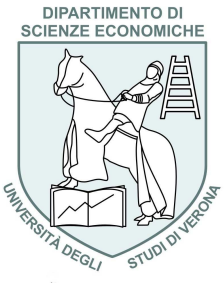

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Anna Rita Bennato, Laura Magazzini

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International Cooperation in Pharmaceutical Research

Anna Rita Bennato* Laura Magazzini†‡

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Abstract

Since 1990 the global patent regime strengthened dramatically. The introduction of the Trade-Related Aspect of Intellectual Property Rights (TRIPS) agreement in 1995 has represented an important evolution into the Intellectual Property Rights (IPRs) regime. On January 1, 2005 the TRIPS regulations about the new patent regime came into force in all developing countries, imposing all WTO members patent protection in all productive areas, including pharmaceutical products (with the exception of least-developed members of WTO, for which enforcement of product patent protection and undisclosed information rights for pharmaceuticals is postponed to 2016). Despite the attention devoted to the issue by the theoretical literature, scattered empirical work is available at date. We aim at studying whether the new patent regime has stimulated international cooperation on innovative activities between WTO members, focusing on less developed countries. In particular, we adopt a gravity framework in order to examine the impact of the level of enforcement of property rights on bilateral flows of pharmaceutical knowledge. The analysis is conducted using data from the PatentScope and ISI Web of knowledge, and results provide a sound test of conflicting theories about the effect of TRIPS enforcement on technology transfer.

Keywords: IPRs, pharmaceutical products, R&D co-operation.
JEL classification: F13; O34; O57.

*University of Rome "Tor Vergata", Department of Economics, and University of Bristol, bennato@economia.uniroma2.it

†University of Verona, Department of Economics, laura.magazzini@univr.it

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1 Background

The introduction of the agreement on Trade-Related Aspect of Intellectual Property Rights (TRIPS) has represented an important evolution of the Intellectual Property Rights (IPR) regime at the international level. The agreement was introduced with the aim to foster technological innovation and the transfer and dissemination of technologies among countries. Establishing a minimum standard at the global level in the protection of the IPR, the TRIPS agreement was directed to increase the technological cooperation between developed and developing countries. It is recognized that a higher protection on IPR may influence foreign investments, technology transfer and joint research programs by which research could be addressed to the local needs (Maskus, 1997; Correa, 2007).

Despite the attention devoted to the issue by the theoretical literature, scattered empirical evidence is available at date. Theoretical literature provides grounds to the idea that an increase of stringency of the IPR can lead to a rise in R&D investments, by means of a greater monopolistic power that guarantees a faster growth driven by technological innovation (e.g. Nordhaus, 1969; Grossman and Helpman, 1991; Grossman and Lai, 2004). Although it is beyond any doubts that the linkages between trade and IPR may have important dynamic effects, today the question if the TRIPS agreement have reached the expected results in term of increased technological cooperation is still an open issue.

Within this scenario, we report a novel empirical strategy to assess the peculiarities of the TRIPS agreement on cooperative innovation in the pharmaceutical industry using a gravity approach. We seek to investigate if the increased strength of patent protection has varying effects on pharmaceutical R&D, captured by the number of patented drugs and health-related publications jointly signed by researchers in the developed and developing world. By means of a large data covering a broad international panel of countries over the period 1998 to 2008, we aim at studying whether the TRIPS agreement has effectively spurred cooperation in pharmaceutical R&D.

Many studies addressed the role performed by trade and FDI in driving innovation and technology transfer between countries. Maskus and Penubarti (1995) have used an extend version of the Helpman-Krugman model of monopolistic competition to measure the effect of the patent protection on international trade flows. Their study points out how an increase in the stringency of the IPR can have a positive impact in terms of increased flows of bilateral trade in developing countries. Their results find confirmation in Primo Braga and Fink (1997) analysis, showing a positive link between tighter patent protection and manufacturing trade flows. The basic idea builds on the fact that imports

act as a means through which technology could be introduced in receiving countries (Coe and Helpman, 1995; van Pottelsberghe de la Potterie and Lichtenberg, 2001; Acharya and Keller, 2007).

On the other hand, empirical studies have shed light on confused and controversial results. Empirical works analyzing the impact of IPR reforms expressed by increased trade flows often do not take into account the efficacy of enforcement, strictly correlated with country characteristics. Branstetter, Fisman and Foley (2006) analyze whether stronger IPR system accelerating the technology transfer yields positive effect to all countries. They build their analysis using affiliate-level data and aggregate patent data on US multinational firms over the period 1982-1999, studying the effect of patent protection system on the royalty payments and R&D expenditures. From their results it can be deduced that a stronger IPR encourages multinational firms to engage in more technology transfer. Indeed, they register a significant rise of patents filed by nonresidents following the reforms. Clearly, nothing can be concluded whether IPR system is welfare enhancing for these countries, because this analysis does not take into account the impact of reforms at the national levels.

Lanjouw and Lerner (1997), and McCalman (2001) demonstrate how the international harmonization of the IPR could yield opposite effects for developing countries. It turns up that a strong patent regime provides large income transfer between countries, for which developing countries are the major contributors, to the advantage of the patent holder that are multinational firms located in developed countries. Moreover, even though there is a positive relation between the patent protection and the level of R&D, it is reverted after a certain threshold for which the peculiarities of countries are determinant (Alvi *et al.*, 2007).[1]

We contribute to the empirical literature by providing evidence regarding the harmonization of the new IPR at the international level. We investigate whether the interaction of the TRIPS agreement has stimulated the international cooperation in the pharmaceutical sector between WTO members, focusing on the less developed countries. Although there is a huge consensus about the role that patent plays in health-related research and development, to the best of our knowledge there is no evidence about the effect of the IPR on the patent cooperation at international level.

On 1 January 2005 the TRIPS regulations about the new patent regime came into force in all developing countries, imposing to all members of WTO to provide patent protection in all productive areas for which such protection previously was not present

[1]Fundamental to these studies is the role played by FDI and the income level of the countries. Moreover, confirmation of the role assumed by the imitation process is provided.

(e.g. pharmaceutical products).[2] This date has represented an important step toward an harmonized international patent regime. Under the terms of the TRIPS agreement, many new developed countries with innovative and technology capabilities (such as India, Brazil and Thailand) were allowed to retain their own national patent regime until 2005, when all countries have been forced to implement the new IPR regime. The passage from the national patent regime to the international patent regime in the years before and after 2005 provides an opportunity to estimate the impact of the new IPR system on the pharmaceutical patent cooperations. During the transition period these new developed countries had the opportunity to strengthen a stable pharmaceutical industry, creating the conditions for some of the foreign companies in the industry to initiate investment in R&D cooperation with these countries.[3] Indeed, in the recent years developing countries have grown interest in attracting FDI and technology transfer, for which IPR clearly plays a crucial role. Although the theory indicates that the scales are tipped in favor of a positive relationship between IPR and FDI, the empirical evidence is far from being sufficient to confirm that. Indeed, there is a strong presumption that FDI and licensing are beneficial for the recipient country but it is important to underline that it is not a warranted outcome in all circumstances. Moreover, the development of innovation and the decision where to locate R&D labs and production plants could be influenced by local/regional characteristics (such as the availability of proximal skilled labor force), that have stronger effect on innovation than national and international policies (such as strengthening IPR).

Furthermore, there is a well developed literature suggesting that the patent system is no longer the main mechanism to spur innovation (Mansfield, Schwartz and Wagner, 1981; Chin and Grossman, 1990; Deardorff, 1992). There are other methods (such as secrecy and licensing agreements) that are more effective than patents (Levin *et al.*, 1987; Cohen, Nelson and Walsh, 1996). In spite of this, the pharmaceutical industry seems to rely on patents more then other sectors (Diwan and Rodrick, 1991).

Several studies have attempted to estimate the effects of patent protection on pharmaceutical innovation providing contentious results. Despite the IPR system encourages firms to invest in R&D devising new technology, the same system discourages them to introduce the second generation products (Scotchmer, 1991). Moreover, an increase in

[2]With the exception of least-developed members of WTO, for which enforcement of product patent protection and undisclosed information rights for pharmaceuticals is postponed to 2016.

[3]Many less developed countries, in the year before 2005 were slowly launching some of the major changes in the intellectual property rights. In 2002 India has already introduced by earlier amendments to the Patent Act the new extension of patent protection from 14 years to 20 years (Padmashree, 2007). While with the aim to joint the North American Free Trade Agreement (NAFTA), in 1991 Mexico was one of the first developing countries to enforce its patent system (Léger, 2005).

the strength of the IPR in developing countries would reduce the investments in R&D, decreasing the rate of innovation and imitation, leaving FDI the only channel of technology transfer (Helpman, 1993; Glass and Saggi, 1995; Lai, 1998). Whenever licensing is allowed, an increase in stringency of IPR provides additional resource available for R&D (Yang and Maskus, 2001). On the other hand, the introduction of the international patent regime in developing countries seems to be essential, because without this protection northern firms have more incentive in making new technology difficult to imitate (Taylor, 1993; 1994). Besides, even if developing countries could not find direct benefits from the introduction of the IPR, indirectly they could take an advantage by means of international cooperation.

The remainder of the paper is structured as follows. Section 2 describes the data and empirical measures used in the analysis, while in Section 3 we test the effect of increased protection of IPR on technological and scientific collaborations and report our findings. Finally, Section 4 concludes with a summary of the main results.

2 Data and measures

International cooperation in pharmaceutical research is studied having recourse to a range of rich databases. Our measure of technological and scientific collaboration rely on the information contained in patents and publications. The dependent variables were constructed employing ad hoc queries on *PatentScope registered* for inventions (patents) related to pharmaceuticals, and from *ISI Web of Knowledge* for the peer-reviewed research articles published about health-related subjects (Lerner, 1994; Zucker, Darby and Armstrong, 2003).[4]

Based on patent information, a measure of technological collaboration between two countries is computed by looking at the data about the country of resident of the inventors. A collaboration is counted if a patent is signed by inventors located in both countries (irrespective of the country of the patent assignee). In order to identify pharmaceutical patents, we exploited the International Patent Classification (IPC) and consider the classes A61K and A61P. Indeed, with references to IPC scheme, these two classes contain information about the drugs or other biological compositions for medical, dental or toilet purposes, and therapeutic activity of chemical compounds or medicinal preparations.[5] Using *PatentScope registered* database we construct a sample of 234,126 patents

[4]For more details about *PatentScope registered* and *ISI Web of Knowledge* refer to http://www.wipo.int and http://apps.isiknowledge.com, repectively.

[5]For more details see: http://www.wipo.int/classifications/ipc/ipc8/?lang=en.

published between 1998 and 2008 in cooperation between thirty partner countries, of which eleven are developing or transitional economies.[6]

For the same panel, from *ISI Web of Knowledge* we extract more than 1.5 million health-related research articles published over the period 1998-2008.[7] The database reports the affiliation of all the authors involved in a publication, along with the country. A scientific collaboration between two countries is considered if this is jointly signed by researchers located in two different countries.

The choice of the countries considered in the analysis has been driven by considerations about their size and importance in the pharmaceutical sector, in particular in the production of generics (World Generic Market Report, 2009). Moreover, in the past, with few exceptions, they were recognized as having the weakest protection (Mansfield, 1994; 1995; Lee and Mansfield, 1996). Therefore, it is of interest to examine how the international patent regime has affected the R&D potential of these countries. Indeed, in the recent years owing to the TRIPS agreement, these countries have been among those undergoing major reforms in their national legislation about IPR protection. Furthermore, due to their little effective patent protection some countries (such as Brazil, China, and India) were not parties of the Paris Convention or the Patent Cooperation Treaty.[8]

Two different strategies have been employed to measure the level of IPR enforcement in the developing or transitional countries considered in the analysis. First, we consider two dummy variables identifying the time periods that are mostly relevant in terms of the TRIPS agreements in the countries analyzed: a dummy variable for the time period 2000-2004 and a dummy variable identifying the years from 2005 on (the base category is the period before 2000). Then, we rely on the effectiveness of the legal regime and the quality of governance as measured by the Economic Freedom of the World (EFW) index provided by the *World Economic Forum and the Economic Freedom Network*. The index, published in the annual report of the Economic Freedom of the World (Gwartney and Lawson, 2008), measures the degree to which the policies and institutions of countries are supportive of economic freedom.[9] Although, the EFW index assesses the degree of

[6] Argentina, Austria, Belgium, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Luxembourg, Mexico, Morocco, Netherlands, Portugal, Rep. of Korea, Russian Federation, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom and United States.

[7] Since journals publish scholarly material in a variety of matters, we confine our data to research articles that are defined by their health-related contents.

[8] For a specific analysis about these countries see Park and Lippoldt (2008).

[9] See www.fraserinstitute.org for complete methodological details.

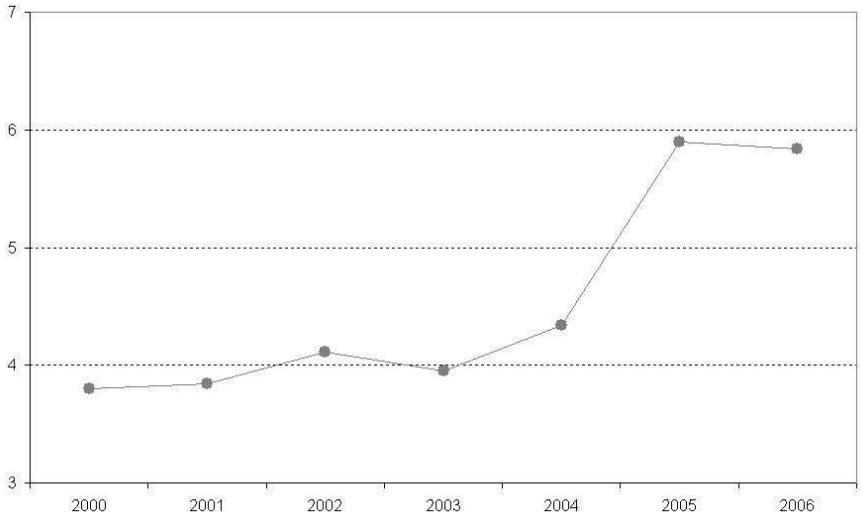

Figure 1: EFW index for the protection of IPR (EFW_2C): basic trend for the developing countries included in the analysis

economic freedom present in five major areas,[10] we use in our study data confined to the legal structure and security of property rights, and specifically of protection of IPR (area 2C).[11] Figure 1 reports the average values of the index computed considering the developing countries included in our sample. The year 2005 represents a clear turning point for the protection of IPR in these countries, driven by the implementation of the TRIPS agreement.

Finally, we use several variables from three international national databases, in order to assess the impact of the national endowment on collaborative activities. With the aim to examine the research quality of each countries we built a dataset extracting information from the following websites: World Bank (*World Development Indicator)*[12], UNESCO (*United Nations Educational Scientific and Cultural Organization Institute for Statistics*)[13], and OECD (*Main Science and Technology Indicators*)[14].

[10]These five areas are: i) size of government: expenditures, taxes, and enterprises; ii) legal structure and security of property rights; iii) access to sound money; iv) freedom to trade internationally; v) regulation of credit, labor, and business (Gwartney and Lawson, 2008 - pp. 4).

[11]Data for area 2C are only available from the year 2000.

[12]http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/

[13]http://stats.uis.unesco.org/unesco/TableViewer/document

[14]http://titania.sourceoecd.org

3 Methodology and results

Gravity models have been largely employed for the study of international flows between countries (Anderson and van Wincoop, 2001). Building on the Newton's law of universal gravitation, the model posits that the flow F_{ij} (most commonly trade flow[15]) between two countries i and j is proportional to their "masses" (respectively M_i and M_j) and inversely proportional to the distance between them D_{ij}:

$$F_{ij} = \frac{\beta_0 M_i^{\beta_1} M_j^{\beta_2}}{D_{ij}^{\beta_3}} \tag{1}$$

In order to obtain an estimate of the parameters in equation (1), the model is customarily log-linearized and ordinary least squares is applied. This traditional approach has been recently subject to a strong critique, as it fails to provide consistent estimates of model elasticities if heteroschedasticity is present in the original equation (Santos Silva, Tenreyro, 2006). As a robust alternative, the Poisson pseudo-maximum likelihood estimator is to be preferred, allowing the researchers to solve the consistency issue, as well as the possibility of zero flow between two countries.

Moreover, our empirical assessment of the scientific and technological collaboration relies on the number of patents co-invented by inventors located in countries i and j, as well as the number of publications by scientists located in countries i and j.[16] As a count variable, the Poisson regression framework would be more appropriate for estimation in our context.

Let C_{ijt} be the measure of technological and scientific collaboration between country i and country j at time t. Collaboration between North American and European countries (i) and selected developing countries (j) is taken into account. A gravity equation is considered, where we also include the IPR regime of country j ($IPRR_{jt}$) among the attraction factors:

$$\begin{aligned} E[C_{ijt}|M_{it}, M_{jt}, IPRR_{jt}, \tau_j, \alpha_{ij}] = \quad & \exp(\beta_0 + \beta_1 \log M_{it} + \beta_2 \log M_{jt} \\ & + \beta_3 \log IPRR_{jt} + \tau_j + \alpha_{ij}) \end{aligned} \tag{2}$$

with α_{ij} representing a dyad-specific characteristics, M_{it} and M_{jt} the "masses" of, respectively, country i and j, and $IPRR_{jt}$ measures the level of enforcement of IPR, proxied using (i) time specific dummies and (ii) the the index of intellectual property

[15] The gravity equation has been also applied to study migration flows, equity flows and FDI (see e.g. Portes, Rey, 1998; Brenton *et al.*, 1999).

[16] See footnote 6 for the full list of countries in the analysis.

Variable	Mean	Std. error	Min	Max	N
pt_coop	12.67	67.02	0	1456	2299
publ_coop	28.08	76.23	0	1421	2299
res_i (log)	5.373	.9818	.8059	6.684	1540
res_j (log)	5.180	3.161	-20.03	6.831	1349
RD_i (% GDP, log)	.6185	1.112	-2.131	12.95	1848
RD_j (% GDP, log)	-.3617	.6127	-1.410	1.171	1653
RD_i (total, log)	27.71	1.956	24.23	41.40	1848
RD_j (total, log)	25.89	1.667	22.57	28.96	1653
GDP_i (log)	26.99	1.419	23.69	30.25	2090
GDP_j (log)	26.21	1.298	23.35	28.79	2090
EFW_2C (log)	1.459	.3393	.6419	2.067	1444

Table 1: Descriptive statistics

rights protection published in the annual report of the Economic Freedom of the World (area 2C). Country-specific time trends are included in all specifications (τ_j).

In order to proxy M, international trade literature has relied on GDP and population measures. Here, we use the level of GDP and also take into account the research capabilities of each country, as measured by the number of researchers (per million population), and the expenditure on R&D (both in value and share of GDP).We apply the fixed effect Poisson estimator in order to tackle the possibility for correlation between the regressors included in the model and the dyad-specific component α_{ij}.[17] In addition, standard errors are estimated via bootstrap as it is not possible to assume independence among the dyads (dyad ij is likely correlated with dyad ik even if $j \neq k$).[18]

Descriptives statistics of the variables included in the regressions are reported in Table 1.

The Figure 2 depicts the dynamics of the average value of our dependent variables. The year 2005 seems to be a break-point in the dynamics characterizing collaboration in patents, whereas this is not case for scientific publications.

On the one side, the increase in the number of collaborative patents could be ascribed to an overall increase in the patenting activity within the analyzed countries.

On the other side, increasing protection of IPR could lead to an increase in the *proportion* of collaborative patents. In order to dig further into this issue, Figure 3 depicts the evolution in the share of collaborative patents within the developing countries.

[17] As a drawback, we are not able to estimate the effect of the distance between the two countries (as time-invariant). However, this effect is not directly of interest to our research.

[18] One hundred bootstrap replications are considered.

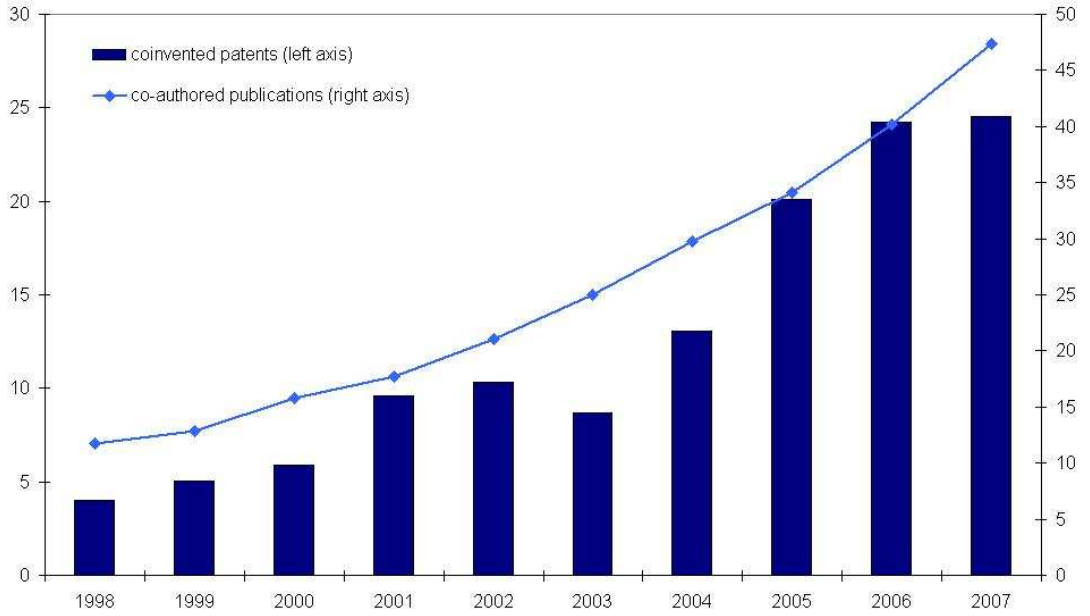

Figure 2: International R&D collaboration in patents and publications (sample average)

By means of box-plots,[19] the Figure shows that the share of collaborative patents and publications in our sample is increasing over time.

Table 2 reports the estimation of the model of technological collaboration, taking into account both the number and the share (within developing countries) of patents with inventors located in country i and j.

Table 3 consider the collaborations built on the basis of scientific publications.

Scientific and technological collaboration is increasing over time at a pace of about 20% in the case of collaboration in patents and 15% for scientific publications.

Interestingly enough, the effect of patent right protection and enforcement of the TRIPS agreements has different effect on technology and science.

On the one side, the index of IPR protection exerts a positive and statically significant effect of cooperation in patents. On the other side, it seems to have no influence on scientific collaborations, as measured by joint publications.

The focus is on area 2C of the database taking into account the protection of property rights. The coefficient is positive and statistically significant in all specifications, when collaboration in patents is considered, whereas statistical significance vanishes when we

[19] Outliers are excluded from the graph.

Measure of "mass"	Variables included in the model				
	M_i	M_j	EFW_2C_j	$I_{2000\leq t\leq 2004}$	$I_{t\geq 2005}$
Count of collaborations					
1. GDP	-1.057**	.5714**	.3946***		
	(.4498)	(.2499)	(.1050)		
2. GDP	-.5933*	-.2255		.1879**	.5757***
	(.3244)	(.1768)		(.0869)	(.1035)
3. R&D (% GDP)	-.0227*	.2147	.5378***		
	(.0138)	(.5604)	(.1801)		
4. R&D (% GDP)	-.0171	-.0048		.3039***	.7201***
	(.0139)	(.4992)		(.0950)	(.1386)
5. R&D (value)	-.0275**	.3524	.5364***		
	(.0127)	(.3495)	(.2073)		
6. R&D (value)	-.0204	-.0381		.2992**	.7185***
	(.0148)	(.1655)		(.1240)	(.1450)
7. Researchers	.1251***	.0232	.4003		
	(.0354)	(.0364)	(.0364)		
8. Researchers	.0879***	.0035		.2570**	.5892***
	(.0328)	(.0212)		(.1039)	(.1326)
Collaborative share (w.r.t. j-total)					
9. GDP	-1.093**	.4156**	.3305***		
	(.4496)	(.2013)	(.0921)		
10. GDP	-.6282	-.2272		.1035	.4286***
	(.4011)	(.1708)		(.1232)	(.1219)
11. R&D (% GDP)	-.0256	.6175	.4732**		
	(.0197)	(.5069)	(.1920)		
12. R&D (% GDP)	-.0190	.2315		.2104	.5670***
	(.0168)	(.5068)		(.1291)	(.1551)
13. R&D (value)	-.0305	.2622	.4640***		
	(.0882)	(.2261)	(.1725)		
14. R&D (value)	-.0227	-.0354		.2275*	.5839***
	(.0198)	(.1396)		(.1257)	(.1599)
15. Researchers	.1055***	.0081	.3951		
	(.0370)	(.0333)	(.2410)		
16. Researchers	.0732***	.0001		.1552*	.4304***
	(.0254)	(.0180)		(.0928)	(.1139)

Poisson (conditional) fixed effect estimation.
Country j time trend included in all specifications.
Statistical significance: *** 1% ; ** 5% ; * 10%.

Table 2: Gravity model of research cooperation, patents

Measure of "mass"	Variables included in the model				
	M_i	M_j	EFW_2C_j	$I_{2000\leq t\leq 2004}$	$I_{t\geq 2005}$
Count of collaborations					
1. GDP	.0852	-.0068	-.0006		
	(.1571)	(.0614)	(.0358)		
2. GDP	.1302	-.0072		.0188	.0022
	(.1957)	(.0538)		(.0374)	(.0391)
5. R&D (% GDP)	-.0171**	.1511	-.0016		
	(.0077)	(.1537)	(.0505)		
6. R&D (% GDP)	-.0175	.2004		-.0113	-.0412
	(.0110)	(.1665)		(.0387)	(.0479)
5. R&D (value)	-.0166*	.0261	.0010		
	(.0090)	(.0545)	(.0405)		
6. R&D (value)	-.0164*	.0628		-.0043	-.0407
	(.0091)	(.0667)		(.0416)	(.0467)
7. Researchers	.0063	-.0102	.0133		
	(.0107)	(.0121)	(.0520)		
7. Researchers	.0049	-.0029		.0253	-.0159
	(.0092)	(.0064)		(.0685)	(.0754)
Collaborative share (w.r.t. j-total)					
1. GDP	.0117	-.0091	-.0173		
	(.1546)	(.0597)	(.0475)		
2. GDP	.0970	-.0180		.0183	-.0072
	(.1838)	(.0505)		(.0323)	(.0404)
5. R&D (% GDP)	-.0211**	.0923	-.0198		
	(.0103)	(.1553)	(.0482)		
6. R&D (% GDP)	-.0213**	.1313		-.0132	-.0609
	(.0097)	(.1694)		(.0400)	(.0504)
5. R&D (value)	-.0209*	.0145	-.0174		
	(.0125)	(.0514)	(.0554)		
6. R&D (value)	-.0204**	.0496		-.0080	-.0624
	(.0096)	(.0588)		(.0450)	(.0606)
7. Researchers	.0112	-.0086	-.0020		
	(.0111)	(.0130)	(.0622)		
7. Researchers	.0058	-.0030		.0348	-.0240
	(.0115)	(.0081)		(.0657)	(.0800)

Poisson (conditional) fixed effect estimation.
Country j time trend included in all specifications.
Statistical significance: *** 1% ; ** 5% ; * 10%.

Table 3: Gravity model of research cooperation, publications

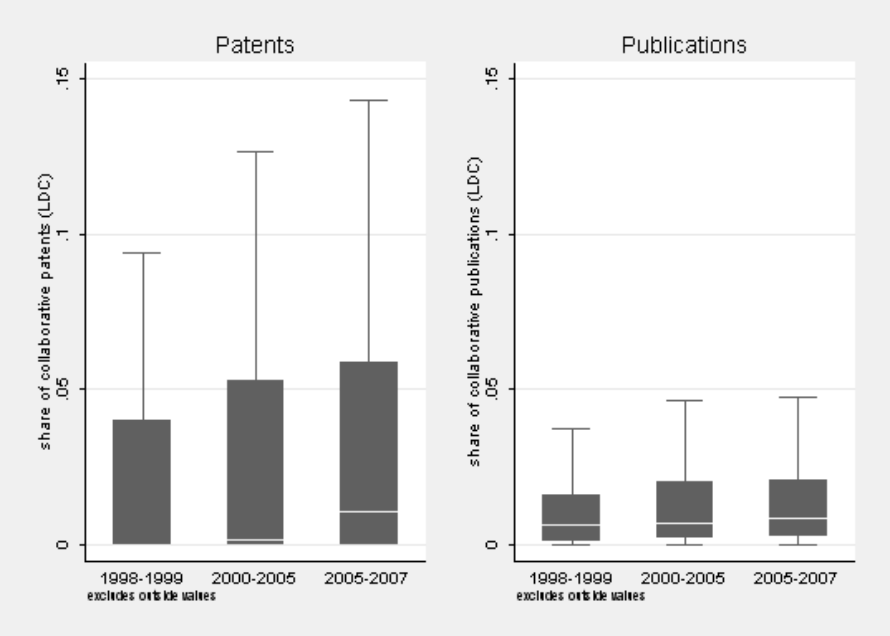

Figure 3: Evolution in patents and publications, average values for developing countries in the analysis

study the collaboration in scientific publications.

Overall, we provide evidence of a positive effect of security of property rights and TRIPS enforcement on technological collaboration, as measured trough patents. On the contrary, the variables seems to have no effect on scientific collaborations.

With the exception of GDP, the national endowment of the developing countries considered in the analysis, in terms of the level and the intensity of R&D activities seem to have no effect as an attractor of technological and scientific collaboration from the developed world. Besides, the development of innovation and the decision where to locate R&D labs and production plants could be influenced by local/regional characteristics (such as the availability of proximal skilled labor force), that may exert strong effect on innovation. The estimation framework allow us to control for these characteristics, as long as these are stable over the analyzed time window. Unfortunately, lack of suitable data prevent us to include variables other than dummies identifying each pair of countries in our specification.

4 Summary and conclusions

Fast evolution is characterizing the IPR regime at the international level. The year 2005 represents an important turning point, when the TRIPS legislation enforced a new patent regime in most developing countries. The new rules provide a unique setting for understanding the impact of a stronger patent regime on international collaboration. A gravity equation is estimated where the dependent variables aim at measuring the level and intensity of technological and scientific collaboration between Europe and North American on the one side and selected developing countries on the other.

In this paper we present a novel approach, assessing the effect of TRIPS enforcement on the level and intensity of scientific and technological collaboration with North American and European countries in selected developing countries.

Two different strategies have been applied in order to measure the level of protection of IPRs. First, we consider dummy variables identifying two important time periods for the enforcement of TRIPS agreement in developing countries: the year 2000 and the year 2005. Second, we rely on the index of legal protection, focusing on the protection of IPRs, published in the Economic Freedom of the World report.

Even though preliminary in nature, our results point to a positive effect of the new patent regime on the level of technological collaboration, whereas it seems not to affect the level of scientific collaboration. The difference effect of TRIPS enforcement between the two worlds is indeed expected on the basis of the specific incentives and ethos underlying the publication of scientific results versus the request of a patent accruing monopoly rights to its holder (Dasgupta and David, 1994).

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