Intellectual property rights and imitation in developing countries

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Abstract

The incentive for a developing country (the South) to enforce intellectual property on its territory and stop imitation of Northern products is strictly linked to the opportunity to participate in the *official* international market, represented in this paper by a multinational. One straightforward result is that as the South increases its share in the multinational's profits, it would also promote to a greater extent the use of intellectual property rights. Moreover, the level of participation in the multinational's profits needed to support intellectual property is positively related to the relative value of the quality level achieved by the imitated products with respect to the quality level achieved by the *official* products. Consistent with the theoretical predictions, the empirical analysis brought on panel data finds that patents, representing both profits by innovation and innovative capacity, positively impact on IPR, but this impact decreases with imitative ability.

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1 Introduction

Innovators, mostly living in rich economies, have vested interests in building IPR (Intellectual Property Rights) institutions. Indeed, innovators seek protection to recoup their investments and appropriate the returns. Since the birth of the WTO (World Trade Organization) and the establishment of the TRIPs (Trade Related Aspects on Intellectual Property Rights) agreement, international pressure on DC (Developing Countries) to use IP (Intellectual Property) has noticeably increased. Many DC make a large use of imitation to sell products invented by others at lower prices. Imitations are of lesser quality in comparison to the original products. One argument to convince DC to accept the new setting, with stringent IP, is an increase in imports of the best products. In addition, letting aside imitative process and making use of IP, DC would participate in the *official* market and they could gather throughout the world the monopoly rents coming from their production of IP.

A policymaker's decision on the amount of IPR protection depends on weighing the benefits and costs. The intuition behind this paper is that there is a moment during the development process when a country is ready to enter this *official* market. Entering beforehand could be not convenient for a poor country and a wrong decision can be detrimental for the development process. At the beginning of this development process, indeed, competition is mainly supported by imitation and adaptive innovation. As a country reaches higher technological levels and as its demand targets high-quality and differentiated products, a larger share of domestic firms advocates IPR. Ultimately, whenever a country's GDP per capita approaches the highest levels, IPR compliance steps up considerably.

As always, history is a good teacher to consult. The experience of the USA and other advanced countries about economic development is that they initially did not respect IP.[1] At the beginning of the American industry, markets were functioning with the infringement of foreign IP. Only in a subsequent moment, when the US economy became a mature one, IP was utilised as a pervasive instrument, and this happened long after UK started

[1] Chang [2001], at page 293, underlines that "Historical evidence shows that ... in the early days of industrial development in the now-advanced countries, IPR, especially other countries' IPR, were not well respected. Compared with the developed countries of yesteryears, the contemporary developing countries seem to be behaving much better in many ways. And if that is the case, it seems unfair to ask the modern-day developing countries to behave to a standard that was not even remotely observed when the now-advanced countries were at the similar, or even more advanced, stages of development."

to adopt IP.[2] The Chinese experience seems also to confirm this intuition, as suggested in Yang and Clarke [2005].[3] Today and not before, having left the DC club, China is ready to enter into the TRIPs agreement. Only now the biggest country in the world seems ready to give up the wild usage of imitation of occidental products and ready to shape the incentives of the R&D sector in the *official* way.

A point stemming from usual economic reasoning can be made easily to enrich the perspective over these observed economic phenomena. Following a Coasian bargaining process and assuming that DC are not less rational than developed ones, there are not economic arguments to support the thesis that DC are not choosing what is best for them. If the adoption of IPR, fostering FDI (Foreign Direct Investment) and licensing, would better the technological transfer [Yang and Maskus, 2009] compared to imitative process there is no reason why DC would not choose unilaterally to adopt IPR from the beginning of their development process. Globerman [1988] pointed out that allowing imitations and piracy might discourage FDI but at the same time "encourages the creation of indigenous industry by supplying local producers with the financial capital, experience and trained labor force required to become *legitimate* producers in the future"(emphasis added).

Having these intuitions in mind, a model where the choice to accept the TRIPs agreement is based on the incentive to participating into the *official* international market is developed. The model represents an attempt to explore and develop this intuition. Since the focus is to understand the incentives of DC, a few assumptions, keeping simple and sufficiently realistic the technical formulation, allow to sharpen the division of profits on which the choice of TRIPs agreement participation should be made. The empirical analysis that follows, based on a macroeconomic panel dataset relative to a hundred countries, relates the adopted level of IPR to the amount of patenting and the imitative ability, taking into account GDP per capita, population, WTO membership, openness to trade, FDI, and economic freedom.

The remainder of the paper is organised as follows. In Section 2, the most relevant literature is briefly reviewed. In Section 3, the model is introduced and its main implications for the South are discussed. Section 4 empirically

[2]The adoption of IP laws in US started with the Patent Act of 1790, approximately one century after UK, and extended progressively to more and more areas of business.

[3]After a thorough overview of the development of the IP system in China, in the conclusion, Yang and Clarke [2005] explicitly state: "There can be no doubt that China has made more significant progress on the protection of IP in recent years. During the past decade or so, a new legal mechanism has been implemented."

validates the theoretical results. Section 5 concludes the paper.

2 Related literature

There are many different contributions that have dwelled on the foremost question of the paper. Whether and when it is profitable for DC to implement a system of IP has been addressed directly and indirectly by economic literature since the eighties.

Krugman [1979], starting from the concept of the "product cycle" [Vernon, 1966], shows how the trade between the North and the South can stem from a temporal lag between the innovation in the North and the diffusion of the technology in the South. The result is the North exporting new products and importing old products. Grossman and Helpman [1991a,b] work in the same direction featuring endogenous innovation and endogenous technology transfer. Diwan and Rodrik [1991] state that patents should be protected in the South in order to promote the development of technologies more appropriate to the South. The paper by Helpman [1993], developing a dynamic general equilibrium framework, finds that the South does not benefit from tight IP. This finding is robust with respect to examined variations such as the presence of FDI.

Starting from the framework developed in these seminal contributions, many papers investigate some related issues. Lai [1998] discusses the importance of the channel of production transfer from the North to the South. On the same theoretical ground, Glass and Wu [2007] notice that when innovations consist of new varieties, stronger Southern IPR protection encourages FDI and innovation, but when innovations consist of higher quality levels, FDI and innovation can fall. Developing a similar framework, Dinopoulos and Segerstrom [2010] find that a more stringent IPR protection in the South raises permanently the rate of international technology transfer within multinational firms and generates a temporary increase in the Northern innovation rate. However, finding an optimal level of IPR enforcement in the South is a matter of balance between the attraction of multinationals' technology and a limitation of rent transfer to the high-income developed countries [Markusen, 2001]. Currie et al. [1999] delineate three phases of Southern development in which the very same IP policy can generate different outcomes. Yang and Maskus [2001] study the effects of stronger IP in the South on the incentives of firms in the North to innovate and to license advanced technologies. Glass and Saggi [2002] study a setting where, in addition to innovation and imitation, also FDI is endogenous. Their work

shows that the results can be very different depending on whether IPR protection consists of an increase in the cost of imitation or of an exogenous decrease in the imitation intensity.[4] On the same line, Parello [2008] stresses that strengthening IPR hurts the rate of technology transfer to the South via a permanent fall in the long-run rate of imitation. Lai and Qiu [2003] find that the Nash equilibrium IPR protection standard of the South is naturally weaker than that of the North. Grossman and Lai [2004] consider the simultaneous choice of IPR protection by trade partners finding that the optimal index of patent protection may be independent of, or even decreasing in, the size of the economy; in addition, they find that harmonization of patent policies is neither necessary nor sufficient for global efficiency. Chen and Puttitanun [2005] conduct a theoretical and empirical analysis on the optimal level of Southern IPR that balances the trade-off between facilitating the imitation of Northern advanced technologies and providing incentives for domestic innovations. They find a U-shaped curve of a DC's IPR with respect to its economic development. Whether the U-shaped is a good picture of reality or not, a large part of these contributions seem to pinpoint that only after a stage in the development process it is profitable to line up the IPR to the level of the most developed countries.

Many authors focus on the empirical side of this issue. Smith [1999, 2001] finds a significant empirical relation among imitative ability, patent protection, and trade. Evidence to confirm this view is presented also in the paper by Co [2004]. The importance to consider imitative ability with respect to IPR protection is finally stressed by Falvey et al. [2006, 2009]. In their empirical works, following the intuition by Thompson and Rushing [1996], they strongly support the existence of a threshold level in development after which patent protection changes its impact on economies. Finally, also Ginarte and Park [1997] suggest a threshold effect, a critical size of an innovating sector before a country has an incentive to provide patent rights.

Perhaps, the work to which the theoretic model of this paper is the closest is that by Chin and Grossman [1991]. They propose a North-South model finding that the interests of the North and the South generally conflict in the matter of protection of IP. The channel through which patent protection can enhance the welfare of the South is a reduction of production costs due to innovation. The counterbalancing force is that an enforcement of patent protection mitigates oligopolistic competition, to the detriment of welfare in

[4]Even though patents have complex effects on imitation costs [Mansfield et al., 1981], this issue is simplified in the model, where respecting IPR means no possibility of imitation whatsoever for the South.

both countries. In the current work,[5] on the contrary, the products of the North and the South are of different quality, consumers are heterogeneous, and imitative ability, explicitly modeled and empirically proxied, directly affects the quality level of the product of the South not enforcing IPR. By explicitly considering the division of profits, assumed to be connected to R&D capacity, one can finally investigate how the choice of the South to respect IP is influenced by its imitative ability.

3 The model

There are two countries, N (North) and S (South), and a company that has no capacity constraint, M. The company represents the *official* way of world production. In S, it can be purchased either the *official* product of the company with quality Q_M or a product obtained locally through imitation with quality $Q_I \equiv \rho Q_M$; where $0 < \rho < 1$ is the imitative ability of the country S. Production costs are assumed to be equal to 0.[6]

The consumers' utility functions in the two countries are as follows:

$$U^S(Q,p) \equiv \theta Q - p, \qquad U^N(Q,p) \equiv 2\theta Q - p;$$

where θ is the taste parameter uniformly distributed in the interval [0,1]. This formulation of utility functions is in line with the intuition that, for the same level of quality and the same position in the taste dimension inside the segment [0,1], a consumer in N is willing to pay the double than a consumer in S. It is like saying that in S people are less exigent about quality level or that their opportunity cost is smaller in absolute terms.

In order to be able to investigate later on the incentives of S to join the TRIPs agreement, respecting IPR and giving up the possibility to imitate ($\rho = 0, Q_I = 0$), the next subsection concentrates on S.

3.1 Company's and imitated products in S

The local industry is competitive, so $p_I = 0$.

[5] I am deeply indebted to Bordoy [2002] as I started to build my model from her Ph.D. work.

[6] By having put all the production costs at the same level, Q_i can be interpreted as an efficiency index of production. For instance, it can represent the ratio between the quality of the product and the production cost.

The indifferent consumer, identified by $\tilde{\theta}$, has the same level of utility by buying either from M or from local producers.

$$\tilde{\theta}Q_M - p_M^S = \tilde{\theta}Q_I - p_I, \quad \tilde{\theta} = \frac{p_M^S}{Q_M - Q_I}.$$

The quality differential is $\Delta \equiv Q_M - Q_I = Q_M(1-\rho)$. The demands the company and local producers face are

$$D_M^S = max\left\{1 - \frac{p_M^S}{\Delta}, 0\right\}, \quad D_I = min\left\{\frac{p_M^S}{\Delta}, 1\right\}.$$

The government of S has at its disposal the tariff $\lambda \geq 0$ as instrument to protect local producers and to maximise total welfare in S. Thus, λ is the degree of protection of S, and $D_M^S\lambda$ is the total government's revenue in S.

The timing of the game is: (1) the government of S fixes λ; (2) the company fixes p_M^S; (3) the consumers in S choose, so D_M^S and D_I are obtained. In order to find the equilibrium values one can proceed by backward induction, hence addressing (3), (2), (1).

By choosing p_M^S, the company maximises its profit, that is

$$\Pi_M^S = (p_M^S - \lambda)\left[max\left\{1 - \frac{p_M^S}{\Delta}, 0\right\}\right].$$

Neither $p_M^S = 0$ (for which $D_M^S = 1$) nor $p_M^S = \Delta$ (for which $D_M^S = 0$) are optimal strategies. The equilibrium value is $p_M^{S*} \in (0, \Delta)$. Solving the maximization problem,

$$p_M^{S*} = \frac{\Delta + \lambda}{2}, \quad D_M^S = \frac{\Delta - \lambda}{2\Delta}, \quad D_I = \frac{\Delta + \lambda}{2\Delta}.$$

Now, the consumer's surplus can be computed.

$$CS^S(\lambda) = \int_0^{\frac{\Delta+\lambda}{2\Delta}} \theta Q_I d\theta + \int_{\frac{\Delta+\lambda}{2\Delta}}^1 \left(\theta Q_M - \frac{\Delta+\lambda}{2}\right) d\theta = \frac{Q_M}{2} + \frac{\lambda^2 - 2\lambda\Delta - 3\Delta^2}{8\Delta}.$$

Since the government's revenue is equal to $\lambda\frac{\Delta-\lambda}{2\Delta}$, the total welfare of S is

$$TW^S(\lambda) = \frac{Q_M}{2} - \frac{3\lambda^2 - 2\lambda\Delta + 3\Delta^2}{8\Delta}.$$

The maximization of $TW^S(\lambda)$ results in the optimal level of industry protection in S, that is

$$\lambda^* = \frac{\Delta}{3}.$$

Observation 1 *The level of industry protection (optimal tariff) is negatively related to the country's imitative ability. The higher ρ, the higher Q_I, the smaller Δ, and the smaller λ^*.*

Observation 1 is coherent with the intuition that stronger economies need less protection than weaker ones. Another relevant result is that the value of λ^* implies that D_M^S, D_I do not depend on Δ: $D_M^S = \frac{1}{3}$, $D_I = \frac{2}{3}$. The government uses the tariff to obtain always the same division of the demand between the company and the local sector.

The precise value of the total welfare, useful in the following, can be computed.

$$TW^S = \frac{Q_M}{2} - \frac{3\Delta^2 - \frac{2}{3}\Delta^2 + \frac{1}{3}\Delta^2}{8\Delta} = \frac{Q_M}{6} + \rho\frac{Q_M}{3}. \tag{1}$$

3.2 The TRIPs agreement

When S signs the TRIPs agreement, it gives up the possibility to imitate the product of M. Thus, imitative ability goes to 0 ($\rho = 0$, $Q_I = 0$).

Respecting the IPR international setting is often paired with the fulfillment of the WTO conditions about free trade. The two international agreements are deeply related and the discussion of one usually involves the discussion of the other. As a result, it seems likely that governments respecting the TRIPs agreement also refrain from using tariffs. Thus, the additional assumption of $\lambda = 0$ is done.

In this new setting the company has not to compete with local producers. The demand the company serves is composed by all the consumers that get a positive utility choosing to purchase the product. The new indifferent consumer is easily obtained: $\tilde{\theta}Q_M - p_M^S = 0, \quad \tilde{\theta} = \frac{p_M^S}{Q_M}$.

By one side, the price chosen by the company is such that $p \leq \theta_{max}Q_M = Q_M$, because otherwise there would be no consumer with $U^S \geq 0$, and so $D_M^S = 0$.[7] By the other side, in order to sell at least one product the company has to choose the price such that $p \geq \theta_{min}Q_M = 0$. Thus, $p_M^{S*} \in (0, Q_M)$, the demand of the company is $D_M^S = 1 - \frac{p_M^S}{Q_M}$, and its profit is $\Pi_M^S = (p_M^S - 0)(1 - \frac{p_M^S}{Q_M})$.

[7] This constraint was not binding in the preceding subsection because $U^S = \theta Q - p, \quad U^S \geq 0, \quad \theta Q \geq p$, and there is always the possibility of buying the local product at $p_I = 0$, so $\theta Q_I \geq 0, \quad \theta_{min} = 0, \quad 0 = 0$.

The solution to the company's maximization problem is:

$$\frac{d\Pi_M^S}{dp_M^S} = 0, \quad 1 - \frac{p_M^S}{Q_M} = \frac{p_M^S}{Q_M}, \quad p_M^{S*} = \frac{Q_M}{2}.$$

Thus,

$$D_M^S = 1 - \frac{Q_M}{2Q_M} = \frac{1}{2}, \quad \tilde{\theta} = \frac{1}{2}.$$

The consumer surplus is

$$CS^S = \int_{\frac{1}{2}}^{1} \left(\theta Q_M - \frac{Q_M}{2}\right) d\theta = \frac{Q_M}{8}.$$

The company's equilibrium profit for the products sold in S is

$$\Pi_M^{S*} = \frac{Q_M}{2}\frac{1}{2} = \frac{Q_M}{4}.$$

The government's revenue is zero because there is no tariff.

In N, the company gets the profit $\Pi_M^N = p_M^N D_M^N$. Since the utility function is different, $U^N(Q,p) = 2\theta Q - p$, the indifferent consumer is $2\tilde{\theta}Q_M - p_M^N = 0, \quad \tilde{\theta} = \frac{p_M^N}{2Q_M}$.

The boundaries of the company's price in N are obtained as usual: $U^N \geq 0, \quad 2\theta Q_M \geq p_M^N, \quad \theta_{max} = 1, \quad p_M^N \leq 2Q_M; \quad p_M^N \geq 0$, so $p_M^N \in (0, 2Q_M)$.

The maximization plan of the company follows.

$$\frac{d\Pi_M^N}{dp_M^N} = 0, \quad \left[1 - \frac{p_M^N}{2Q_M}\right] = \frac{1}{2Q_M} p_M^N, \quad p_M^{N*} = Q_M.$$

Consequently, the equilibrium values in N are

$$D_M^N = 1 - \frac{Q_M}{2Q_M} = \frac{1}{2}, \quad \tilde{\theta} = \frac{1}{2},$$

$$CS^N = \int_{\frac{1}{2}}^{1} (2\theta Q_M - Q_M) d\theta = \frac{Q_M}{4}, \quad \Pi_M^{N*} = \frac{Q_M}{2}.$$

3.3 What is better for the South

In the model, the company represents the *official* way of world production. Nowadays, companies are increasingly delocalised and the ownership structure is scattered among different countries. Thus, the company's profit is assumed to be divided between the two countries.

In this work, the question of interest is when it is profitable, hence advisable, for a DC to enter into the WTO respecting the TRIPs agreement, at what share of the profit gained by the *official* system, in this case M, it is convenient to give up the system based on imitation. In order to answer this question, one need to find $\tilde{x}$, namely the value of $x = \frac{\Pi_S}{\Pi_M}$ such that S prefers to respect the TRIPs agreement. Evidently, the total profit of the company is the sum of what it earns in N and what it earns in S, $\Pi_M = \Pi_M^N + \Pi_M^S$. On the contrary, Π_S is how much Π_M gets S.

After the TRIPs agreement,[8] the total welfare in S is

$$TW_T^S = CS^S + \Pi_S = CS^S + x\left(\Pi_M^N + \Pi_M^S\right) = \frac{Q_M}{8} + x\frac{3}{4}Q_M. \qquad (2)$$

By (1) and (2), the value $\tilde{x}$ that respects the condition $TW^S = TW_T^S$, is obtained and the next observation follows.

Observation 2 *S prefers to sign and respect the TRIPs agreement when its share of the company's profits is above the threshold level*

$$\tilde{x} = \frac{1}{18} + \frac{4}{9}\rho. \qquad (3)$$

In order to better understand the incentives to stop imitation, it is possible to think in terms of the development of a country. At the beginning of the development process, having no technological expertise for products of high quality, $x = 0$. In this situation, looking at (1) and (2), $TW^S > TW_T^S$; without the possibility to share the profits obtained through M, it is strongly preferred to stick to the imitation regime. As x increases, the incentives to adhere to the TRIPs agreement grow and, when x reaches the value of $\tilde{x}$, the government of S is indifferent. When $x = 1$ (a situation similar to $(1 - x) = 1$ for N at the beginning of the development process of S), it holds that $TW^S < TW_T^S$: it is strongly preferred to adhere to the TRIPs agreement.

Looking at (3), one can see that as imitative ability ρ decreases $\tilde{x}$ decreases too.

Observation 3 *The less a country is able to imitate, the smaller is the share in the profits of the official system that makes the country willing to accept to give up the imitation of the company's product.*

[8] It is implicitly assumed that without IPR in the South $\Pi_S = 0$, because no profit by IP goes to the South before adhering to the TRIPs agreement.

The last two observations will be empirically tested in the next section. Specifically, it will be tested if there is a positive relation between a country's share in the *official* profits and IPR adoption and if this relation depends negatively on imitative ability.

A possible additional assumption would be to divide the company's profit according to the country's participation to the *construction* of the quality level of the product. That could be the amount of IP produced in any country, the IP on the knowledge necessary to obtain the product with that quality level. That is,

$$xQ_M = Q_S, \qquad (1-x)Q_M = Q_M - Q_S = Q_N.$$

Thus, in addition to being the share of the company's profit, x would be the share of the creation of the quality Q_M through the R&D performed by S. Symmetrically, $(1-x)$ would be the share of N.

By this perspective, there are new insights about the consequences of the passage to the TRIPs agreement for a country originally belonging to the South. At the beginning $Q_N = Q_M$ and $Q_S = 0$. N is the only country that participates to the R&D world process, N is the only one that contributes to the creation of the quality Q_M; consequently, N is the only country getting the company's profit ($x = 0$). If S has the opportunity to change its imitative system to an R&D one, transforming Q_I in Q_S, with a $x = \frac{Q_S}{Q_M}$ at least equal to the values of $\tilde{x}$ seen above, the TRIPs agreement becomes convenient for S. As countries develop and switch from imitative to innovative R&D, they are more likely to be interested in promoting stronger IPR protection.

Technology may be spread out through many different formal and informal channels. A country's quality of production depends upon its level of development and wether it is able to carry out technical innovation or imitate existing technology. Perhaps, the value of Q_S is connected to the value of ρ, so it can be that at the beginning of a development process, despite the rise of $\tilde{x}$, ρ increases at the same time that Q_S is increasing. At the beginning of a development process, countries are not likely to be significant innovators, but they may well have the adaptive capabilities to engage in imitation activities [Falvey et al., 2006]. Then, in a subsequent moment, Q_S could achieve the sufficient value to catch $\tilde{x}$ and make a country willing to accept the TRIPs agreement. This intuition, exploring the linkages between Q_S and ρ, can suggest an interesting direction for further research.

If there is agreement that a country's share in the *official* profits is determined by the amount of its contribution to the creation of the quality

Q_M, and ultimately by the share in the R&D world process, this dimension can be proxied with patents.[9] The theoretical model, therefore, yields the testable predictions that a country's IPR increase with its patents and that this relation depends negatively on imitative ability.

4 Empirical validation

In this section, the Blundell and Bond [1998] methodology is used to empirically validate the theoretical results.[10] A panel dataset, described in the following subsection, allows to determine wether and how the adopted level of IPR is affected by the amount of patenting and imitative ability, taking into account the level of development, market size, and other relevant economic variables of a country. The implicit assumption in the empirical validation is that the data on patents encompass both a measure of the profits resulting from innovation and the innovative capacity of a country.

4.1 Data description

To empirically test the predictions of the model, observations on a hundred countries (all countries for which data are available) relative to the period 1980-2005 are used. Detailed descriptions of the data sources may be found in Appendix A.

The index of IPR protection is provided by Ginarte and Park [1997] and Park [2008], and it is the most commonly used indicator of IPR protection.

Imitative ability, IMITAB, refers to a country's capacity to copy and produce technology and goods of other countries. Following Falvey et al. [2009] and Smith [1999], schooling is considered a proxy for imitative ability. In particular, imitative ability is measured by the average number of years of education received by people aged 25 and older.[11] The schooling data are taken from the International Human Development Indicators database and they are an update of the data by Barro and Lee [2012].

[9] Data on R&D expenditures, unluckily, are scarce (especially before 1996) and not reliable for developing countries.

[10] Blundell and Bond [1998], building on the work of Arellano and Bover [1995], developed a system estimator of linear dynamic panel-data models that uses additional moment conditions.

[11] Similar qualitative results were obtained using other proxies for imitative ability, like average years and percentage of completion of secondary and tertiary schooling in the population over 15 and 25 years (data source: Barro and Lee [2012]). These results are available upon request.

A widely used measure of innovation is the number of patent applications filed by residents. PATENTPC, the per capita number of residents' patent applications, proxies a country's share both in the *official* profits and in the R&D world process.

A country's level of development is measured by its GDP per capita, GDPPC. Population, POP, is a measure of market size. WTO is a dummy for world trade organization membership.

The proxy used for a country's integration to the world economy is its openness to international trade, TRADE, measured by the sum of exports and imports as a share of GDP. FDI stands for foreign direct investments or, better, net inflows of investment from abroad (new investment inflows less disinvestment). Good institutions ensure free and competitive environments. The Fraser Institute's economic freedom index,[12] ECOFRE, controls for differences in institutional quality.[13]

Since IPR evolve slowly during time, the index of IPR protection is surveyed quinquennially. Therefore, to be consistent with the patent rights index, data at 5-year intervals are used. The schooling data proxying IMITAB are also surveyed on a quinquennial basis [Barro and Lee, 2012]. With the exception of WTO, observed precisely in the sample years, all the remaining variables are averaged over 5-year periods, with the last year of the period identifying the time of the variable value. In other words, for instance, 2000 values of IPR, IMITAB, and WTO correspond to 1996-2000 averaged data of all the remaining variables. Averaging observations over 5-year periods, 4 of which precede the year of IPR, diminishes potential simultaneity without deleting most of the covariance between IPR and the independent variables. Furthermore, robustness checks performed with no averaged lagged values do not change significantly the results, and the dynamic specifications of the estimated model deal with strict endogeneity.

Table 1 reports some descriptive statistics for all the variables. Furthermore, a full breakdown of our dataset by 5-year interval is provided in Table 3 in Appendix A.

With a positive correlation of .74 between IMITAB and IPR, the effect of imitative ability on IPR protection seems to be straightforward. Indeed,

[12] In alternative to the Fraser Institute's economic freedom index, estimations were also run with the Heritage Foundation's index of economic freedom, reaching similar qualitative results. Since data on the latter start only in 1995 reducing hence the estimation sample, the former was preferred. Even so, the results are available upon request.

[13] Tariff rate and R&D expenditures, that have problems regarding the availability of data, and government's consumption expenditures were also examined. The results reported in the paper are robust with respect to omission of the above variables.

Table 1: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
IPR	2.765	1.162	.2	4.88
IMITAB	6.865	2.910	.5	13.1
PATENTPC	1.2e-04	3.2e-04	2.1e-08	.003
GDPPC	8406.6	9810.8	101.5	49246.8
POP	5.6e+07	1.6e+08	224000	1.3e+09
WTO	.450	.498	0	1
TRADE	70.383	46.129	13.54	397.13
FDI	3.736	21.183	-3.62	362.04
ECOFRE	6.210	1.357	1.78	9.14

The sample period is 1980-2005.

Figure 1 plots the positive relationship between imitative ability and IPR protection. This relationship, however, should be investigated more accurately and it could also be reversed once profits by innovation and innovative capacity are taken into account, as it is discussed in the next subsection.

4.2 Empirical results

The data presented above allow to explain the level of IPR adoption in terms of imitative ability, patenting, level of development, market size, and other relevant variables. In particular, it is investigated wether the response of IPR to patents varies with imitative ability.

In order to estimate the model, before averaging over 5-year periods, some variables are transformed in natural logarithms (lnPATENTPC, lnGDPPC, lnPOP). In addition, the patent variable is interacted with imitative ability. The coefficient on the interaction term (IMITAB*lnPATENTPC), determining how imitative ability influences the relation between patent applications and IPR adoption, allows to test the predictions of Observation 2 and 3. The four estimated specifications are presented in Table 2.

Specifications (1) and (2) are obtained by pooled OLS. Since innovation investments take time to pay off, changes in IPR should not affect the contemporaneous explanatory variables. However, to control for potential endogeneity, variables are averaged on past years (see data description). Errors are clustered at the country level to allow for unrestricted correlation between annual observations within the same country. Both specifications include year dummies and constant. Specification (1) controls for more variables; on the contrary, Specification (2) is more parsimonious.

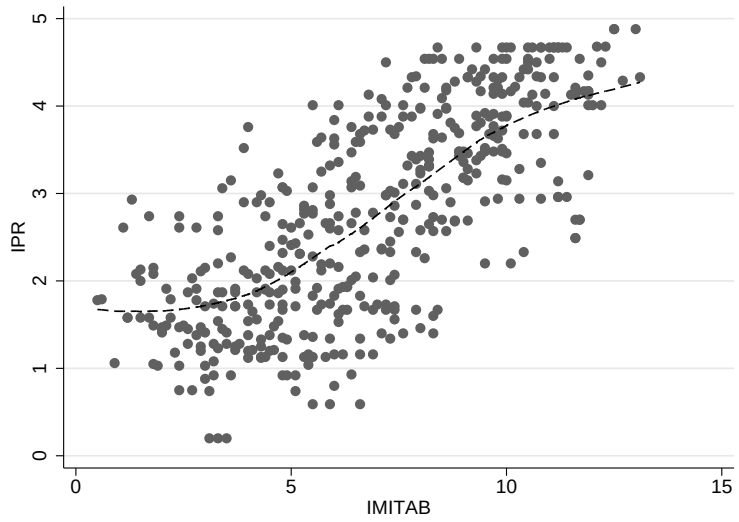

Figure 1: Overall scatterplot and lowess regression curve of IPR and IMITAB over the period 1985-2005

To assess robustness of results, two dynamic specifications are also estimated. Verbeek [2008] shows that the estimated coefficients of the dynamic and static panel data models are interpretable as short- and long-run effects, respectively. Dynamic specifications (3) and (4) take into account potential residual endogeneity between patents and IPR. These specifications are fit with the two-step GMM system estimator [Blundell and Bond, 1998] and use the Windmeijer's finite-sample correction for standard errors [Windmeijer, 2005]. Both specifications include year dummies, constant, and one lag of the dependent variable. lnPATENTPC is treated as endogenous and instrumented by lags of the variables. To avoid the problem of instrument proliferation, contrary to Specification (3) that uses all available lags of the dependent and the endogenous variables as instrument, Specification (4), to economize in instruments, sets the maximum number of lags to two. However, given the coherence among the signs of the estimated coefficients, instrument proliferation does not seem to exert a large influence in the estimated model.

The estimation results on the interaction term in Table 2 indicate a lower positive effect of patents on IPR for countries with higher imitative ability. The overall impact of an increase in lnPATENTPC on IPR is dependent on IMITAB; further, the negative impact of an increase in IMITAB is dependent

Table 2: OLS and Blundell-Bond linear dynamic panel estimations

Dependent variable: IPR Explanatory variables:	(1) Pooled OLS	(2) Pooled OLS	(3) Dynamic panel	(4) Dynamic panel
IPR lag 1	-	-	.674***	.811***
			(8.50)	(7.30)
IMITAB*lnPATENTPC	−.007**	−.005*	−.012***	−.011**
	(−2.19)	(−1.77)	(−3.04)	(−1.98)
lnPATENTPC	.167***	.176***	.036	.065
	(3.66)	(5.03)	(.63)	(.91)
lnGDPPC	.172*	.190***	.189	.025
	(1.73)	(2.84)	(1.56)	(.15)
lnPOP	.118**	.106***	.044	.014
	(2.61)	(2.83)	(.83)	(.19)
WTO	.256	.222	.357**	.299
	(1.18)	(1.20)	(2.11)	(1.41)
TRADE	.0002	-	-	-
	(.19)			
FDI	.0005	-	-	-
	(.57)			
ECOFRE	.072	-	-	-
	(1.06)			
Observations	423	453	441	441
Groups	-	-	100	100
Instruments	-	-	90	44
Year dummies F (1-2) or χ^2 (3-4)	7.72***	11.97***	21.59***	22.54***
Regression F (1-2) or χ^2 (3-4)	50***	58***	1332***	724***

The estimation sample is 1980-2005 (5-year intervals), including initial lags; robust t (1-2, errors clustered by country) and z-statistics (3-4) in parenthesis; significance levels: *10%, **5%, ***1%; all model specifications include constant; specifications (3-4) treat lnPATENTPC as endogenous; "ln" refers to natural logarithm of the variable.

on lnPATENTPC.[14]

An increase in GDP per capita implies that the quality level of products to purchase is higher. The significantly positive effect of GDP per capita in Specification (1) and (2) confirms that more developed countries have stronger patent regimes. On the contrary, whenever the dynamic structure of the data is accounted for in Specification (3) and (4), it is not the level of development *per se* that influences the adoption of IPR, but rather the patent profits. Once patents and imitative ability are controlled for, the GDP per capita variable is no longer important.

[14]Therefore, the positive relation between IMITAB and IPR presented in Figure 1 is reversed once PATENTPC are taken into account.

The coefficients for population, representing market size, are positive consistent with the scale effect on IPR architecture costs. Since the TRIPs agreement requires WTO members to increase their IPR standards, the coefficient estimates for WTO are found positive. Trade, FDI, and economic freedom have positive influences on IPR but are not statistically significant at conventional levels. Therefore, they are dropped after Specification (1) to gain estimation efficiency.

All models have significant (increasing) year dummies, pointing to a time trend in IPR. It seems, therefore, that countries institute patent regimes in response to global pressure on the level of patenting. The Arellano-Bond tests for serial correlation in the first-differenced errors at order one[15] and two are, for Specification (3), respectively $z = -3.70^{***}$ and $z = -2.47^{**}$, and, for Specification (4), respectively $z = -3.67^{***}$ and $z = -2.42^{**}$. Finally, the Sargan test of overidentifying restrictions, that tests the null that the overidentifying moment conditions of the models are valid, is, for the homoscedastic version of Specification (3), $\chi^2(78) = 86.73$, and of Specification (4), $\chi^2(32) = 56.11^{***}$. Even if the diagnostic tests suggest that the estimated dynamic specifications are not fully satisfactory, the model is supported by the fact that the estimated coefficients are largely in line with the theoretical economic hypotheses.

Consistent with the theoretical predictions, the empirical analysis finds that patents and imitative ability are strong determinants of patent protection levels across countries and time. In particular, a comparison of all the results shows that the qualitative nature of the effect of imitative ability on the relation between residents' patents and IPR adoption is quite robust, giving strong support for Observation 2 and 3. Representing profits by innovation and innovative capacity, patents positively impact on IPR, but this impact decreases with imitative ability.

5 Conclusion

While IPR may be considered an important determinant of rich economies' innovation and growth rates, other instruments, like imitation, may be more relevant for DC (the South). Under imitation, a higher share of newly discovered goods, services, and processes would be available at cheaper prices. An IPR infrastructure, in addition to stimulating research, has costs to operate and imposes burdens on consumers and on producers who use innova-

[15] Since first-differenced errors are negatively serially correlated by construction, rejecting the null hypothesis of no serial correlation at order one is expected.

tions in their work. The cost of drafting patent legislations, training skilled personnel, and building the necessary IPR institutions can be too high for DC. In their pursue of the maximum social welfare, DC have to thoroughly choose whether and how much to comply with international commitments on IPR. This paper develops the intuition that the advisability of tight IPR depends on variables like the amount of research performed, the capacity of imitating, and the quality level of domestic products. Only after having developed a full fledged R&D capacity, a country has incentives to change its legislation in favour of stricter IPR.

At low levels of economic development, an increase in a country's technology has a lower impact on domestic innovations than on the ability of imitating Northern technologies, which makes IPR less desirable. Once the country's technology is above a certain threshold, since the effect of domestic innovations on social welfare dominates that of imitative ability, the optimal protection of IPR increases. The main result of this paper is that the South finds profitable to adhere to the IPR international architecture once it has the capacity to generate the IP that guarantees a sufficient participation in the multinational's profits. This threshold level of participation, $\tilde{x}$, is positively related to the imitative ability of the South. Or equivalently, given the profits share, there is some level of imitative ability after which participation is not optimal. An interaction term in the empirical validation is included to account for this.

The empirical results support the implications of the theoretical model. They confirm both the positive impact of patents on adopted level of IPR protection and the presence of an imitation effect on this impact. The significant negative coefficient on the interaction between residents' patents and imitative ability is evidence that a higher level of imitative ability requires a higher level of patents to sustain a given level of IPR. A higher adoption of IPR is also observed for countries with higher levels of development and a larger market size. However, whenever the dynamic structure of the data is accounted for, the proxy variables GDP per capita and population are no longer important and it is WTO participation that positively affects IPR.

This work illuminates the conflict opposing countries over TRIPs agreement and, more generally, strong IPR enforcement. At the core of this conflict are profits by innovation, innovative capacity, and imitative ability. Given that no variable among these is exogenously given, a promising direction for further research should be to better explore the possibility and the mechanism by which a country could convert imitative ability in R&D capacity.

Table 3: Sample breakdown by 5-year interval

Year	N. of countries	%
1980	70	15.45
1985	74	16.34
1990	70	15.45
1995	83	18.32
2000	83	18.32
2005	73	16.11
Total	453	100

A Data

The empirical analysis is based on a macroeconomic panel dataset relative to a hundred countries' economies for which comparable data are available. The data cover the period 1980-2005. A sample breakdown by 5-year interval is presented in Table 3. The variables used in the analysis are obtained as follows:

- IPR is the index of intellectual property rights protection as measured by Ginarte and Park [1997] and Park [2008]. It is an unweighted sum of scores for coverage, membership in international treaties, duration of protection, enforcement mechanism, and restrictions.
- IMITAB is the imitative ability proxied by the mean years of schooling of adults, that is the average number of years of education received by people aged 25 and older, converted from education attainment levels using official durations of each level (source: International Human Development Indicators and Barro and Lee [2012]).
- PATENTPC is the per capita number of residents' worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention (source: World Intellectual Property Organization).
- GDPPC is the real gross domestic product divided by midyear population (source: World Bank and OECD). Data are in constant 2000 U.S. dollars.
- POP is the de facto total population, which counts all midyear estimates of residents regardless of legal status or citizenship (source:

United Nations Population Division).

- WTO is a dummy for world trade organization membership (source: WTO).
- TRADE is the sum of exports and imports of goods and services measured as a share of gross domestic product (source: World Bank and OECD).
- FDI is foreign direct investment composed by net inflows of investment (new investment inflows less disinvestment) to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in the economy from foreign investors as a share of gross domestic product (source: IMF, World Bank and OECD).
- ECOFRE is an economic freedom index composed by size of government and taxation, private property and the rule of law, soundness of money, trade regulation and tariffs, regulation of business, and labour and capital markets (source: Fraser Institute).

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