In the name of TRIPS: the impact of regulatory changes on patent activity by residents and non-residents in Latin America[1]

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ABSTRACT

We analyse the effect of country-specific regulatory changes inspired on Trade Related Aspects of Intellectual Property Rights (TRIPS) on patenting activities in Latin America (LA). TRIPS constitutes a major milestone in terms of international harmonisation of intellectual property rights (IPR). Harmonisation means, in practice, that developing countries make their regulation on IPR more stringent. By analysing national legislation on IPR for 44 countries, we built exogenously a variable that captures when each country hosts "the spirit of TRIPS". This allows us to assess the impact of paradigmatic TRIPS requirements on patenting activities. We follow two goals: i) to assess whether such impact was different in LA than in developed countries; ii) to analyse the difference in how residents and non-residents reacted to changes in regulations in LA. Our results support the hypothesis that more rigid regulations on IPR pushed forward by TRIPS in LA had a positive impact on patenting, but only on non-residents, while patenting by residents was negatively affected by those changes.

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1. **Introduction**

In the last decades and in particular after the signature of the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement in 1994, there has been a clear trend towards the harmonization of intellectual property rights (IPR) regimes around the world. For most developing countries, harmonization meant, in practice, a strengthening of their IPR laws.

There are theoretical arguments suggesting that stronger IPR regimes could favor innovation and technology transfer in developing countries. However, others have argued that lax IPR regimes could be better for countries in early stages of technological development. In fact, it has been stated that technology accumulation in developed countries (DC) that have become global innovation leaders took place in a context of much weaker IPR regimes than those currently in place in most nations (Chang, 2002).

The debate about the impact of strong IPR regimes on developing countries has spurred a number of contributions which led to heterogeneous results. Notwithstanding this heterogeneity, these studies mostly show that more stringent patent regimes often fail to stimulate innovation activities in developing countries. They may stimulate patenting activity, but mostly for non-residents.

However, most of these studies do not analyze specifically the impacts of TRIPS-oriented patent reforms, but compare countries with different levels of IPR protection. Moreover, to the best of our knowledge, the studies that do deal with TRIPS do not identify the specific date in which countries adapted their patent regimes to reach TRIPS compliance.

In this paper we review national patent legislation of 44 countries to identify the specific date in which their national laws aligned with some of the most important mandates included in the TRIPS agreement. More specifically, we identify the dates in which each country established that patent length was 20 years and when they stopped excluding some sectors from the possibility of patenting. On this basis we are able to build exogenously a variable that captures when each country hosts "the spirit of TRIPS".

This allows us to assess the impact of regulatory changes aligned to TRIPS on patenting activities. We are specifically interested in Latin American (LA) countries, since almost all countries in the region had to adapt their patent laws in order to meet TRIPS requirements. As a first step in the analysis, we assess whether changes in the regulations in DC and in LA countries that strengthen patent protection to TRIPS mandates, occurred before or after 1994 (when TRIPS was signed). Then, we pursue two main empirical goals: i) to assess whether the impact of TRIPS-oriented patent reforms was different in LA than in DC; iii) to analyse the difference in how residents and non-residents reacted to changes in patent regulations in LA, an issue that, in spite of its relevance in the conceptual discussion, has been seldom analyzed empirically.

We build a dataset of patents grants, patents applications and relevant economic variables for 30 DC and 14 LA countries for the period 1980-2018. We identify the year when each of these countries changed their regulation accordingly to TRIPS main mandates. We estimate zero-truncated negative binomial regressions in a differences-in-differences (DiD) framework to compare LA against DC, regarding the impact on patenting activities due to changes in patent regulations. We pursue similar steps to assess reaction by residents against not residents.

The analysis on regulatory changes shows that while LA countries had to strengthen their patent laws after TRIPS, DC had already aligned their patent systems to those minimum standards before signing the agreement. We found that patenting activities were not affected by changes in regulations, neither in DC nor in LA countries, when controlling for several factors including time and country fixed effects. Instead, changes in regulation seemed to benefit particularly residents from DC: we found that as a consequence of those changes, patenting activities increased more for residents in relation to non-residents in DC while the opposite was true for LA countries.

The structure of the paper is as follows. In section 2 we briefly review the conceptual framework around the impact of patent regimes on innovation in developing countries. Section 3 describes the objectives and content of the TRIPS agreement. Section 4 presents the hypothesis that we aim to analyze through our research. Section 5 describes the methodology and the sources of information. The descriptive statistics and the results of our econometric analysis are presented in Section 6. Section 7 concludes.

2. **Theory: patents, innovation and development**

Patents are exclusive rights of production, copying, distribution and licensing of a technology within a country granted by the State. This means that whoever registers a technology using the patent system has the right for several years to make crucial decisions about the conditions in which that knowledge will be used. The rationale of patent systems is that exclusive rights are needed to generate incentives for innovation. If competitors are not excluded, innovators could not appropriate the rewards of their efforts and they would be discouraged. Hence, innovation levels would be lower than optimum at the society level.

Patents are granted only to innovations that meet a number of criteria, including novelty and non-obviousness (or inventive step). Most of the innovations that meet these criteria are originated in DC, as well as in Asian Tigers and increasingly in China and India. Firms and research organizations in these countries have not only the human resources and the knowledge base required to undertake world-class innovation activities, but also the monetary resources needed to finance that kind of activities; in the case of firms, they also often have other complementary assets required for a profitable exploitation of patented technologies -e.g, marketing and production capabilities, established brands, etc. Hence, stronger patent systems would primarily benefit innovators in those countries.

Yet, there are theoretical arguments claiming that developing countries would also benefit from stronger patent regimes. The first one replicates the basic rationale for patents; namely, that the existence of monopoly rights over patented knowledge provides incentives to make investments in innovation that otherwise would not have taken place due to weak appropriability conditions. Hence, stronger patent systems would stimulate knowledge creation activities, because they guarantee some degree of appropriability to innovative firms operating in developing countries. Secondly, patent protection may have a positive effect on foreign direct investment as well as on embodied or disembodied technology transfer by multinationals since these firms may be more prone to use, export and/or license their technological assets to countries which offer a legal environment that prevent from copying (Fink and Maskus, 2005). Thirdly, stronger patent systems in developing countries may orient the research agenda of international firms towards technological needs of these regions. This has been argued especially for research in the health area (Akiyama and Furukawa, 2009; Diwan and Rodrik, 1991).

In contrast, there are also theoretical arguments suggesting that in developing countries the costs of patents (associated with the price increase in technological inputs) tend to outweigh the benefits, making weaker IPRs preferable (Park, 2007). This is due to several contextual factors characterising developing countries' innovation systems, which has given rise to the hypothesis of non-linearities in the effect of patents on innovation (Hudson and Minea, 2013).

To begin with, wealth is lower and firms have less resources in developing countries. Thus, an increase in R&D costs due to patents may be more limiting for firms operating there (Park, 2007). Secondly, higher costs also hinder technology diffusion and imitative innovation strategies, which prevail in developing countries. The availability of absorptive capabilities, such as human capital, are lower in developing countries (Sweet and Eterovic Maggio, 2015), thus the returns to innovation efforts are also lower. This implies that the potential positive effects of patent systems in creating incentives for innovation may be easily outweighed in the South by the negative effects on technology diffusion and imitation. In fact, some authors claim that since local innovation in the South tends to be lower quality it is preferable to create conditions for imitation and dissemination of high quality international innovations (Chen and Puttitanun, 2005).

The importance of reducing the costs of imitation in relation to IPRs is addressed by the so-called "North-South models". Grossman and Lai (2004) develop a model where the benefits of IPRs depend on market size and innovation capabilities. If the developed markets are larger and have more innovation capabilities, they will have a greater share in the global returns to innovation, so it is logical that the optimal level of IPR in those countries is higher than in less developed ones. As a consequence, only once innovative capabilities are acquired and countries get closer to the international frontier it makes sense to create local appropriability conditions for domestic innovation (Chu et al., 2014). Taking this argument further implies that international harmonization lacks a sound conceptual basis because not everyone enjoys the same opportunities to benefit from patents.

This paper fits into the discussion about the rationale for more stringent patent rights in developing countries, with the focus on LA. It poses the following research question**s: how do TRIPS-related regulations affect patenting activities in LA countries?**

3. What does TRIPS imply?

Before the signature of the TRIPS agreement the legal international framework around intellectual property issues was built around a series of treaties administered by the World Intellectual Property Organization (WIPO). In the case of patents, the relevant treaty was the Paris Convention, signed in 1883 and later on modified by several amendments. This treaty, whose adherence was not mandatory not related to any other international disciplines, gave countries ample flexibility for adopting different rules in terms of the duration and scope of their respective patent laws. A report prepared in 1987 by WIPO analyzed more than 100 countries and found that patent duration went from 5 to 20 years, and that only in 35% of the cases the maximum duration was 20 years. Another similar report found 19 different technological sectors which were excluded from patentability in at least one of the countries under analysis. The pharmaceutical sector was the most usual target of these exclusions and it is only in the 1960s that a general trend towards the patentability of medicines begins to take place in DC (Roffe and Santa Cruz, 2006).

The TRIPS agreement, signed in 1994 and valid since 1995, meant a dramatic change in this scenario. First, it was part of a wider series of agreements signed during the so-called Uruguay Round that also gave place to the birth of the World Trade Organization (WTO); since then on, intellectual property issues are included within the multilateral trading system rules and disciplines. Second, it set a number of minimum global standards for patenting and other intellectual property rights. In the case of patents the main provisions aimed at reinforcing the scope and strength of patent rights include: i) the term of protection must be at least twenty years from the date of filing of an application; ii) patents must be admitted in all technology fields[2]; iii) no discrimination is allowed with respect to the place of the invention, or based on whether the products are locally produced or imported; iv) the so called reversal of the burden of proof in civil proceedings relating to infringement of process patents is to be established if certain conditions are met (if a person is suspected of having infringed the patent for a process, then he or she must prove his or her innocence). The agreement also established a number of administrative and judicial procedures in order to improve the enforcement of patent rights.

Developed countries had one year (until 1996) to become TRIPS-compliant, while developing countries had five years (until 2000), and least-developed countries had 11 years (until 2006). Developing countries and least-developed countries that had not previously recognized pharmaceutical patents had 10 years to become compliant (until 2005[3]).

4. Hypothesis building

As legal rights, patent systems have become increasingly global since the turn of the XXI century. This process implied tight negotiations among stakeholders with conflicting interests, and it could be enforced globally thanks to the participation of the WTO. As said before, one crucial milestone in international **harmonisation**, when several countries agreed on new bottom lines for their national regulations, was the TRIPS agreement. Negotiations over TRIPS witnessed DC pushing for stronger systems while developing countries tried to defend the *status quo* in an attempt to commit as little as possible with more rigid rules. As a consequence of TRIPS and other previous international agreements, the patent system became more global, and especially for developing countries but for other countries too, harmonisation drove to **strengthen** their national IPR laws. Park and Lippoldt (2008) claimed that since 1995 (just after TRIPS) developing countries "experience greater percentage increase in IPR strength than did the developed world" (pp.28). Thus, we could claim that while DC legislation was mostly aligned with the minimum TRIPS standards, most LA countries had to adjust their patent laws to become TRIPS-compliant (Oliveira et al., 2004).

Following this argument, we propose:

Hypothesis 1: By signing TRIPS LA countries had to adjust their patent laws towards more stringent regulation more frequently than DC, whose regulations were already TRIPS-compliant.

The conceptual discussion on section 2 shows that while some scholars argue that developing countries would also benefit from more stringent IPR regulations, other scholars claimed the opposite. Thus, another issue we investigate is whether reaching milestones in patent laws aligned to TRIPS mandates, whenever they have occurred, had the same impact on patenting activities in LA and in DC.

The empirical literature summarised in Table A1 in Annex provides little support to the traditional rationale for promoting more rigid IPR in developing countries (i.e. that it would stimulate innovation in better protected markets). In contrast, there is some support to the argument that stronger systems favour technological transfer, mostly through licensing and trade (Watson, 2011; Sharma and Saxena, 2012).

Regarding the former, the positive effects on patenting activities due to more stringent IPR laws found in studies such as Di Vita (2013) and Kanwar and Evenson (2003), mainly reflect the results of DC,

[2] The only exceptions are: a) diagnostic, therapeutic and surgical methods for the treatment of humans or animals; b) plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, countries must implement a system for protection for plant varieties, either by patents or by a sui generis system or by any combination thereof.

[3] In November 2001, this period was extended to 2016 for least-developed countries

which is clear once developing countries are analysed separately. Schneider (2005), using information of a group of 42 developed and developing countries for the 1970-1989 period, finds that patent strength (measured by the index developed by Ginarte and Park (1997)[4]) has a positive impact on innovation (measured as the number of US patent applications by residents of a given country) in DC but a negative effect on developing ones. In turn, Chen and Puttitanum (2005) find that stronger patent protection has a positive impact on patent applications made in the United States Patent and Trademark Office only after some economic development threshold (measured by GDP per capita levels) is attained.

Some studies that focus on the pharmaceutical industry, one of the few sectors for which patents are the most relevant appropriability mechanism (Cohen et al., 2000), find similar results. Qian (2006), using a panel of 92 countries, analyzes 26 countries that established pharmaceutical patent laws during 1978-2002. Its findings show that national protection per se does not stimulate domestic innovation (measured by citation-weighted U.S. patents awards, the level of domestic R&D investments and pharmaceutical industry exports). However, innovation does increase in countries with higher income per capita and larger human capital and economic freedom levels. Gamba (2017) analyzes the impacts of IPR compliance with TRIPS in pharmaceuticals with data for 74 developed and developing countries over the period 1977-1998. The author finds that innovation (measured as patent filings at the European Patent Office) is sensitive to the introduction of IPR protection for pharmaceuticals but that developing countries profit significantly less -roughly half- than developed ones from it, suggesting that to take advantage from increased levels of protection developing countries should avail other assets needed for innovation such as infrastructure, human capital and credit.

Regarding technological transfer, there are positive effects found particularly in relation to licensing (Branstetter et al., 2006; Yang and Maskus, 2001; Smith, 2001) and trade (Fink and Primo Braga, 2005; Ivus, 2010; Falvey et al., 2006) while results of stronger IPRs on FDI are mixed. For example, Park and Lippoldt (2008) find positive effects -which are larger in DC-, Nunnenkamp and Spatz (2004) suggest that FDI is responsive to IPR protection only for countries above certain threshold of human capital and Kanwar and Sperlich (2019) find no effects in developing countries. Hamdan-Livramento (2009) uses indexes for TRIPS compliance and enforcement for a sample of developing countries exclusively for the period 1994-2005. The author finds that TRIPS impact is positive on technological transfer measured as FDI flows and licensing but negative for the actual application on new technologies (measured as the ratio between entrepreneurs using new technologies over total entrepreneurs); the suggested interpretation of this finding is that TRIPS compliance may increase the costs of using new technology by entrepreneurs in developing countries.

This discussion is not conclusive but seems to support the argument that DC may benefit more largely than developing countries from stronger patent regulations. This is also consistent with the political economy of international IPR regulations, since DC historically pushed for more stringent rights *vis a vis* developing countries (Drahos, 2007; Adede, 2003; Kuanpoth, 2003). Thus we pose our second hypothesis.

Hypothesis 2: After aligning patent laws to the minimum standards designated by TRIPS (whenever it occurs) patent activities in LA countries increased less than in DC.

In recent years, there has been a discussion regarding whether patents reforms favour resident or non-residents firms (see Table A1 in Annex). A series of studies use patent strength indexes to discuss the potential effect of reforms on that dimension. Allred and Park (2007), on the basis of a panel of 100

[4] The index considers 5 dimensions: extent of coverage, membership in international patent agreements, duration of protection, provisions for loss of protection and enforcement mechanisms.

countries and data for 1965-2000, find negative effects of patent strength -measured with the index by Ginarte and Park (1997) and Park and Wagh (2002)- on patenting by residents and no significant effects on non-residents patent filings in developing countries. Falvey et al. (2006), for a panel of 47 countries between 1975 and 1994, find non-significant effects on domestic patent applications while positive effects on foreign applications in countries with low levels of GDP per capita. Arza and López (2013) using a panel of 41 countries find that in LA only non-residents increased patenting activities in the scenario of stronger IPR systems after TRIPS signature. German-Soto and Chapa Cantú (2018) look for structural changes in time series of number of patents by country and find them mainly for non-residents in the case of developing countries. Interestingly, all these studies find positive effects in patenting by residents when DC are considered instead.

In contrast, very few studies assess the effect of actual reforms. For example, Branstetter et al. (2006) examine 18 episodes of IPR reforms in developing countries between 1986 and 1997 and find that residents patent filings are largely unaffected by those reforms, while non-residents filings grow after those episodes. Similarly, Lerner (2002) analyzes 177 cases of changes of the IPR system across sixty countries between 1950 and 2000 and finds that their impacts on patent applications by residents was negative, while foreign applications reacted positively to those changes. Finally, Huang et al. (2017) analyze the differential impact of the 2001 IPR reform in China on Western and Chinese firms and suggest that Chinese firms may be less responsive to patent law strengthening since they are embedded in a culture in which informal institutions prevail. They use a data set of 1070 patents granted between 1985 and 2008 both in China and the United States (i.e. they analyze patents which have been approved in both countries) to Chinese and Western firms conducting R&D operations in China. The results confirm their hypothesis as they show that Chinese firms are less likely to apply for patents than Western firms.

Overall, the literature is yet scant and fragmented but it suggests that strong patent protection benefits more non-resident firms than resident firms in developing countries. Therefore, we pose:

Hypothesis 3: After LA countries aligned their patent laws to the minimum standards designated by TRIPS (whenever it occurs), residents of those countries benefited less than non-residents (i.e. their patent activities increase less)

5. Methodology

5.1 Sources of information

We built a dataset of 30 DC and 14 LA countries. For these countries we use information provided by the World Intellectual Property Organization (WIPO) on patents applications (PA) and grants (PG) by residents and non-residents in each national patent office We employ World Bank data (World Development Indicators database) for selected macroeconomic control variables[5] for the period 1980-2018, and European Patent Organization data and Patent Cooperation Treaty data (from WIPO) for other control variables as can be seen in Table A2 in Annex. In addition, we used several primary and secondary sources listed in Table 1 to identify regulatory changes in patent laws for each of those countries, as explained in further details in the following section.

5.2 Methods for hypothesis testing

In order to test for the hypotheses, we first need to build a variable that identifies the year when each country modified its Patent Law in a way that guarantees a minimum standard established by TRIPS. To that end we reviewed the national legislation of all countries included in the sample and in some cases we also used secondary evidence.

Following Branstetter et al. (2006) reforms in patent systems can be grouped in five categories: i) expansion of eligible inventions; ii) expansion of patent length; iii) expansion of patent scope; iv) improvement in patent enforcement; v) improvement in patent administration. For the sake of our exercise we focus on issues i) and ii) which are directly reported in the legislation and involve benchmarks that can be strictly compared across countries. While dimensions iv and v are also reflected in the legislation, establishing clear benchmarks is challenging and their real impact also depends on the effective enforcement of the regulations. In turn, dimension iii refers to the broadness of allowed patent claims, and is difficult to compare across national legislations.

In Table 1 we identify two turning points in patent reforms for each country associated with dimensions i and ii. We identify the year[6] when reforms enabled patenting activities in all sectors that are eligible by TRIPS (NSR, no sector restriction). In pragmatic terms in most cases this was the year of patent reform that allowed patents on pharmaceutical products. We also identify the year when there was an expansion of patent length that increases patent duration up to a minimum of 20 years (PL20, patent length of minimum 20 years). We establish the most recent of those years as the one that defines when patent laws are aligned to the *spirit of TRIPS* (ST).

To test for Hypothesis 1 we compare values of these two indicators in different subsamples of countries, to identify whether, in contrast to DC, LA countries had to adjust their patent laws, making them stricter, after signing TRIPS.

We then use the ST year to identify breaking points in patenting activities, in all countries in our dataset and in LA, in particular (Hypothesis 2), and even more specifically by LA resident firms (Hypothesis 3).

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[5] We also use data from the Penn World Table 9.0 (Feenstra et al., 2015) to complete some missing World Bank data.

[6] If the reform took place after June 30th, it counted for the following year.

To that end we compare patenting trends in LA with those observed in DC, by estimating differences-in-differences (DiD) models. This a methodological design to assess the effect of 'treatment' for one group controlling for the differences between treated and untreated groups that may be unrelated to the 'treatment'. The method has been widely used since its introduction by Ashenfelter and Card (1985). We use zero-truncated negative binomial regression framework because we work with over-dispersed count data where only positive observations were informed. The baseline equation to be estimated is:

$$E(X_{ct}, ST_{ct}, L_c) = exp(X_{ct}\beta_1 + \beta_2 ST_{ct} + \beta_3 L_c + \beta_4 ST_{ct} * L_c) \qquad \text{Eq [1]}$$

Where sub-indices c and t, represents countries and years, respectively. The dependent variable P is alternatively measured as granted patents or applications. The explanatory variables are ST ('Spirit of TRIPs') which is a dummy variable that adopts the value 1 since the year the regulation was first adapted to be aligned to 'spirit' of TRIPS per country, as showed in Table 1. Variable L is a dummy variable to identify Latin-American countries. The vector X includes control variables informed by the empirical literature as important determinants of patenting activity. Descriptive statistics of these variables can be found in Table A2 in the Annex. These are: country size (population in millions), wealth (constant 2011 international dollars PPP GDP per capita), infrastructure (investment as share of GDP expressed in percentage points), trade openness (imports plus exports as share of GDP expressed in percentage points) and two additional controls for relevant regulations: a dummy that identifies the period since when the countries signed the Patent Cooperation Treaty (PCT) and a dummy for the years since when countries became members of the European Patent Organization (EPO). These two dummies are included because both regulatory arrangement could decrease incentives to patent in the different national offices involved. We include year dummies in all specifications and coefficients are estimated using cluster (by country) standard errors.

Coefficients in negative binomial regressions can be transformed to be interpreted as semi-elasticities. By applying logs to both sides of Equation [1] we can write:

$$E(log(X_{ct}, ST_{ct}, L_c) = X_{ct}\beta_1 + \beta_2 ST_{ct} + \beta_3 L_c + \beta_4 ST_{ct} * L_c \qquad \text{Eq [2]}$$

Then

$$\beta_1 = \frac{\partial log(P)}{\partial x} \cong log\ log\ (P_{x0+1}) - l(P_{x0}) = \frac{P_{x0+1}}{P_{x0}}) \quad \text{Eq [3]}$$

By applying exponential (exp) to both sides of Equation [3] and subtracting 1 we obtain the proportional change in patents for each marginal change in X, which is the semi-elasticity of variable x on P.

$$exp(\beta_1) - 1 = \frac{P_{x0+1} - P_{x0}}{P_{x0}} \qquad \text{Eq [4]}$$

In non-linear models the interpretation of coefficients for interactions terms also need to be transformed to be able to interpret them as additional effects to given semi-elasticity. To test for Hypothesis 2, we need to assess whether there was a significant the effect of ST for LA countries. In other words, we want to learn whether the variable L significantly modified the semi-elasticity of the variable ST on P. To this end we follow the suggestion made by Shang et al. (2017) to estimate the difference in semi-elasticities (DIS) from coefficients estimated in Eq [2].

$$DIS_1\ [of\ E(X_{ct}, ST_{ct}, L_c)\ with\ respect\ to\ ST_{ct}] = exp\ exp\ (\beta_2 + \beta_4)\ - exp\ exp\ (\beta_2) \qquad \text{Eq [5]}$$

If DIS_1 is negative and significant, we validate H2.

For Hypotheses 3 we expand our database to include patents by residents and non-residents for each country and we estimate Equation [6]

$$E(X_{ct}, ST_{ct}, L_c) = exp(X_{ct}\gamma_1 + \gamma_2 ST_{ct} + \gamma_3 L_c + \gamma_4 ST_{ct} * L_c + \gamma_5 R_{crt} + \gamma_6 R_{crt} * ST_{ct} + \gamma_7 R_{crt} * L_c + \gamma_8 R_{crt} * L_c * ST_{ct}) \qquad \text{Eq [6]}$$

The sub-index r identifies in each country and time periods, patents by residents and non-residents. We add the dummy R to the estimation that adopts the value 1 when r=resident and the value 0 when r=non-resident. For Hypothesis 3 we are interested in testing additional effects in patenting activities after TRIPS oriented reforms in LA by residents in relation to non-residents of those countries. Following Arroyabe et al. (2020), who used the Shang et al. (2017) DIS framework in the context of triple interactions, we estimate DIS_2 from Eq [6]

$$DIS_2\ [of\ E(X_{ct}, ST_{ct}, L_c)\ with\ respect\ to\ ST_{ct} * L_c] = exp\ exp\ (\gamma_4 + \gamma_8)\ - exp\ exp\ (\gamma_4) \qquad \text{Eq [7]}$$

If DIS_2 is negative and significant, we validate H3.

We estimate several specifications of Eq [2] and Eq [6] using patent applications and patent grants as dependent variables and including country and time fixed effects (FE). [7]

6. Results

6.1. Descriptive results: the spirit of TRIPS

Table 1 shows the year in which each country of our sample adapted their patent legislation to the "spirit of TRIPS" (ST). In the case of non-LA countries, almost all of them had their patent laws aligned with TRIPS by the first half of the 1990s with the exception of Hungary (1996) and Korea (1997). In turn, all LA countries had to adapt their patent legislation after the signature of TRIPS with the exception of Mexico (which had to undertake that adaptation in 1992 within the negotiations that led to the signature of the North American Free Trade Agreement with the US and Canada). In fact, only Brazil, Ecuador and Mexico were aligned with the TRIPS spirit before the beginning of the new century. LA countries adapted their regulation to TRIPS compliance around the year 2000, which marked the maximum limit authorized in TRIPS agreement for developing countries. In contrast, in DC patent regulation aligned to the ST came before TRIPS, around the year 1990. This suggests that the enforcement of TRIPS, beyond harmonization, also implied strengthening the patent regulations in LA countries, which goes in line with Hypothesis 1.

[7] For robustness checks we: i) exclude countries FE to estimate the semi-elasticity of being a 'LA country' (see Table A5 in the Annex), ii) we exclude Japan and United State from the sample, to control for outliers (see Table A6 in the Annex).

Table 1. Regulatory changes by country, and sources of information

	Country	Spirit of TRIPS (ST)	No sector restriction (NSR)	Source for NSR	Patent length=20 years (PL20)	Source for PL20
Latin-American Countries	Argentina	2001	2001	Law 24481 on Patents and Utility Models, as amended by Law 24572 (September 1995) - patents on pharmaceutical products were allowed only after five years of the publication of the law)	1995	Law 24481 on Patents and Utility Models, May 1995
	Bolivia (Plurinational State of)	2001	2001	Decision 486 of the Andean Community (CAN), September 2000.	1994	Decision 344 of the Commission of the Cartagena Agreement, October 1993.
	Brazil	1997	1997	Law 9729 on Industrial Property, May 1996 (the law provisions entered into force in 1997)	1997	Law 9729 on Industrial Property, May 1996 (the law provisions entered into force in 1997)
	Chile	2005	1991	Law 19039, January 1991	2005	Law No. 19,039 on Industrial Property, as amended by Law 19996 (February, 2005)
	Colombia	2001	2001	Decision 486 of the Andean Community (CAN), September 2000.	1994	Decision 344 of the Commission of the Cartagena Agreement, October 1993.
	Costa Rica	2000	1983	Patent Law (Invention, Designs and Industrial Models and Utility Models) No. 6,867, April 1983	2000	Law 6867 as amended by Law 7979 (January 2000)
	Ecuador	1998	1998	Intellectual Property Law No. 83. May 1998	1994	Decision 344 of the Commission of the Cartagena Agreement, October 1993.
	Guatemala	2001	2001	Industrial Property Law (Decree No. 57-2000), September 2000	2001	Industrial Property Law (Decree No. 57-2000), September 2000
	Honduras	2000	2000	Industrial Property Law (Decree No. 12-99-E), December 1999	2000	Industrial Property Law (Decree No. 12-99-E), December 1999
	Mexico	1991	1991	Industrial Property Law, June 1991	1991	Industrial Property Law, June 1991
	Nicaragua	2001	2001	Law 354 on Patents, Utility Models and Industrial Designs. September 2000	2001	Law 354 on Patents, Utility Models and Industrial Designs. September 2000
	Paraguay	2005	2005	Law No. 2,047/2002 , December 2002	2001	Law No. 1,630/2000 on Patents, November 2000
	Peru	2001	2001	Decision 486 of the Andean Community (CAN), September 2000.	1994	Decision 344 of the Commission of the Cartagena Agreement, October 1993.

	Uruguay	2002	2002	Law 17164 on Patents, Utility Models and Industrial Designs, September 1999 (the law established that pharmaceutical products would not be patentable until November 1 2001)	2000	Law 17164 on Patents, Utility Models and Industrial Designs, September 1999
	LA (average)	**2000**	**1998**		**1998**	
Developed Countries	Australia	1995	1991	Patents Act No 83, October 1990	1995	Patents (World Trade Organization Amendments) Act 154, December 1994
	Austria	1995	1992	Law on Patents 1970 (as amended up to Federal Law No. 819/1994	1995	Law on Patents 1970 (as amended up to Federal Law No. 819/1994
	Belgium	1984	1984	Patent Law, March 1984	1984	Patent Law, March 1984
	Canada	1990	1987	Canada Patent Act R.S.C 1985	1990	Patent Act R.S., 1985, as amended by R.S., 1985, c.33
	Czech Republic	1991	1991	Law No. 527, November 1990.	1991	Law No. 527, November 1990.
	Denmark	1986	1986	Consolidate Patents Act No. 110, March 1986.	1986	Consolidate Patents Act No. 110, March 1986.
	Estonia	1994	1994	Patent Act March 1994	1994	Patent Act March 1994
	Finland	1996	1996	Patents Act No. 1967/550, as amended up to Act No. 1995/1695, December 1995	1985	Patents Act No. 387, May 1985.
	France	1993	1960	Dutfield & Suthersanen (2008).	1993	Law No. 92-597 on the Intellectual Property Code, July 1992
	Germany	1976	1968	Dutfield & Suthersanen (2008).	1976	Adams (2006, p. 79).
	Greece	1993	1993	Council Regulation (EEC) 1768/1992 of June 18, 1992 "Concerning the Creation of a Supplementary Protection Certificate for Medicinal Products" and Law 2077/1992 'Ratification of the Treaty on the European Union and the respective protocols and declarations included in the final act" of August 5, 1992	1988	Law on Technology Transfer, Inventions and Technical Innovation No. 1733/1987 (as last amended by Law No. 1739/1987, November 1987)
	Hungary	1996	1996	Patent Act 33/1995, April 1995 (the provisions of the law were made effective by January 1, 1996)	1984	Patent Act No. 2 of 1969, as amended by Decree Law No 5 in 1983
	Iceland	1997	1997	Patents Act No. 17/1991, December 1991 (patents for pharmaceutical products were allowed only after five years after the entry into force of the Act)	1992	Patents Act No. 17/1991, December 1991.
	Ireland	1992	1964	Dutfield & Suthersanen (2008).	1992	Patents Act, February 1992
	Israel	1968	1968	Patents Law 5727, August 1967	1968	Patents Law 5727, August 1967
	Italy	1979	1979	R.D. No. 1,127, 1939, as amended by D.P.R. No. 338, June 1979.	1979	R.D. No. 1,127, 1939, , as amended by D.P.R. No. 338, June 1979.

Japan	1995	1976	Adams (2006, p. 59).	1995	Patent Act 114, December 1994
Netherlands	1987	1987	Patents Act of 1910, as amended in May 1987	1987	Patents Act of 1910, as amended in May 1987
New Zealand	1995	1954	Patents Act No 64, November 1953.	1995	Patents Amendment Act, December 1994
Norway	1993	1993	Act No. 86 of June 26, 1992 (in force December 31 of 1992).	1985	Patents Act of 1967, as amended in 1985, Art. 40.
Poland	1993	1993	Law on Inventive Activity of 1972, as amended in April 1993,	1993	Law on Inventive Activity of 1972, as amended in April 1993,
Portugal	1992	1992	Branstetter et al. (2006), Appendix	1992	Branstetter et al. (2006), Appendix
Republic of Korea	1997	1987	Branstetter et al. (2006), Appendix	1997	Patent Act 950, 1961, as amended by Law 5080, December 1995 (the increase of patent duration was made effective by July 1, 1996
Slovakia	1991	1991	Law No. 527 on Inventions, Industrial Designs and Rationalization Proposals, November 1990	1991	Law No. 527 on Inventions, Industrial Designs and Rationalization Proposals, November 1990
Slovenia	1993	1993	Law on Industrial Property of 1992, as amended in 1993, Art. 37.	1993	Law on Industrial Property of 1992, as amended in 1993, Art. 37.
Spain	1992	1992	Dutfield & Suthersanen (2008).	1986	Law 11/1986 on Patents and Utility Models, March 1986
Sweden	1994	1978	Dutfield & Suthersanen (2008).	1994	Act No. 479 of December 20, 1967, as amended up by Act 1993:1406 (in force 1994).
Switzerland	1977	1977	Dutfield & Suthersanen (2008).	1977	Federal Law on Patents for Inventions of 1954, as revised in December 1976
United Kingdom	1978	1949	Patents Act, 1949	1978	Patents Act, October 1977
United States of America	1995	1952	United States Patent Act ,1952	1995	United States Code (U.S.C.), Title 35–Patents, as amended in December 1994.
DC (average)	**1990**	**1982**		**1988**	

Notes: NSR (no sector restriction, all TRIPS eligible sectors -mainly pharmaceutical- became eligible by patent laws) / PL20 (patent length reached 20 years) / ST (max {NSR ; PL20}).

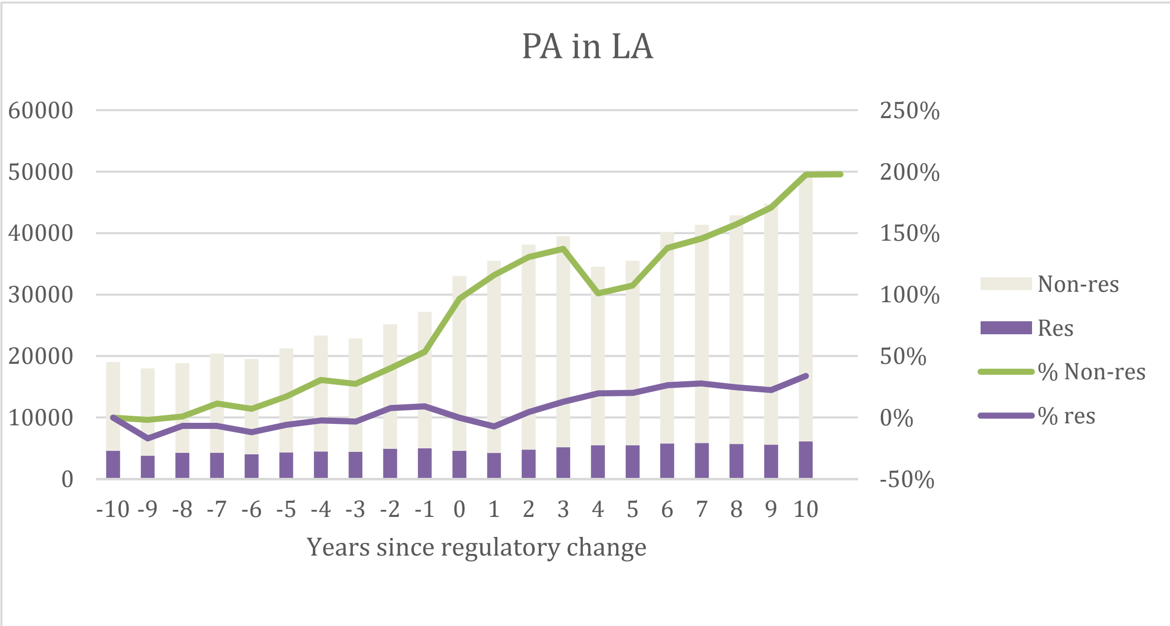
Source: Cited regulations available at WIPO Lex and cited papers.

Figures 1 to 4 shows how PA and PG evolved in LA countries and in DC in relation to the year each country first had a patent regulation that was aligned to the 'spirit of trip' (ST) (denominated by year 0 in those figures). We only graph 10 years before and 10 years after the regulatory change. In Annex, Tables A3 and A4 present accumulated figures of PA and PG for the whole period after and before ST per country and we test for the significance of the mean differences.

PA clearly grew in LA countries after patent reforms (Figure 1). PG have also increased but less intensively and in a more erratic pattern (Figure 2). The increase in means before and after ST was 258% for PA (from a mean of 1498 to 5359 PA before and after ST in average for LA countries) and 148% for PG (from 760 to 1885 PG before and after ST in average for LA countries) (see Tables A3 and A4). In DC there was also growth in patent activities after patent reforms but it was less intense (Figures 3 and 4). The increase in the mean difference before and after changes in regulation aligned to ST were 18% for PA (from 31125 to 26723) and 44% for PG (from 12132 to 17515) (see Tables A3 and A4). In the case of DC, there were marked differences between European and non-European countries. While PA showed a strong increase in the latter, they decreased in the former (except Iceland and Slovenia). This may reflect the impact of the creation of the EPO in 1977. Table A2 in Annex shows the year in which each European country in our sample became a member of EPO. As patent applicants may have the incentive to file a claim in EPO covering many European countries, this implies, *ceteris paribus*, that national patent offices receive less applications after the country joins EPO. In sum, when comparing patenting activities in LA countries and DC after changes in regulation, it seems that patenting activities grew more in LA than in DC, which goes against our Hypothesis 2.

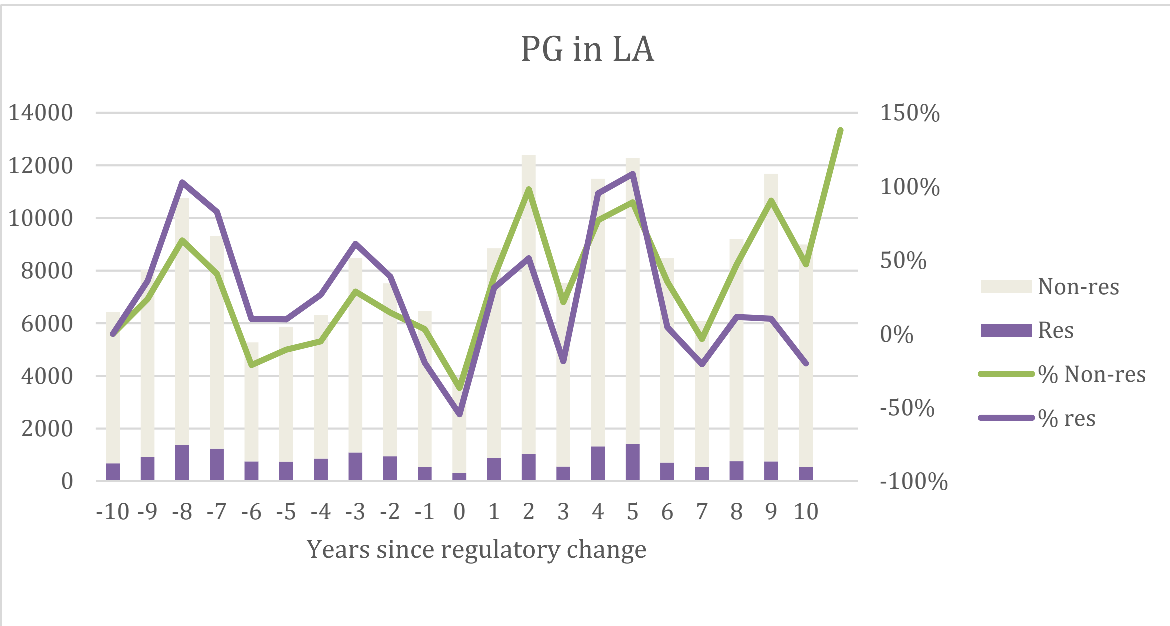
One interesting result depicted in these figures is the different behavior in patent activities by residents and non-residents in both groups of countries. In LA, growth in PA by residents after the regulatory change looks quite flat when compared with the same curve for non-residents (Figure 1). In fact, the proportion of patents filed by residents in relation to non-residents decreased markedly before and after ST (Table A3, from 22% to 13%). In DC, the difference between growth rates by residents and non-residents is not marked for PA (Figure 3), while residents seemed to widen the gap against non-residents when looking at PG (Figure 4). In LA, the behavior of PG is quite erratic for both, residents and non-residents (Figure 2). Thus, these Figures suggest that while non-residents seemed to be taking more advantage of patent reforms in LA countries, the opposite is true for DC, which goes in line with Hypothesis 3.

Figure 1. Patent Applications by residents and non-residents in LA countries over time in relation to regulatory change, in total (bars, left) and in percent change (lines, right)



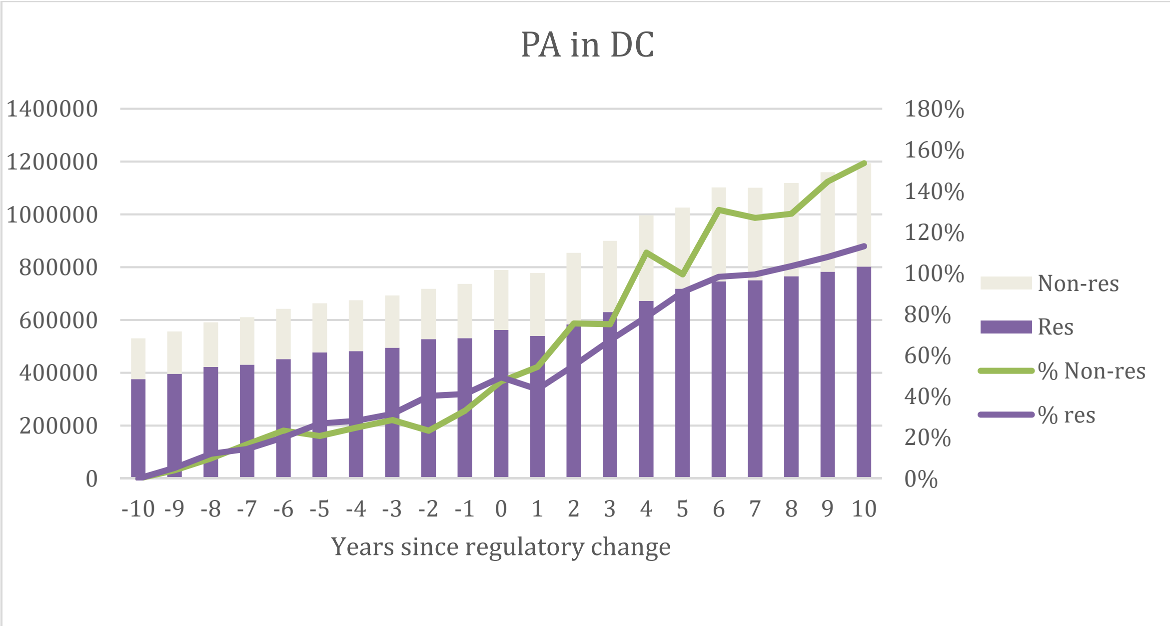
Source: WIPO and Table 1.

Figure 2. Patents Granted to residents and non-residents in LA countries over time in relation to regulatory change, in total (bars, left) and in percent change (lines, right)



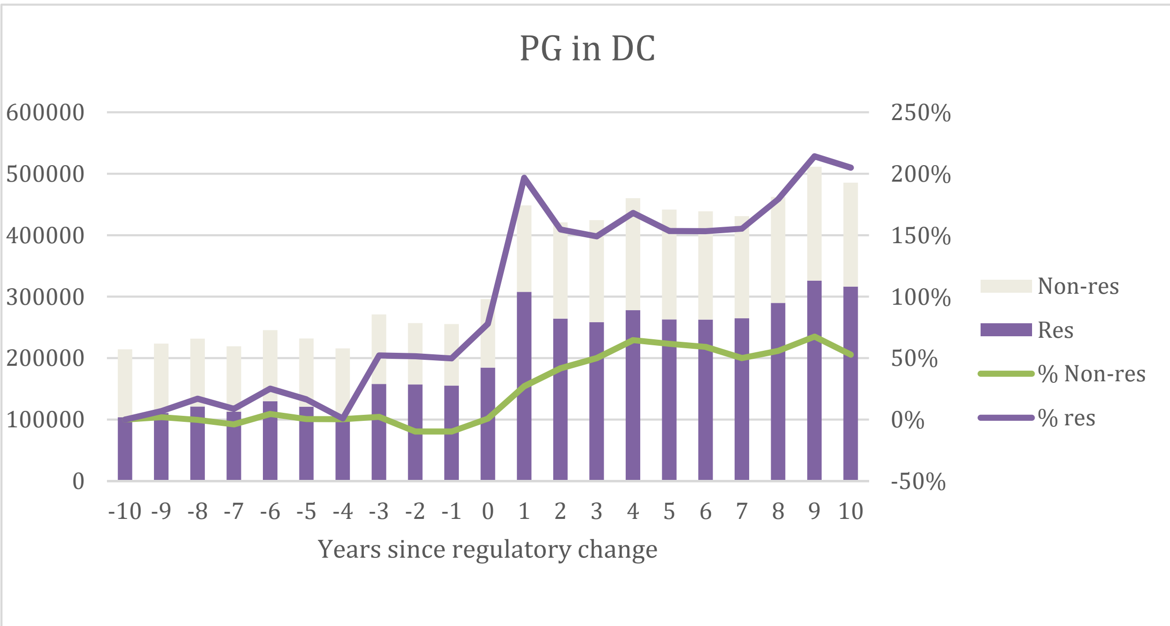
Source: WIPO and Table 1.

Figure 3. Patent Applications by residents and non-residents in DC over time in relation to regulatory change, in total (bars, left) and in percent change (lines, right)



Source: WIPO and Table 1.

Figure 4. Patents Granted to residents and non-residents in DC over time in relation to regulatory change, in total (bars, left) and in percent change (lines, right)



Source: WIPO and Table 1.

6.2. Econometric results, Hypotheses 2 and 3

This section formally assesses Hypotheses 2 and 3. We estimate Eq. [1] and Eq. [6] and calculate the semi-elasticity of ST on PA and PG to assess whether being a LA country makes a difference in such semi-elasticity (DIS), for Hypothesis 2, and whether this was different for residents and non-residents, for Hypothesis 3. Results are shown in Table 2.

In Annex Tables A5 and A6 we present some robustness checks. In Table A5 we exclude country fixed effects and include a dummy for LA; in table A6 we exclude Japan and United State from the sample, to control for the extreme values.

The first columns (1) and (2) of Table 2 show our baseline estimation, including control variables, country and year fixed effects (not shown) and the dummy that identifies, for each country, the period when patent regulations are adapted to the ST. The results for control variables have the expected signs with the exception of GDP per capita, which correlates negatively with PA[8]. In turn, as expected larger countries (proxy by population) tend to patent more as well as those that invest a higher proportion of their GDP in infrastructure. Openness, in turn, has a negative relation with patenting activities, possibly because it accounts for mainly small countries with unsophisticated production structure. In turn, neither having signed the Patent Cooperation Treated, nor having changed their regulation to be aligned to the ST, have effect on PA or PG[9].

To address Hypothesis 2, Columns (3) and (4) estimate Eq. [1] to test whether being a LA country makes a difference in semi-elasticity of adopting TRIPS-related patent regulation (ST). Consistent with our descriptive analysis in previous section, we find that being a LA country increases the semi-elasticity of ST in 0.63 % points[10] for PA, however for PG there is no significant DIS. We prefer results for PA to PG, because they would more trustfully show how patentees react by a change in regulation. Do they file more patents when regulations change? And who does that more intensively, residents or non-residents? As we know, the process of granting a patent strongly depends on how national offices work; speed may be different across countries as well as the criteria and rigor in examining applications and granting the exclusive rights. Thus, since our **Hypothesis 2** states that patenting in LA countries increased less than in DC, **it must be rejected**. Our results, suggest that, at least in terms of filing new applications, being a LA country increases the effect of the change in patent regulations *vis a vis* being a DC. This result is robust to excluding Japan and the US from the sample (Table A6 in Annex). However, the coefficient becomes not significant when countries fixed effects are excluded (Table A5 in Annex); yet, the conclusion would still be to reject Hypothesis 2.

We now turn to Hypothesis 3 and estimate Eq. [6] to test whether being a resident changes the DIS estimated in Hypothesis 2. Results are shown in columns (5) and (6). We found that, in fact, being a resident decreases previous estimated DIS (difference in semi-elasticity of ST of being a LA country), both for PA and for PG. This negative effect is large in magnitude and significant at 1%. We split the sample between LA countries and DC to be able to provide a better idea of magnitudes. We start by reading results on PA; in LA (column 7) being a resident decreases the semi-elasticity of the effect of ST in 0.84 % points[11], however in DC (column 9) such effect is positive in 1.2 % points[12]. For PG results are similar. In LA being a resident has a negative impact on the effect of ST while it has a positive impact in DC (columns 8 and 10, respectively). These results are consistent with our descriptive findings; changes in regulation aligned to the ST seem to have promoted patent activities

[8] When no country fixed effects are included (i.e when there are no controls for differences across countries), GDP per capita becomes positive and significant for PA, accounting for the expected effect in the relation between levels of development and patenting activities.

[9] We also split the sample between LA countries and DC and estimate Eq. [1] for subsamples and still we find no significant effect of ST (results not shown). However, if no controls for country fixed effects are added (Table A5 in the Annex) the dummy becomes significant at 10% for PG (not for PA). This suggests that within a country, the change in regulation does not seem to have a significant effect in patenting activities, but in average, countries initiating those reforms have more PG than those that have not gone through that process yet. Analysis using LA and DC sub-samples (not shown) shows that this result is driven by differences across LA countries.

[10] Calculated using Eq. [5] with the nlcom in Stata as post estimation command of Eq. [1], the result is significant at 5%

[11] Similar procedure as in footnote 9, result is significant at 1%.

[12] Similar procedure as in footnote 9, result is significant at 1%.

mainly by non-residents in LA countries, and by residents in DC. Since **Hypothesis 3** states that aligning patent laws to the minimum standards designated by TRIPS increases the gap in patent activities between residents and non-residents, **it must be validated**. These result are still valid in the robustness checks presented in Tables A5 and A6 in Annex.

Table 2. Negative binomial regression on PG and PA, the effect of changes in patent regulation, LA countries in relation to DC (Hypothesis 2), residents and non-residents (Hypothesis 3).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variable \ Countries included in the sample	PA	PG	PA	PG	PA	PG	PA	PG	PA	PG
	All	All	All	All	All	All	LAC	LAC	DC	DC
ST: Patent regulation adapted to the 'spirit' of trips	0.0984	0.222	-0.0989	0.110	-0.499**	-0.273	0.288**	0.491***	-0.362*	-0.111
	(0.104)	(0.204)	(0.148)	(0.245)	(0.203)	(0.269)	(0.124)	(0.175)	(0.204)	(0.319)
LAC*ST			0.527**	0.319	1.159***	0.915**				
			(0.210)	(0.319)	(0.295)	(0.364)				
Residents					-0.447	-1.198***	-1.641***	-2.041***	-0.454	-1.177***
					(0.279)	(0.324)	(0.121)	(0.164)	(0.284)	(0.340)
LAC*Residents					-1.254***	-0.880**				
					(0.305)	(0.362)				
Residents*ST					0.971***	0.928***	-0.997***	-0.739***	1.015***	0.931***
					(0.282)	(0.274)	(0.220)	(0.270)	(0.282)	(0.282)
LAC*Residents*ST					-1.954***	-1.668***				
					(0.350)	(0.375)				
GDP per capita	-4.56e-05**	-1.18e-05	-2.69e-05	1.97e-07	-1.60e-05	2.13e-05	4.10e-05*	8.38e-05**	5.63e-07	3.79e-05
	(1.99e-05)	(2.86e-05)	(2.23e-05)	(3.34e-05)	(2.30e-05)	(3.46e-05)	(2.24e-05)	(3.86e-05)	(3.61e-05)	(4.72e-05)
Population (millions)	1.62e-08***	1.84e-08**	1.49e-08***	1.79e-08**	1.92e-08***	1.73e-08***	7.40e-09***	1.02e-08	2.33e-08***	1.84e-08***
	(3.82e-09)	(8.42e-09)	(4.62e-09)	(8.78e-09)	(3.52e-09)	(6.57e-09)	(2.77e-09)	(7.97e-09)	(4.41e-09)	(6.21e-09)
Openness as % of GDP	-0.00786***	-0.00799*	-0.00807***	-0.00796*	-0.0105***	-0.00887**	-0.00102	0.0134**	-0.0117***	-0.0137***
	(0.00248)	(0.00420)	(0.00254)	(0.00428)	(0.00245)	(0.00376)	(0.00176)	(0.00563)	(0.00335)	(0.00353)
Investment as % of GDP	0.0264***	0.0159	0.0194*	0.0124	0.0229**	0.0110	0.00755	-0.0221	0.0111	0.000793
	(0.00948)	(0.0192)	(0.0109)	(0.0186)	(0.0113)	(0.0162)	(0.0105)	(0.0231)	(0.0182)	(0.0211)
European Patent Organization (EPO) membership	-1.043***	-0.350	-0.982***	-0.317	-1.055***	-0.306			-1.086***	-0.296
	(0.186)	(0.242)	(0.177)	(0.232)	(0.164)	(0.226)			(0.172)	(0.244)
Patent Cooperation Treaty (PCT)	0.0331	0.229	0.0104	0.215	0.113	0.288	-0.0682	0.396	0.250	0.225
	(0.130)	(0.201)	(0.139)	(0.207)	(0.145)	(0.217)	(0.145)	(0.276)	(0.242)	(0.320)
Observations	1,448	1,409	1,448	1,409	2,885	2,769	820	735	2,065	2,034

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

7. Conclusions

In recent years there have been strong debates around the nature and impacts of the international patent regime. These debates have been spurred by the signature of the TRIPS agreement, which led to the harmonization of patent regulations around the world. In practice, this harmonization meant a strengthening of IPR rules in developing countries, since they had to adapt their national legislations to the new minimum standards set up by TRIPS. While there are conceptual reasons suggesting that strong IPR regimes could benefit developing countries (since they may foster domestic innovation activities as well as technology transfer from developed countries firms), many authors have stated that in fact weak patent regimes are better adapted for less advanced nations, as they may facilitate technology diffusion and imitative innovation activities, which are pervasive in those countries. Learning by doing dynamics may also enhance domestic capabilities for innovation if opportunities for technology experimentation and adaptation are open.

Notwithstanding the relevance of this debate from the point of view of public policies, so far the empirical evidence on the subject is relatively scant and fragmented. This paper aims to contribute to fill this knowledge gap by analyzing the effects of country-specific regulatory changes inspired on TRIPS on patenting activities in Latin America.

In a nutshell, the evidence provided by previous empirical studies mostly show that strong patent regulations only have positive impacts on innovation activities after some income threshold is attained. In turn, papers dealing with the differential impacts on residents vs non-residents in developing countries conclude that only the latter benefit from that kind of regulations.

A large part of the available literature on this subject is based on indexes that aim to capture the strength of national patent regimes (i.e. the Ginarte-Park index). The very few papers analyzing specifically the impact of TRIPS oriented patent reforms use binary dummy variables (Gamba, 2017) or indexes of TRIPS compliance (Hamdan-Livramento, 2009). Against this background, and to the best of our knowledge, this is the first paper that analyses that impact by identifying the specific date in which each country's regulations were adapted to what we call the "spirit of TRIPS". In this way, we are able to build exogenously a variable that captures when each country hosts the ST, which allows us to assess the impact of paradigmatic TRIPS requirements (i.e. a minimum patent length of 20 years and the prohibition of excluding specific sectors from patent protection) on patenting activities in the region. Moreover, we are able to capture the impact of the regulatory change on patenting in LA countries, not only in general, but also specifically for residents vs non-residents patent activities.

Our results show that LA countries had to strengthen their patent regimes as a consequence of TRIPS signature, while almost all DC had their national legislation already adjusted to TRIPS standards. While that change drove to an increase in patent applications in LA countries, it was due to the growth of non-residents applications. In turn, patent files by residents in fact decreased after LA countries hosted the ST in their patent legislation (patent grants to residents also fell after that regulatory change). In contrast, both patent applications and grants to residents increased in DC once their legislation was aligned with the ST. These findings confirm the results of previous studies, namely, that strengthening patent regimes in developing countries does not favor patenting activities by residents; only non-residents reap the benefits of those regulatory changes.

In other words, it seems that stronger patent regimes *per se* do not favor domestic patenting activities in LA. Only non-residents, presumably global players, do patent more in LA countries after their regulations were aligned to the ST. In fact, Danguy et al. (2014) argue that the upsurge in patenting activities worldwide was driven by globalization of intellectual property (global firms extending their patents abroad) rather than greater research productivity. These globalization strategies have been facilitated by the internalization and harmonization of patent systems.

Some authors suggest that this strategic behavior, mostly associated to technology blocking or negotiation across multiple patent holders, is the main motivation behind patenting activities (Boldrin and Levine, 2008, 2013). These patents may be actually diminishing the overall capacity to innovate, because firms have to circumvent existing knowledge or negotiate over patented technologies with too many actors, and because only a bunch of firms have financial capacity to cover these transaction costs, losing the diversity of ideas than enrich innovation. In fact, recently Gold (2021) argued that too much intellectual property may have generated inefficiencies in the innovation system and can be one important reason behind research productivity decline.

Strategic behavior in patenting activities may be more prominent among technology world leaders rather than in resident firms in developing countries, which rarely have the resources to implement intellectual property strategies worldwide. In contrast, increased patenting by non-residents in those countries does not necessarily mean that more new technologies are available there, since, as we said, strategic patents may not be associated to technology transfer or innovation.

In sum, the promotion of economic developing and catching up does not seem to justify policies towards international harmonization of intellectual property. On the one hand, internationalization seems to benefit global players (non-residents of developing countries) while putting in disadvantage, in terms of patenting activities, firms headquartered in developing countries. On the other hand, the literature has suggested that stringent IPR laws can actually discourage innovation activities, especially in those countries that largely rely on imitation and incremental innovation as early stages of technology accumulation. Public policies in developing countries should instead focus on dealing with shortages in capabilities and with market and coordination failures that hinder private innovation activities.

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Annex

Table A1 - Summary of empirical literature

	Paper	IPR explanatory variable	Dependent Variable	Period	Countries in sample	Developed vs. Developing	Resident vs. Non Resident	Data structure and methodology	Results
Related to H2	**Gamba (2017)**	**Regulation dummy** (=1 for years when IPR for pharmaceuticals comply with TRIPS requirements)	Citation-weighted domestic patent applications filed at the European Patent Office	1977-1998	25 developed + 49 developing	**Yes,** introducing interaction with dummy for development	No	Panel (Zero Inflated Negative Binomial model, FE)	Developing countries profit significantly less than developed
	Qian (2006)	**Regulation dummy** (=1 if the country implemented pharmaceutical patent laws)	Citation-weighted U.S. patents awards, domestic R&D investments	1978-2002	92 developed + developing	**Yes**, introducing interaction with log GDP per capita PPP	No	Panel (matched sampling techniques and through country-pair FE)	National patent protection stimulates domestic innovation only in more developed
	Schneider (2005)	**Patent strength index** by Ginarte and Park (1997) *	US patent applications by residents of a given country	1970-1989	18 developed + 24 developing	**Yes**, by the splitting sample	No	Panel (but OLS for split sample)	Developing countries (-), developed countries (+)
	Chen and Puttitanum (2005)	**Patent strength index** by Ginarte and Park (1997) *	US patent applications by residents of a given country	1975-2000	64 developing	Level of development, introducing interaction with GDP per capita	No	Panel (FE)	U-shaped relationship with economic development
	Nunnenkamp and Spatz (2004)	**Patent strength indexes** by Ginarte and Park (1997)* and from WEF Survey	***Technology transfer:*** FDI of US investors (stock, technology content, value added and exports of affiliates)	1995 and 2000	developing + developed	**Yes**, by interacting with GDP per capita, years of schooling, institutional indicators	No	Cross sectional (left-censored tobit models)	(+) only for countries above certain threshold of human capital

	Hamdan-Livramento (2009)	**Compliance with TRIPS index**	-***Technology transfer***: trade, FDI, licensing - Ratio between entrepreneurs using new technologies over total entrepreneurs	1994-2005	53 developing	Only developing	No	Panel (FE and RE)	-FDI (+), licensing (+), trade (non-signif) -Entrepreneurs' exploitation of new technologies (-)
	Kanwar and Sperlich (2019)	**Patent strength index** by Ginarte and Park (1997)* modified to buttress their implementation	***Technology transfer:*** FDI	2004-2015	Developing + least developed	Only less developed	No	Panel (conditional DID)	No effects
	Ivus (2010)	**Patent strength index** by Ginarte and Park (1997)*	***Technology transfer:*** imports growth in patent-sensitive industries (relative to non-sensitive) from developed countries	1962-2000	18 developing	Only developing	No	Panel (IV and DID)	(+)
	German-Soto and Chapa Cantú (2018)	Date of structural break in the number of patents	Patents by residents and non-residents	1963-2011	16 developed + 19 developing from 7 regions	**Yes**, by splitting the sample in regions and for each individual country	**Yes**, by splitting the sample	Time series: structural breaks in the number of patents	No structural brake for LA (neither residents nor non-residents). In developing countries, mainly non-residents (+); while in developed countries, mainly residents (+)
Related to H3	**Huang et al. (2017)**	Period dummy =1 for years after China IPR law change in 2001	Dummy =1 if patent granted in China and the US to firms conducting R&D operations in China is filed as a utility model patent, =0 if invention patent	1985-2008	China	No	**Yes**, by introducing interaction with dummy of Western or Chinese	Panel (LOGIT with FE)	Chinese firms are less likely to apply for patents than Western firms
	Allred and Park (2007)	**Patent strength index** by Ginarte and Park (1997) and Park and Wagh (2002)*	National patent application by residents and non-residents, firm-level R&D	1965-2000	100 developed + developing	**Yes**, by splitting the sample	**Yes**, different dependent variable	Panel (FE fixed effects negative binomial regression)	- Resident patent filings and R&D: developing (-), developed (+) - Non-resident patent filings: developing (non-signif.), developed (inverted u)

Lerner (2002)	**Regulation dummy** (177 changes)	- Patent filings in Great Britain - National patent applications by domestic and foreign entities	1950-2000	60 developed + developing	**Yes**, introducing interaction with GDP per capita relative to wealthiest country	**Yes**, different dependent variable	- Mean differences - Panel (OLS and IV)	- Non residents (+), residents (-) in both developed and developing - Greater effect on patent filings in GB for richer countries
Branstetter et al. (2006)	**Regulation dummy** (=1 in post-reform years)	-***Technology transfer***: royalty payments and R&D spending from U.S. multinational firms affiliates -Resident and non-resident patent applications	1982-1999	16 developed + developing	No	**Yes**, by splitting the sample	Panel (FE)	- Royalty payments and affiliate R$D (+) - Non-resident patenting (+), resident patenting (non-signif.)
Park and Lippoldt (2008)	**Patent strength index** by Ginarte and Park (1997) and Park and Wagh (2002)*	- ***Technology transfer***: FDI and imports - National patent applications by residents and non-residents in developing countries	1990-2005	Developed + developing + least developed	**Yes**, by splitting the sample (for technology transfer as dependent variable)	**Yes**, by splitting the sample (for patent applications in developing countries as dependent variable)	Panel (but FGLS)	-Technology transfer: (+) for all groups of countries, larger effect in developed -Patent applications in developing countries: residents (+), non-residents (+)
Arza and López (2013)	**Patent strength index** by Ginarte and Park (1997) and **Regulation dummy** (=1 after 2000 for LA countries)	Patents by residents and non-residents	1980-2011	28 developed countries + 13 Latin American countries	**Yes,** two strategies: splitting samples and by interacting with LA dummy	**Yes,** two strategies: splitting samples and by interacting with RES dummy	Panel (FE)	- TRIPS had no effect in patenting activity in LA region and only non-resident increased patenting activities in LA region as consequence of stronger patent systems or after TRIPS
Falvey et al. (2006)	**Patent strength index** by Ginarte and Park (1997)*	-Domestic and foreign patent applications to the labour force	1975-1994	47 developed + developing	**Yes,** allowing for thresholds on initial GDP per capita	**Yes**, different dependent variable	Panel (FE, RE and OLS). Threshold regression techniques	-Low levels of GDP per capita: domestic (non signif), foreign (+) -High levels of GDP per capita: domestic (+), foreign (+)

*Considering 5 dimensions: extent of coverage, membership in international patent agreements, duration of protection, provisions for loss of protection, enforcement mechanisms

Table A2: Control variables descriptive statistics

	Country	Patent Cooperation Treaty (PCT) year	European Patent Organisation (EPO) membership year	Control Variables (2018)			
				GDP per capita	Population (millions)	Openness as % of GDP	Investment as % of GDP
Latinamerican Countries	Argentina	-	-	18.288	44	31	21
	Bolivia (Plurinational State of)	-	-	6.986	11	57	21
	Brazil	1978	-	14.283	209	29	15
	Chile	2009	-	22.874	19	58	23
	Colombia	2001	-	13.321	50	37	21
	Costa Rica	1999	-	15.680	5	67	19
	Ecuador	2001	-	10.412	17	46	26
	Guatemala	2006	-	7.509	17	46	12
	Honduras	2006	-	4.560	10	102	26
	Mexico	1995	-	18.134	126	80	23
	Nicaragua	2003	-	4.910	6	93	23
	Paraguay	-	-	12.068	7	70	22
	Peru	2009	-	12.793	32	49	21
	Uruguay	-	-	20.916	3	40	17
	LAC	-	-	13.052	40	58	21
Developed Countries	Australia	1980	-	45.378	25	43	24
	Austria	1979	1979	46.260	9	108	25
	Belgium	1981	1977	43.582	11	165	25
	Canada	1990	-	44.078	37	66	23
	Czech Republic	1993	2002	33.436	11	150	26
	Denmark	1978	1990	48.419	6	105	23
	Estonia	1994	2002	31.035	1	145	26
	Finland	1980	1996	42.061	6	78	25
	France	1978	1977	39.556	67	63	23
	Germany	1978	1977	45.936	83	89	22
	Greece	1990	1986	25.141	11	73	13
	Hungary	1980	2003	28.465	10	166	27
	Iceland	1995	2004	48.606	0	91	23
	Ireland	1992	1992	70.855	5	212	24

Israel	1996	-	33.609	9	58	22
Italy	1985	1978	35.828	60	60	18
Japan	1978	-	39.294	127	37	24
Netherlands	1979	1977	49.787	17	158	21
New Zealand	1992	-	36.352	5	56	24
Norway	1980	2008	65.389	5	71	27
Poland	1990	2004	28.786	38	108	21
Portugal	1992	1992	28.999	10	87	18
Republic of Korea	1984	-	36.777	52	83	30
Slovakia	1993	2002	31.226	5	190	23
Slovenia	1994	2002	32.728	2	162	21
Spain	1989	1986	34.831	47	68	20
Sweden	1978	1978	59.317	10	120	27
Switzerland	1978	1977	47.718	9	89	23
United Kingdom	1978	1977	40.522	66	62	17
United States of America	1978	-	55.719	327	28	21
Non-LAC	-	-	41.656	36	100	23

Sources: GDP per capita built from World Bank data (2020) and Penn World Table 9.0 (Feenstra et al., 2015); World Bank was also the source for population, trade and investment data. Patent Cooperation Treaty (PCT) year source was WIPO (WIPO, 2020a), and European Patent Organization (EPO) membership year source was EPO (European Patent Office, 2019).

Notes: GDP per capita control variable is based on purchasing power parity (PPP) at constant 2011 international dollars data. Openness as % of GDP is the sum of exports and imports of goods and services expressed in percentage points of gross domestic product. Investment as % of GDP is gross capital formation expressed in percentage points of gross domestic product.

Table A3: Patent applications (PA), total patents by country before and after regulatory changes aligned to the ST.

	Country	ST	Data availability (years)	Total Patent Ap				
				1980 to ST (-1)				
				#	% Residents	Media	SD	#
Latinamerican Countries	Argentina	2001	[1980-1984]; [1990-2018]	69.067	21%	4.317	1.373	85.835
	Bolivia (Plurinational State of)	2001	[1980-1985]; [1993-1995]; 2014; [2016-2017]	877	15%	97	31	892
	Brazil	1997	[1980-2018]	121.671	32%	7.157	651	494.354
	Chile	2005	[1980-2018]	38.901	12%	1.556	894	40.936
	Colombia	2001	[1980-1981]; [1983-1989]; [1991-2018]	17.421	10%	917	488	32.552
	Costa Rica	2000	[1980-1983]; [1986-1990]; 1993; [2010-2018]	829	28%	83	33	5.166
	Ecuador	1998	[1980-1984]; [1986-1989]; [1991-1997]; [1999-2010]; [2013-2018]	2.856	11%	179	91	9.263
	Guatemala	2001	1982; [1984-2018]	2.803	17%	156	68	5.680
	Honduras	2000	1980; [1982-1985]; [1987-1988]; 1990; 1992; [1995-1996]; [1998-2002]; [2011-2013]; [2015-2018]	856	18%	66	70	1.954
	Mexico	1991	[1980-2018]	51.499	15%	4.682	721	363.910
	Nicaragua	2001	[1983-1986]; [1992-1993]; 1995; [1997-2000]; [2011-2014]	603	7%	55	47	659
	Paraguay	2005	[1983-1985]; [1989-1990]; [1992-1993]; [2000-2010]	1.455	11%	121	84	1.886
	Peru	2001	[1980-1983]; [1985-1988]; [1990-1994]; [1996-1997]; [1999-2018]	7.447	11%	438	270	19.569
	Uruguay	2002	[1980-1989]; [1991-2012]; [2014-2015]; 2017	5.782	14%	275	158	9.186
	LAC			322.067	22%	1.498	2.242	1.071.842
Developed Countries	Australia	1995	[1980-1984]; [1995-2018]	82.100	41%	16.420	569	570.721
	Austria	1995	[1980-2018]	56.410	59%	3.761	1.232	57.734
	Belgium	1984	[1980-2018]	17.617	19%	4.404	1.244	38.788
	Canada	1990	[1980-2018]	279.291	8%	27.929	3.271	999.066
	Czech Republic	1991	[1993-2018]					59.800
	Denmark	1986	[1980-2018]	35.657	17%	5.943	256	75.910
	Estonia	1994	[1994-2018]					5.920
	Finland	1996	[1980-2018]	81.182	37%	5.074	872	47.630

France	1993	[1980-2018]	257.400	60%	19.800	3.491	432.555
Germany	1976	[1980-2018]					2.104.822
Greece	1993	[1980-2018]	26.716	42%	2.055	1.260	13.342
Hungary	1996	[1980-2018]	61.886	58%	3.868	805	43.366
Iceland	1997	[1980-2018]	1.852	21%	109	25	6.086
Ireland	1992	[1980-1991]; [2016-2018]	43.207	18%	3.601	629	394
Israel	1968	[1980-2018]					204.775
Italy	1979	1980; 1983; 1985; 1988; [1992-1994]; 1996; [1999-2000]; [2007-2014]; [2016-2018]					204.257
Japan	1995	1980; [1983-2018]	4.141.007	92%	318.539	50.845	8.996.665
Netherlands	1987	[1980-2018]	33.973	39%	4.853	1.457	87.690
New Zealand	1995	[1980-2018]	59.963	25%	3.998	473	164.387
Norway	1993	[1980-2018]	64.631	17%	4.972	557	114.707
Poland	1993	[1980-2018]	76.149	83%	5.858	955	125.859
Portugal	1992	[1980-2018]	28.921	4%	2.410	710	11.434
Republic of Korea	1997	[1980-2018]	451.143	55%	26.538	24.886	3.443.929
Slovakia	1991	[1993-2018]					22.129
Slovenia	1993	[1991-2012]; 2018	619	34%	310	407	8.904
Spain	1992	[1980-2018]	92.322	24%	7.694	3.490	82.808
Sweden	1994	[1980-2018]	81.018	63%	5.787	1.690	85.576
Switzerland	1977	[1980-2018]					138.406
United Kingdom	1978	[1980-2018]					1.103.103
United States of America	1995	[1980-2018]	2.119.461	54%	141.297	34.457	10.090.916
Non-LAC			8.092.525	71%	31.125	74.945	29.341.679

(***) p<0.01, (**) p<0.05, (*) p<0.1, (-) p>0.1

Source: WIPO (2020b).

Notes: Media differences for Germany, Israel, Italy, Switzerland and the United Kingdom have not been calculated since regulations in these countries switched to the 'spirit of TRIPS' (ST) prior to 1980. Neither for Czech Republic, Estonia and Slovakia because no data was available before ST.

Table A4: Patent grants (PG), total patents by country before and after regulatory changes aligned to the ST

	Country	ST	Data availability (years)	Total Patent Gra				
				1980 to ST (-1)				
				#	% Residents	Media	SD	#
Latinamerican Countries	Argentina	2001	[1980-1984]; [1986-1988]; [1990-2018]	35.876	24%	1.888	1.136	27.919
	Bolivia (Plurinational State of)	2001	[1980-1985]; [1993-1995]; 2014; [2016-2017]	661	8%	73	50	246
	Brazil	1997	[1980-1996]; [1998-1999]; [2001-2002]; [2005-2006]; [2008-2018]	67.620	13%	3.978	2.587	62.708
	Chile	2005	[1980-2018]	11.045	8%	442	185	15.672
	Colombia	2001	[1980-1981]; [1983-1989]; [1991-2008]; [2010-2018]	8.148	9%	429	169	13.189
	Costa Rica	2000	[1980-1983]; [1986-1990]; 1993; [2010-2018]	172	34%	17	11	923
	Ecuador	1998	[1980-1984]; [1986-1989]; 1991; [1993-1997]; 1999; 2002; 2004; 2007; [2013-2018]	1.353	6%	90	50	304
	Guatemala	2001	1982; [1984-2005]; [2007-2018]	1.238	15%	69	45	1.451
	Honduras	2000	1980; [1982-1985]; [1987-1988]; 1990; 1992; 1996; [1999-2002]; [2011-2013]; [2015-2018]	464	22%	42	23	1.031
	Mexico	1991	[1980-2018]	24.083	7%	2.189	891	199.971
	Nicaragua	2001	[1983-1986]; [1992-1993]; 1995; 1997; [1999-2000]; [2011-2014]	247	6%	25	41	263
	Paraguay	2005	[1983-1985]; [1989-1990]; [1992-1993]	195	4%	28	12	
	Peru	2001	[1980-1983]; [1985-1988]; [1990-1994]; [1996-1997]; [1999-2018]	4.253	7%	250	84	7.602
	Uruguay	2002	[1980-1989]; 1991; [1993-2000]; [2002-2004]; [2008-2012]; [2014-2015]; 2017	2.044	14%	108	61	457
	LAC			157.399	14%	760	1.427	331.736
Developed Countries	Australia	1995	[1980-1984]; [1995-2018]	35.089	8%	7.018	1.010	350.812
	Austria	1995	[1980-2018]	49.617	34%	3.308	1.978	30.624
	Belgium	1984	[1980-2003]; [2005-2018]	17.465	19%	4.366	1.237	31.828
	Canada	1990	[1980-2018]	195.058	7%	19.506	3.175	471.556
	Czech Republic	1991	[1993-2018]					29.640

Denmark	1986	[1980-2018]	7.912	15%	1.319	251	30.478
Estonia	1994	[1996-2018]					2.847
Finland	1996	[1980-2018]	38.126	31%	2.383	275	31.850
France	1993	[1980-2018]	242.713	42%	18.670	6.025	318.177
Germany	1976	[1980-2018]					631.260
Greece	1993	[1980-2010]; [2012-2018]	28.045	38%	2.157	2.349	7.982
Hungary	1996	[1980-2018]	36.007	49%	2.250	625	19.562
Iceland	1997	[1980-2018]	597	4%	35	17	1.386
Ireland	1992	[1980-1992]; [2016-2018]	12.911	2%	1.076	228	940
Israel	1968	[1980-2003]; [2006-2016]; 2018					86.191
Italy	1979	1980; [1982-1983]; 1988; [1992-1994]; 1996; [1999-2000]; [2007-2018]					156.296
Japan	1995	[1980-1981]; [1983-2018]	862.913	85%	61.637	15.973	4.203.092
Netherlands	1987	[1980-2018]	35.917	9%	5.131	3.281	63.431
New Zealand	1995	[1980-2018]	36.564	8%	2.438	745	97.253
Norway	1993	[1980-2018]	29.635	11%	2.280	437	44.022
Poland	1993	[1980-2018]	56.608	83%	4.354	1.256	70.495
Portugal	1992	[1980-2018]	16.835	3%	1.403	981	11.750
Republic of Korea	1997	[1980-2018]	102.597	37%	6.035	4.890	1.795.273
Slovakia	1991	[1993-2018]					10.423
Slovenia	1993	[1992-2011]; 2018	33	6%	33		6.623
Spain	1992	[1980-2018]	85.101	20%	7.092	2.432	57.243
Sweden	1994	[1980-2018]	71.820	31%	5.130	2.709	41.816
Switzerland	1977	[1980-2002]; 2004; [2006-2018]					104.763
United Kingdom	1978	[1980-2018]					415.719
United States of America	1995	[1980-2018]	1.192.828	55%	79.522	16.071	4.748.245
Non-LAC			3.154.391	54%	12.132	22.343	13.871.577

(***) p<0.01, (**) p<0.05, (*) p<0.1, (-) p>0.1

Source: WIPO (2020b).

Notes: Media differences for Germany, Israel, Italy, Switzerland and the United Kingdom have not been calculated since regulations in these countries switched to the 'spirit of TRIPS' (ST) prior to 1980. Neither for Czech Republic, Estonia and Slovakia because no data was available before ST. For Slovenia there was just one year with observations before, so the t-test could not be applied. For Paraguay no data was available after ST.

Table A5: Robustness check for Table 2: no country fixed effect included. We include a dummy for being a 'LA country'

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variable \ Countries included in the sample	PA All	PG All	PA All	PG All	PA All	PG All	PA LAC	PG LAC	PA DC	PG DC
ST: Patent regulation adapted to the 'spirit' of trips	0.436**	0.528**	0.340	0.480*	-0.0309	0.0425	0.271	0.584***	0.0334	0.00864
	(0.189)	(0.211)	(0.248)	(0.262)	(0.228)	(0.255)	(0.186)	(0.203)	(0.225)	(0.240)
LAC*ST			0.280	0.150	0.785***	0.658**				
			(0.300)	(0.328)	(0.286)	(0.331)				
Residents					-0.319	-1.096***	-1.620***	-1.970***	-0.443	-1.195***
					(0.250)	(0.254)	(0.138)	(0.186)	(0.279)	(0.268)
LAC*Residents					-1.404***	-0.812**				
					(0.272)	(0.357)				
Residents*ST					0.953***	1.183***	-1.018***	-0.927***	1.127***	1.342***
					(0.223)	(0.265)	(0.241)	(0.258)	(0.223)	(0.264)
LAC*Residents*ST					-1.587***	-1.774***				
					(0.313)	(0.391)				
GDP per capita	3.28e-05*	3.02e-05	3.37e-05*	3.06e-05	3.70e-05*	3.26e-05	0.000199***	0.000197***	1.87e-05	1.42e-05
	(1.91e-05)	(1.98e-05)	(1.96e-05)	(2.01e-05)	(2.04e-05)	(2.07e-05)	(2.15e-05)	(3.15e-05)	(2.30e-05)	(2.20e-05)
Population (millions)	2.43e-08***	2.26e-08**	2.44e-08***	2.26e-08**	2.38e-08***	2.12e-08**	2.09e-08***	1.91e-08***	2.49e-08	2.09e-08
	(9.03e-09)	(9.42e-09)	(9.16e-09)	(9.44e-09)	(8.94e-09)	(9.45e-09)	(2.71e-09)	(5.21e-09)	(1.60e-08)	(1.39e-08)
Openness as % of GDP	-0.0150**	-0.0140**	-0.0149**	-0.0139**	-0.0159***	-0.0163***	-0.0117**	-0.0111*	-0.0139	-0.0149*
	(0.00587)	(0.00577)	(0.00597)	(0.00581)	(0.00584)	(0.00596)	(0.00474)	(0.00667)	(0.00960)	(0.00865)
Investment as % of GDP	0.0565*	0.0645**	0.0567*	0.0647**	0.0521*	0.0711***	0.0301*	0.0366	0.0353	0.0609**
	(0.0295)	(0.0279)	(0.0294)	(0.0277)	(0.0274)	(0.0264)	(0.0178)	(0.0263)	(0.0321)	(0.0296)
European Patent Organization (EPO) membership	-1.031***	-0.844**	-1.013***	-0.838**	-1.197***	-0.777**			-1.382***	-0.905**
	(0.367)	(0.344)	(0.371)	(0.348)	(0.371)	(0.344)			(0.436)	(0.361)
Patent Cooperation Treaty (PCT)	-0.0792	0.146	-0.129	0.121	-0.0523	0.169	-0.190	-0.211	0.879***	0.962***
	(0.242)	(0.292)	(0.244)	(0.286)	(0.293)	(0.346)	(0.170)	(0.289)	(0.239)	(0.291)
LAC	-2.084***	-2.106***	-2.252***	-2.193***	-1.817***	-1.985***				
	(0.458)	(0.428)	(0.474)	(0.433)	(0.498)	(0.425)				
Observations	1,448	1,409	1,448	1,409	2,885	2,769	820	735	2,065	2,034

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A6: Robustness check for Table 2: exclusion of Japan and United State from the sample, to control for extreme values

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variable \ Countries included in the sample	PA All	PG All	PA All	PG All	PA All	PG All	PA LAC	PG LAC	PA DC	PG DC
ST: Patent regulation adapted to the 'spirit' of trips	0.108	0.166	-0.118	-0.00809	-0.561**	-0.395	0.288**	0.491***	-0.428**	-0.245
	(0.113)	(0.205)	(0.168)	(0.243)	(0.220)	(0.267)	(0.124)	(0.175)	(0.201)	(0.298)
LAC*ST			0.565***	0.462	1.217***	1.034***				
			(0.217)	(0.303)	(0.302)	(0.352)				
Residents					-0.641**	-1.410***	-1.641***	-2.041***	-0.649**	-1.389***
					(0.278)	(0.336)	(0.121)	(0.164)	(0.281)	(0.341)
LAC*Residents					-1.062***	-0.673*				
					(0.303)	(0.372)				
Residents*ST					1.134***	1.042***	-0.997***	-0.739***	1.189***	1.062***
					(0.287)	(0.291)	(0.220)	(0.270)	(0.280)	(0.283)
LAC*Residents*ST					-2.110***	-1.781***				
					(0.359)	(0.395)				
GDP per capita	-4.98e-05**	-1.53e-05	-3.20e-05	5.29e-07	-1.79e-05	2.91e-05	4.10e-05*	8.38e-05**	2.13e-06	5.26e-05
	(2.30e-05)	(3.50e-05)	(2.42e-05)	(3.83e-05)	(2.52e-05)	(3.98e-05)	(2.24e-05)	(3.86e-05)	(3.44e-05)	(4.49e-05)
Population (millions)	1.26e-08**	1.63e-08	8.84e-09	1.38e-08	1.75e-08***	2.03e-08	7.40e-09***	1.02e-08	9.90e-08	1.57e-07*
	(5.89e-09)	(1.53e-08)	(5.77e-09)	(1.56e-08)	(6.43e-09)	(1.46e-08)	(2.77e-09)	(7.97e-09)	(7.50e-08)	(8.76e-08)
Openness as % of GDP	-0.00787***	-0.00719*	-0.00794***	-0.00703*	-0.0105***	-0.00811**	-0.00102	0.0134**	-0.0107***	-0.00994**
	(0.00240)	(0.00415)	(0.00242)	(0.00425)	(0.00232)	(0.00376)	(0.00176)	(0.00563)	(0.00383)	(0.00433)
Investment as % of GDP	0.0260**	0.0218	0.0197*	0.0176	0.0222*	0.0140	0.00755	-0.0221	0.00528	-0.00288
	(0.0102)	(0.0193)	(0.0112)	(0.0185)	(0.0114)	(0.0163)	(0.0105)	(0.0231)	(0.0191)	(0.0200)
European Patent Organization (EPO) membership	-1.045***	-0.320	-0.974***	-0.268	-1.039***	-0.280			-0.975***	-0.105
	(0.191)	(0.246)	(0.185)	(0.238)	(0.168)	(0.233)			(0.126)	(0.182)
Patent Cooperation Treaty (PCT)	0.0238	0.294	0.00875	0.285	0.119	0.350*	-0.0682	0.396	0.252	0.240
	(0.128)	(0.189)	(0.134)	(0.196)	(0.143)	(0.211)	(0.145)	(0.276)	(0.242)	(0.329)
Observations	1,372	1,332	1,372	1,332	2,733	2,615	820	735	1,913	1,880

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1