters’ linkages and making them more international through which the local clusters can escape from “lock-in” and become an innovation global value chain. Similarly, Humprey & Schmitz (2002) warn against the lock-in of domestic actors working only with small number of global links, so more global links would result in more innovative performance. These collaborations help in upgrading the national innovation system through voluntary or involuntary knowledge spillovers from those actors. Therefore, if an upgrade is achieved, there will be more connections to knowledge bases and inventors outside the emerging market economies.

Providing knowledge sourcing and collaboration to achieve catch-up is a cumbersome and long process (Kale, 2010). The studies suggest that emerging countries progress “from learning to produce, learning to produce efficiently, learning to improve production, learning to improve products and finally culminates in learning to develop new products” (Kale, 2010: 18). This requires coordinated to a nation’s technology infrastructure, economic institutions and incentive systems (Koh, 2006). During this process, countries should support the national innovation system with supporting institutions and policies (Doh, Jones, Mudambi & Teegen, 2005; Ivarsson & Alvstam, 2005; Park & Lee, 2006; Waguespack et al, 2006).
Although, the effect of the supporting systems for developing domestic innovation capabilities was analyzed by prior literature, few studies assess the specific effect of alignment of IP protection on the catch-up of emerging market economies. For example, Qian (2007) shows that the implementation of patent laws by itself does not promptly stimulate domestic innovation, but patent laws in countries with high levels of development, education, and economic freedom do stimulate innovation. Therefore we evaluate how the innovation capabilities and the catch-up of emerging market economies react to IP protection regulations. Therefore, next we investigate how emerging country catch-up is influenced by different changes to the IP regime; using the 10-year allowance period and providing a gradual change or alternatively increasing the IP regime instantly.

**HYPOTHESIS DEVELOPMENT**

**Effect of Gradual vs Immediate Increase in IP Protection Standards**

Ensuring necessary levels of internal and external knowledge sourcing is possible through introducing higher IP standards as it would increase the incentives for domestic innovators to develop innovation capabilities and appropriate returns from their efforts (Li, Miller, Eden, & Hitt, 2012). Moreover, in order to facilitate collaboration and learning, emerging market economies need to ensure an environment to attract R&D seeking MNEs. MNEs want to make sure that their specific assets are protected, as a lack of IP protection in the emerging country would ward of them to engage in doing competency creating activities. Hence, higher IP standards spurs advanced economy firms to engage in R&D in those contexts, so that local firms can enjoy learning and spillover externalities and build on their output/imitative capabilities (Breschi & Malerba, 2001).

The output/imitative capabilities not only help the local markets to grow but also help domestic firms to possess necessary absorptive capacities to move to the second phase of
emerging country catch-up (Awate et. al, 2012). Firms learn to source knowledge and form collaborations during the transition and consolidation phases (Kumaraswamy et. al, 2012). However, this process of learning and upgrading is not possible if IP standards are strictly enforced, as domestic firms need a weak appropriability regime to gain first hands-on experience and then move to higher value-added activities in order to facilitate the buildup of their capabilities. Numerous studies argue that higher IP standards curtail domestic innovation of emerging country firms, as developed country multinationals take-over the domestic innovation system and prevent domestic firms from upgrading their capabilities to higher value added activities (Chin & Grossman, 1990; Deardorff, 1992; Helpman, 1993; Li, 2008). The dangers of strategic acquisitions by advanced-economy firms, in which advanced economy MNEs buy out emerging economy firm to curtail competition, are also noted in the literature (Gasman & Reepmeyer, 2005).

Therefore, governments still would want to ensure some level of protection for the domestic industries, as the innovative capabilities of the domestic firms are not mature enough to compete with multinational pharmaceutical firms (Li, 2008). Moreover, domestic firms do not grasp the requirements of a higher IP regime change.(Kale & Little, 2008). This is consistent with studies which offer a middle-ground perspective and claim that there is an inverted U” shape between innovation and the IPR strength Gallini, 1992; Horwitz & Lai, 1996). Qian (2007) finds that in the group of sampled countries the implementation of patent laws by itself does not promptly stimulate domestic innovation, but patent laws in countries with high levels of development, education, and economic freedom do stimulate innovation. As Qian (2007) suggests “an optimal level of IPR appears to exist, above which additional strengthening actually tends to discourage innovation.” This means that emerging market economies need sufficient time to transform their process capabilities to innovative capabilities and become a more active innovation system. Therefore, a balance between high and low IP protection is
needed (Qian, 2007).

In our framework, emerging countries’ IP protection levels are shown as being in low level before they became signatory to the TRIPS agreement. With a gradual implementation of IP regulations, emerging countries allow a transition from center-bottom of the framework; from low IP protection to a medium level IP protection first, and then later moving up to the high IP protection level. Such a gradual policy will optimally increase both the quality of knowledge sourcing and connectedness of the national innovation system so that the emerging countries smoothly shift from having low & medium capabilities to start with, to an innovation system with higher amount of value-added activities. Therefore, we argue that emerging countries which don’t protect their domestic industry with keeping lower IP standards until the end of the 10-year allowance period given with TRIPS, show worse catch-up performance. We hypothesize effects of such gradual vs. immediate increase in the IP protection levels on emerging country catch-up as follows:

H1: Emerging market economies that increase IP protection standards gradually compared to an immediate increase will be able to gain more knowledge from national and international sources.

H2: Emerging market economies that increase IP protection standards gradually compared to an immediate increase will be able to achieve a higher connectedness to global knowledge networks.

H3: Emerging market economies that increase IP protection standards gradually compared to an immediate increase will be able to gain a higher level of innovation capabilities.

METHODS

The research uses two research approaches to identify the progress of IP regulations on one hand and the changing innovation capabilities of the emerging market economies on the other.
The changing IP regulations are presented through a narrative representation of the pharmaceutical industry with focus on IP protection changes. Especially the ratification of TRIPS will be the focus of the study and the variation of the usage of a 10-year allowance period related to the treaty will be discussed. Our study focuses is on India, Turkey and Brazil as representations of emerging market economies. We chose these countries as they are representatives for the different TRIPS ratification approaches and all reflect important emerging market economies with different importance level in the global pharmaceutical industry.

**The Cases of India, Turkey and Brazil**

In order to establish a coherent discussion on the development of the IP regulations of the pharmaceutical industry and the changing IP protection standards of India, Turkey and Brazil, we used primary and secondary data. The development of the Indian industry has been studied extensively before and many secondary data sources in form of official governmental reports and academic articles exist. For the Brazilian industry similarly to the Indian industry, much information is publicly available. However, the pharmaceutical industry in Turkey did not gain much attention. Thus, information on the pharmaceutical industry from Turkey is mainly from primary data sources. A number of semi-structured interviews with high ranked industry representatives were conducted to understand the development of the industry especially in line with the countries TRIPS ratification and related fields. Both developments were distinguished in three phases; pre-TRIPS, TRIPS transition, post-TRIPS. Our assumption is that once TRIPS is ratified, the IP protection standard of the respective country was high through the enforcement of controls against TRIPS violations were in place. We acknowledge that these TRIPS violation occurred and that the measure might be impacted by these violation infringements.
**Patents as innovation capabilities**

Innovation and technology management research has used patents as reflection of innovation capabilities of firms for many years (Griliches, 1990; Jaffe, Trajtenberg & Henderson, 1993; Narin, Norma & Perry, 1987). We go in line with this research and consider a firm’s patent output as its main identification factor for innovation capabilities. We consider not only the amount of patent output, but also the connectivity of the inventors and where the knowledge is sourced as part of the innovation capabilities of the country. In line with patent literature, we treat patents as indicators of knowledge flows (Awate et al, 2012; Jaffe et al., 1993).

However, we also acknowledge that patents to identify the innovation capabilities of a country to bear controversies. We acknowledge that patent innovation might not be an extensive measure of innovation and R&D development (Acs, Anselin & Varga, 2002), of the issues concerning the economic value of patents (Hall, Jaffe, & Trajtenberg, 2001) or of their economic impact (Pakes & Griliches, 1980). We see benefits in using patents as a potential tool to study the catch-up process of the Indian, Turkish and Brazilian economy related to the pharmaceutical industry.

**Data Collection and Analysis**

The patent data were derived from the United States Patent and Trademark Office (USPTO) and classified patents that are representative of the pharmaceutical industry as Drug and Medical (Hall, Jaffe, & Trajtenberg, 2001). The Drug and Medical category in Hall et al. (2001) consists of four sub-categories: Drugs (sub-category code 31); Surgery & Medical Instruments (32); Biotechnology (33); and Miscellaneous—Drugs & Medicine (39). The USPTO patent class Pharmaceutical Devises (D24) was also included. The patents extracted were granted within the chosen time frame of January 1, 1980 and December 31, 2010. We mined patents granted to Indian, Turkish and Brazilian inventors. In total we mined 1409 patents granted to Indian inventors, 57 patents granted to Turkish inventors and 421 patents.
granted to Brazilian inventors.

We use a network analysis in order show the development of the innovation capability of the respective country over the period of time. A network analysis allows us to connect the innovation/the patent with inventors and different locations. Thus, we are able to identify where the knowledge to develop the innovation was sourced from and how this knowledge leads to innovation capabilities. We are also able to identify how connected the inventors are. The connectivity of the inventors also allows us to analyze the collaborations capabilities and we expect that through learning and knowledge spillovers, the domestic inventor contributes to the countries overall innovation capabilities. We use UCINET (Borgatti, Everett, & Freeman, 2002) as software to design the network analysis.

**DATA PRESENTATION AND ANALYSIS**

**IP protection changes in Turkey, Brazil and India**

Turkey. Starting from 1970s, Turkish drug companies developed generic drug development capabilities and were able to provide high quality generics to the local market. Moreover, the Turkish healthcare sector, with a population of 50 million people in 1995, was considered big enough to offer lucrative opportunities for foreign entrants. However, the pharmaceutical industry was long protected by tariffs, quotas, price regulations and lack of IP protection, which historically prevented foreign entry.

The Turkish government was the sole buyer of drugs. In the 1990s, the price of generics produced by Turkish pharmaceutical firms was calculated based on the cost the firm announced to the government, which raised significant concerns related to possible self-reporting bias. Therefore, local firms were enjoying noteworthy profits through their protected market against other possible lower cost foreign generic producers. The protection of the local generic producers against competition and the existence of lucrative deals with the
government resulted in a lack of motivation towards innovation among local pharmaceutical firms (TOBB, 2012). In addition, the government lacked behind many countries in providing the necessary infrastructure and incentives such as laboratories, research grants, university support to facilitate innovation. There was no central institution and the Turkish pharmaceutical industry possessed strong generic drug development capabilities, while lacking innovation capabilities.

Before the TRIPS related talks began, Turkey was in the process of developing an IP protection infrastructure. The Turkish equivalent of a Federal Drug Association (FDA) was established in 1990, and a major regulatory change concerning the new drug development processes was planned. However, even this regulatory change didn’t include a protection for the drug as a product. In May 1995, Turkey ratified the TRIPS and only 6 months later it was given the 10-year transition period allowance. The government gave in to pressures from the International Monetary Fund (IMF), as it experienced a major financial crisis in 1994, which forced it to sign a credit agreement with the IMF.

Therefore, in our framework, Turkey starts with at the lower left corner with comparably low IP standards and moves then to a higher level in the post-TRIPS phase. As there is no clear transition period, the IP protection level jumps straight up to high (Figure. 2).

Brazil. Similar to Turkey, for Brazil, access to affordable medicine was important due to its rather large low-income population. Therefore, the government was protecting the domestic pharmaceutical industry through tariffs, quotas and also a low level of appropriability regime, which helped it to develop its process/imitation capabilities. However, in contrast to Turkey, Brazil had established a national system of innovation institutions to foster and enhance the innovation efforts. As a result, Brazil’s innovation capabilities were significantly more developed, and it has been considered among important generic drug producers along with
India and China (Morgan & Fai, 2007; McMahon, Singer, Daar, & Thorsteinsdóttir, 2010).

The U.S. put pressure on countries that mainly produced generic drugs such as Brazil since the late 1980s. The Congress passed a legislation named “Special 301” with the goal to identify countries with inadequate IP protection. Brazil was put on this list in 1989 and was given 100% tariffs on imports from Brazil (Lanjouw & Cockburn, 2000). This increased stress on Brazil to increase its level of IP protection. Thus, before TRIPS the Brazilian Senate discussed rather unsuccessfultly a patent bill to increase IP protection standards (Rozek & Berkowitz, 1998). In line with the TRIPS regulations, Brazil finally gave in to pressures from the US and decided to not capitalize on the 10-year transition period. The country ratified TRIPS in 1996.

In our framework Brazil starts also on the left corner and jumps parallel to Turkey along the higher IP protection line to the right. However, it can be argued that compared to Turkey, Brazil was a slightly higher IP protection level before the TRIPS regulations than Turkey.

India. The Indian pharmaceutical industry developed in several stages largely influenced by government policies that were implemented to improve the country’s healthcare sector or to comply with global IP protection regulations. The ratification of the Industrial Licensing Act of 1951 was one of the first governmental regulations and led to the development of a strong public sector with institutions and laboratories (Panagriya, 2008; Kale & Little, 2007). Since then the government actively implemented policies in the industry to support domestic firms and help the national healthcare sector. Especially generic drug innovation through reverse engineering (process improvements of already existing drugs) was supported by these policies, such as the Patent Act of 1970 (Nair, 2008), going counter to the protection of intellectual property. Additionally, the policies were described as being without any direction or regime, loosely deciding upon strategy without any sense of urgency (Nair, 2008).

In 1994, India also signed the TRIPS agreement and started to move away from a sole generics

The industry began to restructure and conform to global norms after it was obliged to meet TRIPS regulations. A need for R&D activities was acknowledged and many firms set up drug discovery and innovation programs or research facilities/laboratories (Nair, 2008). Furthermore, the Indian government encouraged the incorporation of IP and patent practices into the education of technical and legal professionals for the pharmaceutical industry in order to upgrade working knowledge as well as to change the working culture (Nair, 2008).

**Innovation capabilities of India, Turkey and Brazil**

We investigate each country’s innovation capability over a period of time employing our framework. We looked at three different stages in line with the IP protection changes; before TRIPS (pre-1996, 1996), the 10- year transition period (1996-2005) and after TRIPS (2006-2010).

We start our analysis of innovation capabilities for each country with identifying where the inventors of the country source their knowledge from. Table 1 portrays Turkey, Brazil and India’s capabilities in knowledge sourcing. When we look at the collaboration maps for post-1995 and post-2005, we see that Turkey was not able to increase the number and diversity of its collaborations to international knowledge bases, networks or clusters; as the network maps looks similar for these time frames. The rate of increase was much smaller compared to both Brazil and India. More importantly, the network analysis also shows that Turkey failed to
collaborate with inventors from Germany, which is one of the major pharmaceutical innovation clusters until post-2005 period. Hence, changing the IP regime immediately also resulted in Turkey lagging behind other emerging countries generating international collaborations.

We present the collaboration patterns for countries with two graphs in Table 2; the map on top shows the location of international connections from the patent output of the respective country. The graph shows the foreign locations of inventors as blue node while the patent that was developed by these inventors is represented as a red node. All patents are connected to at least one inventor of the respective country. The graph below shows the locations again and how many inventors are connected to the respective country and the foreign country. The numbers on the arrows indicate the number of inventors connected to the two locations.

Both Table 1 and Table 2 indicate that there was less innovative activity in terms of number of patents for Turkey and Brazil compared to India, before the TRIPS period; therefore both countries had lower level of innovation capabilities. However, we are interested in the change in these capabilities more than their initial positions, which we investigate with changes in each map.

In Hypothesis 1, we were interested in the catch-up performance of emerging countries which decided to implement an immediate increase in their IP protection levels. Turkey and Brazil, didn’t use the 10-year allowance period flexibility and ratified the TRIP immediately. However, in terms of the magnitude of the leap from a low IP protection level to a high one, Turkey’s case sits at the extreme as it didn’t have any product patent protection laws prior to ratifying TRIPS. Therefore, we analyze that an immediate increase in IP protection affects the catch-up process of emerging market economies more.

Hypothesis 1 suggests that for countries such as Turkey that increase IP protection standards
immediately, we should expect very little progression towards increasing their in-house and external knowledge sourcing activities. As Table 1 indicates, Turkey experienced an increase in knowledge sourcing activity along with an increase in number of patents both after 1995 and 2005. However that increase is only evident in external sourcing patterns, lacking a development in implicit knowledge sourcing. Moreover, when compared to Brazil which increased its IP protection immediately but from a slightly higher level starting point, the rate of this increase in external sourcing is much smaller, which is evident from post-2005 maps. These two findings indicate that the Turkish national innovations system was incapable of developing its capabilities towards sourcing knowledge from in-house and external sources as a result of its decision to leap-frog its IP protection level. Therefore, we find a support for our hypothesis regarding the detrimental effect of an immediate increase in IP Protection level on emerging country catch-up, when compared to a gradual increase.

Hypothesis 2 suggests that for countries such as Turkey, which introduced an immediate IP increase, would also fare badly in their capacity to form international collaborations, when compared to countries which introduced more gradual changes. As Table 2 indicates, again Turkey was significantly behind in both their collaboration amount and diversity pre-1995 period compared to both Brazil and India.

In addition, the increase in the ability to connect with international collaborators was more evident when comparing Brazil and India. When we only compare the amount of increase of the ability to connect with international collaborators for Brazil and India, as Table 2 indicates, for period’s post-1996 vs. post-2005, India increased both the number of collaborations to international inventors and also the diversity of its collaboration efforts. This suggests that India, in choosing a more gradual increase in IP protection level ended up with a higher innovation capability than Brazil; Brazil had a higher level of innovation capabilities than Turkey. These two cross-comparisons between Turkey, Brazil and India provide the support
for Hypothesis 2, regarding detrimental effects of an immediate increase in IP protection level on emerging market economy catch-up, when compared to a gradual increase.

It can also be concluded that Hypothesis 3 is supported by the first two findings. We could see that both innovation capability indicators, connectedness and knowledge sourcing show that India has by far the highest level of innovation capability than Brazil and Turkey. The gradual implementation of IP protection regulations has supported the country’s positive development of innovation capabilities and trumped Brazil and Turkey. Both countries lacked the ability to generate the necessary innovation capabilities to compete with India. The sudden increase in IP protection standards did not support the country’s innovation system and caused more damage than it helped the innovation system to develop. Though it can be argued that Brazil, which had a slightly higher level of IP protection than Turkey before TRIPS was able to generate a higher level of innovation capabilities than Turkey.

**DISCUSSION**

Economists have long ascertained that the country characteristics are related to latent innovation potential and the decision to implement domestic patent law (Qian, 2007). Other studies advocate that a country’s pharmaceutical industry’s characteristics should affect its decision to implement patent laws and its innovative potential (Kaufer, 1989). Therefore, we argue that there needs to be an alignment/fit between the local innovation capabilities and the IP protection in the focal country in order for firms to effectively upgrade their domestic innovation capabilities (Figure 2).

The fit is either achieved by having low level of domestic innovation capabilities and low level of IP protection, which would buy extra time for local firms to upgrade their capabilities.
before competing directly with MNEs from advanced market economy in the respective
country. Alternatively, they can compete by having a high level of domestic innovation
capacities complemented by a high level of IP protection standards. If the IP protection
standard is suddenly increased, the challenge for the country is to align with the appropriate
innovation capability level, as evident in the case of Brazil and Turkey. However, without a
gradual implementation of the regulations as in the case of India, it is difficult for the country
to achieve this level and recognize where the level is. Thus, the country is located outside of
the fit area and does only slowly realign into the fit area. Turkey and Brazil are examples of
this slow adaptation level leading to a less high innovation capability level affecting the
countries catch-up process. On the other hand, countries such as India invested in upgrading
their local innovation capabilities first and then raised the IP protection standards allowing a
transition period for the economy to gain innovation capabilities in line. Hence, our results
support our claim that there is an alignment/fit between the local innovative capabilities and
the IP regime affecting the catch-up process of emerging market economies.

CONCLUSION

Basing our arguments on such a co-evolutionary perspective of emerging country catch-up
(Kumaraswamy et al, 2012; Qian, 2007), we investigated the interaction of firm-level
innovation capability development with regulatory changes, and the effect of this interaction
on the catch-up performance of emerging countries. Our focus is on the pharmaceutical
industries in emerging countries, as they experience many different phases of IP protection
levels, which makes it possible for us to investigate the changes in the regulatory changes for
different countries in different periods of time. While becoming signatory to TRIPS provides
us a natural experiment to assess their comparative catch-up performances along with their
existing innovative capabilities (Qian, 2007), variation among countries in terms of their use
of 10-year allowance period is the treatment effect for regulatory evolution.
Our network analysis shows that the more gradual emerging countries increase their IP protection levels, the more they were able to increase their abilities to source knowledge and form necessary collaborations. This result suggests that there needs to be a fit between innovative capabilities of the merging countries and their IP protection levels. In order to explain how emerging countries can achieve fit for better catch-up performance, we develop a cross-country framework that compares the level of domestic innovative capabilities and the progression of IP protection level in these countries, which is absent in the catch-up research stream (Kale, 2010).

Our study contributes to the discussion around the catch-up of firms from emerging market economies (Lorenzen & Mudambi, 2013) a research area that only gained attention in recent years. Through our focus on the effect of institutional change on innovation capabilities over a period of time, we also contribute to a lack of consensus on the effect of IP standards on innovation (Kale & Weild, 2008; Qian, 2007).

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Figure 1: IP protection and domestic innovation capabilities

Figure 2: Area of Fit
### TABLE 1: Knowledge sourcing

<table>
<thead>
<tr>
<th>Country</th>
<th>PRE-1996</th>
<th>1996-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
</tr>
<tr>
<td>Brazil</td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
TABLE 2: Connectedness

India

Turkey
PRE-1996

Brazil