Intellectual Property Rights and International Trade of Agricultural Products

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Abstract

This paper studies the effect of strengthening intellectual property rights (IPRs) after the signing of the TRIPS on agricultural trade and bilateral trade links, for the period 1995-2011. It uses data of agricultural exports and an index of intellectual property (IP) protection that considers specificities of this sector, for a set of 60 economies that allows to study possible divergent results for developed and developing countries. The estimates show that stronger IPRs systems affect negatively total exports and imports of agricultural products, especially for developing countries. At a more disaggregated level, we found heterogeneous results depending on the sub-sectors, but the correlation is negative for most of them. The effect on trade links was investigated using a gravity model and we found that an increase in the IP protection levels is expected to have ambiguous effects depending on the sub-sector and level of development of trading country partners. The increase of IP protection of the exporter and the importer was investigated separately and, in some cases, asymmetric effects were found.

Keywords: Intellectual Property Rights; International Trade; Agriculture; Gravity Model

JEL Codes: O1; O34; Q17; F14

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1 Introduction

The signing of the agreement on Trade-Related Aspects on Intellectual Property Rights (TRIPS) in 1994 has derived in a process of global diffusion and tightening of intellectual property rights (IPRs) systems. While developed countries (DC) have increased the level of existing intellectual property (IP) protection, developing countries (LDC) have adopted new systems with strong levels of protection or have adapted existing systems to the "minimum standards" demanded by the TRIPS.

This process has implications for innovation, productivity, international trade and economic development. Theoretically, IPRs are thought to be incentives to innovate, which in turn spur economic growth. Changes in IPRs may influence returns to innovation, affecting decisions of firms to trade in different markets. However, the role of IPRs as incentives to innovate leading to economic growth has been both theoretically and empirically criticized. In addition, the impact of strengthening IPRs was proved to be sector and technology specific (Teece, 1986; Dosi et al., 2006).

Meanwhile, the link between IP protection and trade flows has been less studied. Theoretically, the net effect of increasing patent protection is not clear. Maskus and Penubarti (1995) discussed that, in principle, stronger IPRs systems are expected to have different and contrary effects on trade. On the one side, firms should be encouraged to export patented goods to countries with stronger IP protection since the risk of imitation is lower. On the other side, stronger IPRs increase the market power of the importing firm, which may encourage the firm to behave in a monopolistic way, increasing prices and reducing sales. Then, the net result will depend on the product sectors and the level of development in trading partner countries. Therefore, empirical analysis are needed to disentangle the effect of stronger IPRs on trade volumes and bilateral trade flows of different sectors and countries.

Among other things, the signing of the TRIPS agreement demanded IP protection for plant varieties either by patents or a *sui generis* system. For this reason, many developing countries have recently adopted stronger IPRs systems for plant varieties. Historically, agriculture and industries that use vegetables and grains as inputs have been very relevant for many developing economies, especially since a high share of the total exports is constituted by products that derive from the use of natural resources (not considering mineral and fuels). This includes agricultural products both as raw material or having gone through some kind of, in general minor, industrial transformation.

Moreover, the use of different IPRs (plant breeders' rights, plant patents, utility patents) has been increasing, especially with the development of biotechnology applied to agriculture.

Therefore, taking advantage of the existence of a new IP protection index for plant varieties recently created by Campi and Nuvolari (2013), this paper explores the effect of strengthening IPRs systems in the agricultural sector after the signing of the TRIPS on traded quantities and bilateral trade flows, for a group of 60 countries, which includes 28 developed and 32 developing countries. Thus, taking into account possible heterogeneities, we also check the robustness of the findings dividing the sample according to development level.

The remaining of the paper is organized as follows. The next section briefly discusses how IPRs may affect trade among countries, reviewing both theoretical and empirical approaches. In the third section, we explain the data. The forth section presents the econometric estimations for the effect of IPRs on trade volumes. The fifth section explores the effect of IPRs on bilateral trade links. Finally, the main conclusions are presented.

2 How are IPRs and Trade Related?

The effect of stronger IPRs on total trade flows and bilateral links has been marginally studied until recently. The question of how they are related is difficult to be addressed because contradictory effects have been identified by economic theory and, ultimately, the answer seems to be an empirical matter.

Theoretically, different models were developed to study this issue concluding that the effect of strengthening IPRs on trade is ambiguous (Grossman and Helpman, 1990; Grossman and Lai, 2004). In models of dynamic general equilibrium of two regions, North and South, where innovation takes place in the North while the South imitates technologies that have been invented in the North, Helpman (1993) identified four channels through which IPRs are likely to affect trade between countries: i) terms of trade; ii) interregional allocation of manufacturing; iii) product availability; and iv) R&D investment patterns. He concluded that whether the strengthening of IPRs are desirable or not can not be answered theoretically. However, his model predicts that "if anyone benefits, it is not the South" (Helpman, 1993, 1274).

Maskus and Penubarti (1995) have shown that it is possible to expect contradictory effects of stronger IPRs on trade. Considering a price-discriminating firm deciding on the distribution of their exports to different countries, they argue that there is a trade-off between the enhanced market power for the firm created by the stronger IPRs systems and the larger effective market size generated by reduced abilities of local firms to imitate the patentable product. The first one derives from the "market-power effect", which would reduce the elasticity of demand faced by the foreign firm and would induce the firm to export less of its patentable product to the market with stronger IPRs. A contrary effect is related with the "market-expansion effect", which would increase the demand curve faced by the firm and attract larger sales. In addition, in larger markets, it is possible to find a "cost-reduction effect" that would raise exports if a stronger patent law reduces the need of the foreign firm to undertake private expenditures to deter local imitation.

Market power and market size effects may also be affected by other factors. Particularly relevant is that decisions of firms to export new patentable products or processes to a particular market will depend not only on IPRs systems, but also on decisions of licensing and foreign direct investment (FDI). Having stronger IP protection in a market could enhance licensing agreements or FDI instead of trade. In addition, imitating is costly, time consuming and depends on capabilities that vary across countries. Therefore, a weak IPRs system in a country with low imitation ability will not necessarily remove incentives of an innovative firm to enter that market. Finally, changes in IPRs would also interact with and be affected by local market parameters, such as demand, the efficiency of local imitative production, and the structure of trade barriers.

There are some empirical studies addressing the question of how IPRs affect trade volumes and bilateral trade flows. Using trade data for a single year, Maskus and Penubarti (1995) investigated whether the distribution of bilateral trade across nations depends on the importing country's patent regime. They found that exporting firms discriminate in their sales decisions across export markets, taking account of local patent laws, across the range of developing countries bilateral imports. Then, they concluded that changes in international patent laws influence international trade depending on the sector and development level.

Several empirical studies have found evidence supporting the hypothesis that the effect of IP protection on import flows varies by different product sectors and is stronger in the knowledge-intensive sectors.

For the case of the US, Smith (1999) found that the link between IP protection and international trade depends on the ability of the importer to imitate the exporter's technologies. She found evidence of the existence of both market expansion and market power effects for the US manufacturing exports, but found the latter to be more relevant for exports to countries with weak capacity of imitation. In the same direction, Co (2004) studied how sensitive are US exports to importing countries' patent rights regimes. Using a trade gravity equation, she found that patent rights regimes per se do not matter; but they matter with importing countries' imitative abilities.

For a panel of countries, Fink and Primo Braga (1999) found that stronger IP protection increases bilateral trade flows of manufactured non-fuel imports. But the results do not hold for trade flows of high technology products, where the effect of IPRs was found to be insignificant. Meanwhile, Delgado et al. (2013) investigated how the implementation of IPRs in developing countries under the TRIPS agreement has affected trade in knowledge-intensive goods and, in contrast, found an increase in imports by developing countries, which was driven by the exchange with high-income countries. They also found that the effect on knowledge diffusion from high-income to developing countries varies by sector.

Ivus (2010) studied how stronger patent rights in developing countries have affected the innovating developed world's exports into their markets. She found that the strengthening of IPRs in developing countries has raised the value of developed countries' exports in patent-sensitive industries. The results are consistent before and after the signing of the TRIPS. This is also consistent with the predictions of Helpman (1993) model, in which higher IPRs produce benefits only for the North. In a similar direction, using country level panel data for the period 2000 to 2007, Shin et al. (2012) studied the role of IPRs in global trade considering the level of technology of the exporting country. They found that IPRs may act as an export barrier to lower income countries. While they argue that recent IPRs reforms have facilitated global trade, they highlight that they have not helped promote the exports of developing countries.

Regarding the effect on total trade and trade links of strengthening IPRs in developing countries, less analyses are available. For the case of China, Awokuse and Yin (2010) found that the strengthening of Chinese patent laws had a strong market expansion effect for trade with both developed and developing countries, leading to an increase in China's import flows, particularly in knowledge-intensive goods. In turn, for the post-TRIPS period, Lesser (2001) found that the effect of stronger IPRs on both FDI and imports is positive and significant for a group of developing countries.

Less evidence is available for the case of agricultural products and the effect of stronger IPRs on their trade. Recently, Yang and Woo (2006) studied whether and how national differences in IPRs affect the flow of planting seeds imports from the United States. They found that whether or not a country adheres to IPRs agreements has no discernible impact on planting seeds imported from the US, which implies that the strengthening of IPRs seems not to induce more agricultural trade. Confirming these results, Eaton (2009) found no evidence that the adoption of the UPOV-approved system of plant breeders' rights positively influences seed imports.

However, this evidence was recently challenged by Galushko (2012) who found that stronger IPRs can foster international seed exchange.

This paper contributes to the current debate by providing evidence for a group of countries using an indicator of IP protection especially built for the agricultural sector. It studies the effect of stronger IPRs after the signing of the TRIPS agreement for different products of agriculture, both raw material and manufactured products that use inputs produced by agriculture.

The case of study has some specificities that deserved being mentioned. Economic theory regarding the effect of stronger IPRs on trade, in general, applies for high-tech products. In that case, if a country increases IP protection, then the theory predicts that technology transfer will occur in that country given that there is less risk of imitation. Therefore, for high-tech products, the important issue is to study imports and how the flows are related with changes in IPRs. In the case of agriculture, many of the products are final goods, whose production is more related with natural endowments of the producing country and, therefore, imitation abilities may not matter as much as in other kind of products. In addition, innovation in this sector depends on the local necessities derived from agro-ecological conditions. For other part of the agricultural products, such as seeds as inputs, imitation abilities do matter, since the genetic information contained in seeds provides the necessary for their reproduction. Unfortunately, the data we have does not discriminate among different kind of products, so we are only able to see the overall effect.

Besides, imitation depends on capabilities of the country receiving the inflow of technology, which is codified in products. Therefore, development level of the country resulting in different imitation abilities is expected to influence the effect of IPRs on trade.

Two other relevant issues make important to consider separately the effect for developed and developing countries. In the first place, developing countries have a higher share of agricultural exports in their total exports, compared with developed countries (Figure 1) and, therefore, agricultural trade has a greater economic relevance for them. Secondly, as part of a global process, IP protection for the agricultural sector has been increasing both in developed and developing countries. However, while most developed countries used to have in place a system of IP protection before the signing of the TRIPS, most developing countries have been adopting these systems after 1995 (Campi and Nuvolari, 2013). Thus, the effect of IPRs would be expected to be different for the early and the newly adopters of IPRs systems.

Finally, most authors addressing the effect of strengthening IPRs on trade, focus on the level of IP protection of the importing country. In contrast, we consider

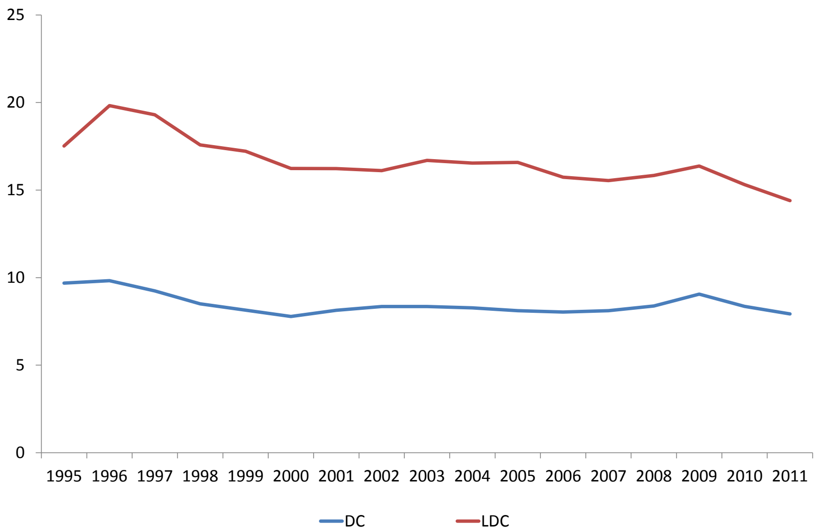

Figure 1: Share of Agricultural Exports on Total Exports.
Developed and Developing Countries

important to analyse separately the effect of increasing IP protection in the importing and the exporting country of agricultural products, since we may expect to observe two different effects. In the first place, an increase in IPRs of the importing country may have an effect on agricultural trade due to the reasons given before (market power and market size effects). In addition,following economic theory, we may expect to observe an effect on exports due to an increase in IPRs of the exporting country if we believe that IPRs may increase productivity and, thus, competitiveness of the sector. Accordingly, we consider both the effect of an increase of IPRs in the importing country and the exporting country.

3 Data

The paper studies the effect of strengthening IPRs on total agricultural exports, imports and bilateral trade relations for 60 countries during the period 1995 to 2011. The list of countries, which can be seen in the Appendix A, includes 28 developed countries and 32 developing countries. Using data from Gaulier and Zignago (2010) (BACI), total trade of agricultural products is computed adding trade of chapters 1 to 24 of the Harmonized System Codes (HS Code) Commodity Classification, excluding chapters 3 and 16, which are related with fishery. We consider as agricultural products grains and vegetables, but also animal products and food that use vegetable products as inputs. Exports and imports of these products are considered to assess the effect of stronger IPRs on total trade. For total links, we use bilateral trade flows of agricultural products.

Since the data was in current US dollars, we converted it into constant dollars (base 2000). To do that, we used as a proxy of the changes in global prices the US imports price index provided by the U.S. Bureau of Labor Statistics (http://www.bls.gov/web/ximpim/beaexp.htm, accesed on February 2014). Agricultural products, as it was defined, aggregates products of several chapters (we call these chapters sub-sectors of the agricultural sector). To consider heterogeneities among price variations for different sub-sectors, we applied the index of each corresponding chapter to our data.

As a measure of IPRs systems, we use an index developed by Campi and Nuvolari (2013), which quantifies the strength of IP protection for plant varieties (inda). It consists of five components that, as a whole, indicate the strength of each country's IP protection system for plant varieties. The index shows that the mean of protection has been steadily increasing over time, especially after the signing of the TRIPS agreement and dispersion has fallen since developing countries have been adopting strong IPRs systems during the last two decades. This reflects the process of strengthening and harmonization of IPRs systems.

To study the correlation between IP protection and total exports/imports, we use three control variables, which are usually included in trade regressions. These variables are constructed using data from Feenstra and Timmer (2013) (Pen World Tables 8.0). The first one is GDP per capita, which is the real GDP at constant 2005 national prices (in millions of 2005 US dollars) and in log (log(gdppc)). Then, we include an indicator of human capital per person, which is based on years of schooling of Barro and Lee (2012) and returns to education from Psacharopoulos (1994) (hc). This variable is expected to have a positive effect on the productivity of a given country and, therefore, also a positive impact on trade. This indicator is relevant for our case since we consider countries of different development levels that are heterogeneous in terms of human capital. Finally, the last independent variable is openness to trade, computed as the sum of total exports and total imports, divided by the total GDP, all in constant prices (log(open)). This variable is also seen as the interaction across country borders and it is believed to facilitate and spur technology transfer and innovation. In addition, to study the bilateral trade relations, we use other independent variables, which will be discussed when we present the estimations for bilateral trade. Table A.1, in the Appendix A, summarizes variables and sources.

4 IPRs and Total Trade. Econometric Estimations

In order to investigate the possible effect of the strengthening of IPRs on trade, firstly, we study the correlation between the index of IP protection and both total imports and exports of agricultural products. Since these simple correlations may mask more complex relations, we include some control variables and carry on a multivariate regression. Table 1 displays the correlation matrix of the independent variables.

Table 1: Correlation Matrix of Independent Variables

Variable	inda	log(gdppc)	hc	log(open)
inda	1			
log(gdppc)	0.3108	1		
hc	0.4264	0.6622	1	
log(open)	0.1927	0.5972	0.3924	1

Taking advantage of the panel structure of the data, we apply fixed effect estimation method using the following models,

$$\log(\text{texpa}_i(t)) = x_i(t) \cdot \beta_x + \mu_{xi}(t) \;; \tag{1}$$

$$\log(\text{timpa}_i(t)) = x_i(t) \cdot \beta_m + \mu_{mi}(t) \;; \tag{2}$$

where,

$$x_i = \{1, \text{inda}_i, \log(\text{gdppc}_i), \text{hc}_i, \log(\text{open}_i)\}. \tag{3}$$

Table 2 displays the results of the fixed effects estimations. The three first models were estimated with total exports of agricultural products as the dependent variable, using Equation (1). They estimate if an increase in IP protection of the exporter countries have a positive effect on their agricultural exports. Since economic theory predicts a positive (texpa) effect on productivity and, thus, competitiveness of the sector, we should expect a positive effect on export volumes. Model 1 displays the estimations for the full sample of countries. The index of IP protection results negative and statistically significant. In order to check the robustness of the results, we divide the sample according to development level in two groups, developed and developing countries.[1] The results are shown in models 2 and 3. The index of IP protection does not have a significant effect on total exports of agricultural products for the sample restricted to developed countries, but the effect is negative and significant for the case of developing countries. The rest of the variables, when they turn out significant, present the expected signs.

[1] See Appendix A for the list of countries.

Table 2: Total Exports and Total Imports of Agricultural Products.
Fixed Effects Estimations

Dependent Variable	Total Agricultural Exports			Total Agricultural Imports		
Model	(1)	(2)	(3)	(4)	(5)	(6)
Sample	FS	DC	LDC	FS	DC	LDC
IP Index	-0.029**	-0.018	-0.057***	-0.036***	-0.054***	-0.024*
	(0.011)	(0.019)	(0.014)	(0.009)	(0.013)	(0.012)
log GDP per capita	0.400***	1.152***	0.081	1.215***	1.224***	1.286***
	(0.071)	(0.116)	(0.087)	(0.056)	(0.082)	(0.076)
Human Capital	0.740***	0.101	1.325***	-0.352***	0.215**	-0.832***
	(0.115)	(0.142)	(0.161)	(0.090)	(0.101)	(0.141)
log Openness	0.789***	0.786***	0.696***	0.770***	0.693***	0.805***
	(0.043)	(0.059)	(0.057)	(0.034)	(0.042)	(0.050)
Constant	4.158***	-1.636*	6.130***	-0.241	-1.821***	0.400
	(0.493)	(0.913)	(0.540)	(0.386)	(0.649)	(0.472)
Observations	1,020	476	544	1,020	476	544
R-squared	0.647	0.777	0.600	0.800	0.859	0.776
Number of Countries	60	28	32	60	28	32

Note: Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10.
FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.

Models 4, 5 and 6 present the estimation results of Equation (2), considering total imports of agricultural products as the dependent variable (timpa). In this case, we observe a negative and significant effect for the full sample and for both samples of developed and developing countries. This implies that the increase of IP protection in the importer country is negatively correlated with the total agricultural imports of that country.

As other authors, such as Awokuse and Yin (2010), have found for industrial products, the effect of strengthening IPRs may be different when considering exports or imports of products at a more disaggregated level. Therefore, we perform fixed effects estimations, in which the dependent variable is the quantity of exports or imports of each of the 24 sub-sectors (excluding 3 and 16, related with fishery) at the first level of the HS Classification Product; and the independent variables are those in Equation (3).

Since we are mainly interested in the effect of the strengthening of IPRs on trade, Table 3 displays the coefficients of the IP protection index for the estimations performed for total exports and imports of each sub-sector.[2] Once again, we check the results for countries grouped according to development level.

The index of IP protection displays different correlations at a more disaggregated level, considering both exports and imports. The first remark is the heterogeneity observed. For some cases, the IP protection index results no statistically significant, while for other cases in which the estimated coefficient is significant, we observe both

[2]All estimation results are available upon request.

Table 3: IP Index Coefficients. Fixed Effects Estimations for Sub-sectors

Dependent Variable	Total Agricultural Exports			Total Agricultural Imports		
Model	(1)	(2)	(3)	(4)	(5)	(6)
Sample	FS	DC	LDC	FS	DC	LDC
HS 1 Live Animals	-0.046	0.085*	-0.074	-0.043	0.017	-0.034
	(0.046)	(0.049)	(0.065)	(0.029)	(0.045)	(0.040)
HS 2 Meat and Edible Meat Offal	-0.117***	-0.045	-0.223***	0.110***	0.060*	0.142***
	(0.044)	(0.048)	(0.064)	(0.027)	(0.036)	(0.038)
HS 4 Dairy, Eggs, Honey, and Edible Products	0.123***	0.030	0.127**	-0.054***	-0.122***	-0.016
	(0.035)	(0.026)	(0.055)	(0.019)	(0.031)	(0.024)
HS 5 Products of Animal Origin	-0.099***	-0.011	-0.119**	0.023	0.061**	0.017
	(0.036)	(0.032)	(0.056)	(0.021)	(0.027)	(0.030)
HS 6 Live Trees and Other Plants	0.024	0.006	0.012	0.101***	-0.043**	0.175***
	(0.029)	(0.045)	(0.038)	(0.021)	(0.021)	(0.031)
HS 7 Edible Vegetables	0.025	-0.096***	0.059**	-0.001	-0.026	0.000
	(0.021)	(0.032)	(0.028)	(0.018)	(0.020)	(0.028)
HS 8 Edible Fruits and Nuts, Peel of Citrus/Melons	0.007	-0.051	-0.003	0.063***	-0.021	0.110***
	(0.023)	(0.036)	(0.030)	(0.016)	(0.018)	(0.023)
HS 9 Coffe, Tea, Mate and Spices	-0.079***	-0.014	-0.106***	-0.047**	-0.007	-0.039
	(0.025)	(0.041)	(0.031)	(0.020)	(0.022)	(0.030)
HS 10 Cereals	-0.104*	0.094	-0.241***	-0.018	-0.019	-0.017
	(0.058)	(0.064)	(0.085)	(0.025)	(0.038)	(0.035)
HS 11 Milling Industry Products	-0.076*	0.020	-0.160***	-0.067***	-0.046*	-0.081***
	(0.041)	(0.042)	(0.061)	(0.020)	(0.025)	(0.030)
HS 12 Oil Seeds/Misc. Grains/Med. Plants/Straw	0.082**	0.025	0.047	0.058**	0.063**	0.061*
	(0.033)	(0.037)	(0.047)	(0.023)	(0.025)	(0.035)
HS 13 Lac, Gums, Resins, etc.	-0.102***	-0.175***	-0.093*	0.036*	-0.025	0.069**
	(0.039)	(0.062)	(0.051)	(0.019)	(0.024)	(0.027)
HS 14 Vegetable Planting Materials	-0.119**	0.087	-0.227***	-0.022	-0.032	-0.084*
	(0.047)	(0.078)	(0.062)	(0.035)	(0.055)	(0.043)
HS 15 Animal or Vegetable Fats, Oils and Waxes	-0.099***	-0.040	-0.133***	-0.054***	-0.033	-0.043**
	(0.031)	(0.038)	(0.045)	(0.017)	(0.025)	(0.022)
HS 17 Sugars and Sugar Confecionery	0.020	-0.038	0.011	-0.070***	-0.033	-0.086***
	(0.033)	(0.033)	(0.050)	(0.020)	(0.025)	(0.029)
HS 18 Cocoa and Cocoa Preparations	-0.081**	0.038	-0.135**	-0.004	-0.048***	0.024
	(0.036)	(0.033)	(0.055)	(0.015)	(0.018)	(0.021)
HS 19 Preps. of Cereals, Flour, Starch or Milk	-0.019	-0.053	-0.013	0.004	-0.061***	0.045**
	(0.028)	(0.033)	(0.041)	(0.015)	(0.017)	(0.023)
HS 20 Preps. of Vegetables, Fruits, Nuts, etc.	-0.140***	-0.107***	-0.149***	-0.024*	-0.045***	0.002
	(0.017)	(0.029)	(0.022)	(0.013)	(0.014)	(0.019)
HS 21 Misc. Edible Preparations	-0.053**	0.071**	-0.111***	-0.004	-0.059***	0.030*
	(0.026)	(0.028)	(0.040)	(0.013)	(0.018)	(0.018)
HS 22 Beverages, Spirits and Vinegar	-0.066**	0.050	-0.141***	-0.087***	-0.115***	-0.067***
	(0.028)	(0.037)	(0.039)	(0.016)	(0.020)	(0.023)
HS 23 Residues from Food Industries, Animal Feed	0.007	0.030	-0.034	0.044**	0.000	0.072**
	(0.032)	(0.033)	(0.048)	(0.019)	(0.022)	(0.028)
HS 24 Tobacco and Manuf. Tobacco Substitutes	-0.048	-0.031	-0.044	-0.038*	-0.104***	-0.008
	(0.050)	(0.099)	(0.058)	(0.023)	(0.033)	(0.032)

Note: Standard errors are in parenthesis. Significance level: *** $p<0.01$, ** $p<0.05$, * $p<0.10$. FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.

a positive or a negative effect on trade of certain types of products. However, most of the significant regressors are negative.

Considering exports, for the full sample, we observe that the index of IPRs is negatively and statistically significantly correlated with the exported quantities for 12 sectors out of 22; positively and significantly correlated with 2 sub-sectors; and non significantly correlated with the rest of the sub-sectors, 8 sectors out of 22.

For the case of developed countries, IPRs have a non significant correlation with exports for most of the sub-sectors (17 out of 22), in 2 sub-sectors we observe a positive and statistically significant correlation between IPRs and exports; and for 3 sub-sectors, this correlation is negative and significant. Meanwhile, for developing countries, when the coefficients are statistically significant, the effect is positive for only one sub-sector and negative for 12 sub-sectors.

For the case of imports (models 4 to 6), we observe even more heterogeneity. For the full sample, the index coefficients that are significant are positive for 6 sub-sectors and negative for 8 sub-sectors. For developed countries, we observe only 3 sub-sectors for which there is a statistically significant and positive correlation and 9 sub-sectors in which the significant coefficients are negative. Finally, for developing countries, when the coefficients are significant, 7 are positive and 5 are negative.

Thus far, the evidence points a negative effect of strengthening IP protection on total trade of agricultural products, especially for developing countries, both considering imports and exports.

5 Do Stronger IPRs Enhance Bilateral Trade?

As we have previously discussed, IPRs might affect bilateral trade in different ways that will ultimately be determined by sector or countries' specificities. A natural framework to explore the possible implication of IPRs on bilateral trade is the Gravity Model (GM) of trade, which has a relevant empirical success at explaining an important extent of the observed trade flows. Initially proposed by Tinbergen (1962), the GM has become the baseline empirical model to explain bilateral trade flows among countries, taking as explanatory variables the GDP of both the importer and the exporter, as well as the distance between them. The modern economic interpretation of the gravity expression generalizes the original idea by including proxies of possible trade barrier–aspects related with geography, culture, bilateral trade agreements, among others. The GM considers separately the effect of such variables for importers and exporters, allowing the possibility of asymmetric effects. However, the GM emerges from a wide set of theoretical models, including monopolistic competition (see: Fratianni (2009), for a comprehensive survey) and Heckscher-Ohlin model with specialization (Anderson, 1979; Bergstrand, 1985).

Our aim at using the GM is twofold: we are interested in the extensive and the intensive margins of IPRs on bilateral trade. In other words, we are not only interested in testing whether strong IPRs systems promote export and import volumes (the intensive margin), but also we want to investigate whether strong IPRs facilitate the creation of bilateral trade relationships (the extensive margin). Additionally, we split the data into four groups of analysis (Table 4). In the first group, we consider all trade relationships present in our data base. Meanwhile, the second group considers all those trade relationships between developed countries; the third one considers trade relationships between developed and developing countries; and the last group considers relationships only between developing countries.

Table 4: Samples Used in the GM Estimation

Group	Partner Countries
Full-Sample	All Countries
DC-DC	Developed - Developed
DC-LDC	Developed - Developing
LDC-LDC	Developing - Developing

More generally, let $W_{ij,k}(t)$ be the export from country i to country j, in sector k, of the year t. Therefore, the gravity equation in its standard specification can be written as,

$$W_{ij,k}(t) = \exp\{x_{ij}(t) \cdot \beta_k\}\eta_{ij,k}(t), \tag{4}$$

where,

$$x_{ij} = \{\log(Y_i), \log(Y_j), \log(X_i), \log(X_j), Z_i, Z_j, \log(d_{ij}), D_{ij}, \gamma_i, \gamma_j\}; \tag{5}$$

$i, j = 1, ..., N$; $Y_i = \{\text{GDP}_i, \text{GDPpc}_i\}$ is a vector of annual GDP and annual GDP per capita for country i; $X_i = \{\text{AREA}_i, \text{POP}_i\}$ is a vector of country-specific macro variables; $Z_i = \{\text{landl, IP Index}\}$ includes a country-specific dummy and the IP index; d_{ij} the geographical distance between both countries; $D_{ij} = \{$contig, comlang_off, comcol, colony$\}$ is a vector of link-specific variables indicating barriers to trade; and it is assumed that $E[\eta_{ij}|Y_i, Y_j, d_{ij}, ...] = 1$. See Table A.1, in the Appendix A, for a complete description of variables and sources.

The estimation of Equation (4) is not straightforward. It requires a special treatment of heteroskedasticity (non-linearity), zero-valued flows, endogeneity and omitted-term biases (Santos Silva and Tenreyro, 2006). The GM can be fitted to data using different econometric techniques, ranging from simple ordinary least squares (OLS) applied to the log-linearized equation (Glick and Rose, 2002; Subramanian and Wei, 2007), the two-stage Poisson estimations where probability of having zero trade flows is also estimated (Burger et al., 2009), and even panel data techniques with instrumental variables (Awokuse and Yin, 2010). A common feature of most estimation techniques is that they all achieve high R-squared coefficients of determination, i.e. a quite satisfactorily goodness of fit. This largely explains the success of the gravity model.

With the aim of studying the effect of IPRs on bilateral trade, we expand the standard GM specification, which contains common explanatory variables, by adding IP protection indexes represented in two country-specific variables, related to exporters and importers: IP index_e and IP index_i. This enriches our analysis, allowing to explore whether trade volumes are strengthened when the exporter and/or the importer have strong IP protection. In addition, we use the GM specification to explore how IPRs contribute to the formation of bilateral trade relationships. To achieve this, we implement a Logit estimation on the observed bilateral trade relationships.

We estimate the GM under three different econometric techniques: i) panel data, assuming fixed effects (FE), ii) Poisson pseudo maximum likelihood (PPML) with time dummies, i.e. in this case we pool all cross-sections, and iii) Logit with time dummies. Notice that in the first two models the dependent variable proxies the observed trade volumes, while in the last model the dependent variable is a binary variable representing the observed bilateral trade relationships.[3] Therefore, as mentioned above, with the first two models we are allowed to study the intensive margins of trade, while in the last one we investigate the extensive margins.

Table 5 presents the estimation results for the aggregated bilateral trade in agricultural products. The first three columns relate to the full sample. The first point to notice is that FE and PPML provide statistically different results, suggesting heteroskedasticity.[4] We find important differences within country specific estimates in each model, which suggests asymmetries between importer and exporter profiles. Actually, the null hypothesis that importer and exporter variables affect proportionally trade flows are rejected for both FE and PPML estimations.

In the estimations of trade volumes, columns (1) and (2) in Table 5, we observe the gravity structure of trade. It is mirrored by the signs of the countries' size (positive) and distance regressors (negative). The country size effect must be seen jointly considering all country specific variables, GDP, GDPpc, and area; although in some estimations the regressors have negative signs, the joint of all country size variables is positive. Regarding the effect of IPRs, we observe significance in the multiplier related to the index of the importer (IP index_i) just for the FE model, see column (1) in Table 5, which is actually low and negative, -0.042(0.007) and in the index of the exporter (IP index_e) (see column (2) of Table 5) for the PPML estimation, with a coefficient of -0.025(0.014). These results agree with our findings in the previous section and suggest that IPR systems do not affect strongly trade volumes and when they do, the effect is negative.

[3]The FE and PPML estimations might be comparable, considering that to implement FE it is necessary to log-linearize Equation (4) and, therefore, zero trade flows are omitted, while in the PPML case we use all observations available in the sample.

[4]Obviously, these differences are observed for time varying variables only because FE estimator does not estimate time-invariant country specific characteristics.

Table 5: Total Bilateral Exports of Agricultural Products. Gravity Model Estimations

Sample	Full-Sample			DC-DC			DC-LDC			LDC-LDC		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Model	FE	PPML	Logit	FE	PPML	Logit	FE	PPML	Logit	FE	PPML	Logit
IP Index_e	0.001	-0.025*	0.002	-0.001	0.014	-0.269**	-0.003	-0.135***	-0.013	-0.036***	-0.334***	-0.058***
	(0.007)	(0.013)	(0.014)	(0.013)	(0.020)	(0.125)	(0.010)	(0.016)	(0.023)	(0.014)	(0.032)	(0.018)
IP Index_i	-0.042***	0.009	0.274***	-0.047***	-0.033*	-0.055	-0.033***	0.024	0.189***	-0.026*	0.140***	0.277***
	(0.007)	(0.013)	(0.014)	(0.013)	(0.019)	(0.115)	(0.009)	(0.018)	(0.022)	(0.013)	(0.029)	(0.018)
log GDP_e	-0.151*	0.560***	0.878***	-3.917***	0.612***	0.605***	0.118	0.481***	1.018***	0.541***	0.106***	0.983***
	(0.092)	(0.011)	(0.015)	(0.204)	(0.016)	(0.196)	(0.121)	(0.014)	(0.024)	(0.193)	(0.036)	(0.025)
log GDP_i	0.775***	0.832***	0.466***	3.038***	0.891***	0.588***	0.491***	0.876***	0.599***	0.620***	0.682***	0.485***
	(0.092)	(0.014)	(0.013)	(0.203)	(0.024)	(0.088)	(0.122)	(0.016)	(0.020)	(0.192)	(0.046)	(0.022)
log GDPpc_e	0.955***	0.274***	0.348***	5.806***	0.421***	3.014***	0.458***	0.314***	-0.010	0.079	0.362***	-0.198***
	(0.095)	(0.020)	(0.019)	(0.202)	(0.047)	(0.363)	(0.129)	(0.026)	(0.037)	(0.192)	(0.048)	(0.037)
log GDPpc_i	0.565***	0.184***	0.518***	-1.674***	-0.054	1.233***	0.612***	0.106***	0.184***	1.115***	0.125*	0.105***
	(0.094)	(0.021)	(0.019)	(0.200)	(0.037)	(0.255)	(0.128)	(0.030)	(0.035)	(0.187)	(0.068)	(0.034)
log Area_e	-	0.053***	0.081***	-	-0.073***	0.742***	-	0.196***	0.070***	-	0.537***	-0.077***
	-	(0.011)	(0.011)	-	(0.018)	(0.228)	-	(0.011)	(0.019)	-	(0.042)	(0.016)
log Area_i	-	-0.155***	-0.054***	-	-0.211***	0.228**	-	-0.170***	-0.113***	-	0.120***	-0.129***
	-	(0.009)	(0.011)	-	(0.018)	(0.108)	-	(0.012)	(0.017)	-	(0.029)	(0.016)
landlocked_e	-	-0.847***	-0.493***	-	-1.149***	1.263***	-	-0.722***	-0.621***	-	-0.415***	-0.727***
	-	(0.034)	(0.031)	-	(0.051)	(0.398)	-	(0.051)	(0.045)	-	(0.092)	(0.052)
landlocked_i	-	-0.533***	-0.075**	-	-0.630***	0.019	-	-0.725***	-0.005	-	-0.127*	-0.398***
	-	(0.031)	(0.034)	-	(0.040)	(0.266)	-	(0.041)	(0.052)	-	(0.075)	(0.055)
log dist	-	-0.568***	-0.765***	-	-0.599***	-1.421***	-	-0.258***	-0.514***	-	-0.601***	-0.721***
	-	(0.016)	(0.018)	-	(0.021)	(0.110)	-	(0.024)	(0.027)	-	(0.031)	(0.027)
contig	-	0.920***	1.253***	-	0.648***	-	-	1.646***	-	-	0.247**	1.556***
	-	(0.044)	(0.231)	-	(0.044)	-	-	(0.073)	-	-	(0.096)	(0.230)
comlang_off	-	0.193***	1.724***	-	0.481***	-	-	0.549***	-	-	0.736***	2.040***
	-	(0.038)	(0.091)	-	(0.048)	-	-	(0.051)	-	-	(0.065)	(0.100)
comcol	-	0.313***	2.034***	-	1.778***	-	-	0.526***	2.767***	-	0.835***	1.481***
	-	(0.080)	(0.118)	-	(0.126)	-	-	(0.098)	(0.218)	-	(0.131)	(0.146)
colony	-	-0.014	0.532*	-	-0.174***	-	-	0.240***	-	-	0.668***	0.232
	-	(0.036)	(0.275)	-	(0.047)	-	-	(0.058)	-	-	(0.117)	(0.311)
constant	yes			yes			yes			yes		
Time-dummies		yes	yes		yes	yes		yes	yes		yes	yes
Observations	62,317	72,930	72,930	12,700	12,852	10,432	32,587	36,176	33,796	17,030	23,902	23,902

Note: Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10. FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.

Looking at the Logit estimations, column (3) in Table 5, we can also check the expected outcome of the gravity model: for a couple of countries the probability of creating a bilateral relationship increases with the countries' sizes and decreases with the distance between them. All other regressors have the expected signs. Interestingly enough, the country specific IP index_i ends up to be positive and significant for the creation of trading channels. This suggests that the creation of new markets, i.e. new links in the trade network, are expected to grow with the tightening of IPRs systems in the importing countries.

Some differences arise on the countries' IP indexes coefficients if we instead sample on the restricted groups of countries. Regarding trade volumes, for the case of trade between developed countries (see columns 4-5 in Table 5), once again the expected effect is negative and mirrored on the IP index of the importer. For the case of trade between developed and developing countries (see columns 7-8), the expected effect is also negative, however this is observed on the IP index_i in the FE models, and on the IP index_e in the PPML model. Finally, for the case of trade between developing countries (see columns 10-11 in Table 5), the estimated effect is negative for both IP indexes in the FE model. Meanwhile, in the PPML model the IP index estimated for the exporter and importer have opposite signs. However, the negative estimate of the IP index of the importer is higher than the positive estimate of the IP index of the exporter, probably suggesting a negative net effect.

Regarding bilateral trade relations, for the case of developed countries (see column 6 in Table 5), we observe that the extensive margin effect expected from the tightening of IPRs systems is negative and small. It is worth noticing that at the aggregated level most developed countries are completely integrated so the extensive margin might be difficult to capture in this sample. However, for the case of trade between developed and developing countries (see column 9 in Table 5) the strengthening of IPR systems leads to an expected extension of trade relationships, when IP protection increases in the importer country. Meanwhile, for the case of trade between developing countries (see column 12 in Table 5) the effect might be ambiguous since the IP indexes estimated for the exporter and importer have opposite signs. However, they are quite asymmetric suggesting that the global effect for the extension of trade markets between developing countries with similar IPRs systems may be positive.

Table 6 summarizes the main results of the gravity estimations. Undoubtedly and in line with the evidence found before, the strengthening of IP protection in the importer or the exporter country has a negative effect in total trade of agricultural products for all the samples considered (intensive margin). For the case of bilateral trade relations (extensive margin), the probability of creating new bilateral trade links seems to increase when the importer country increases the level of IP protection. This may be related with the effect of a lower threat of imitation but also with the reduction of trade barriers in the countries adopting stronger IPRs systems. This may be caused by the fact that the TRIPS were signed at the end of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) in 1994, together with creation of the World Trade Organization (WTO), which aims to supervise and liberalize international trade.

Table 6: Summary of Gravity Model Estimations

	Total Trade		Bilateral Trade Relations	
Sample	IP Exporter	IP Importer	IP Exporter	IP Importer
Full-Sample	(-)	(-)	n.s.	(+)
DC-DC	n.s.	(-)	(-)	n.s.
DC-LDC	(-)	(-)	n.s.	(+)
LDC-LDC	(-)	ambiguous	(-)	(+)

Note: Estimation results for total exports and imports are concluded from both FE and PPML estimations. n.s.: no significant; (+): positive coefficient; (-): negative coefficient; ambiguous: opposite significant coefficients from FE and PPML.

Considering the evidence found in the previous section and in order to investigate possible divergent effects, we estimated the expected effect of the index of IP protection for different sub-sectors. Unlike the GM for the aggregated bilateral trade of agricultural products, IPRs systems show heterogeneous effects when considering the disaggregated level.

Table 7 displays the estimation results of the PPML estimators for the different sub-sectors considered, which are presented to analyse the effect of IPRs on trade volumes. However, most of our observations are robustly observed under the fixed effects estimator (see Table A.2 in the Appendix A). Notice that the results of the other regressors were omitted, since we focus on the effect of IPRs on trade.[5] For most of the sub-sectors, considering both the importer and exporter indexes, the effect of IPRs on trade volumes turns out to be negative. For some sub-sectors, we observe a positive effect of one of the indexes (importer or exporter) and a negative effect of the other (exporter or importer). This mixed evidence is observed for all the different groups of countries considered.

Table 8 shows the results of the Logit estimations, which allows analysing how the strengthening of IP protection is expected to affect bilateral trade relationships. Once again, the estimated effect depends on the sub-sector considered, but for most

[5]All estimation results are available upon request.

Table 7: IP Index Coefficients for Bilateral Trade Volumes. Poisson - Gravity Model Estimations for Sub-sectors

Sample	Full-Sample		DC-DC		DC-LDC		LDC-LDC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i
HS 1	-0.147***	-0.089**	-0.146**	-0.183***	-0.135***	0.139**	0.135	0.051
	(0.052)	(0.041)	(0.063)	(0.054)	(0.045)	(0.056)	(0.125)	(0.084)
HS 2	0.313***	0.059**	0.411***	-0.209***	0.094**	0.293***	-0.422***	0.497***
	(0.025)	(0.024)	(0.033)	(0.029)	(0.040)	(0.039)	(0.077)	(0.064)
HS 4	0.153***	-0.045**	0.115***	-0.088***	0.062*	-0.114***	0.039	0.013
	(0.027)	(0.019)	(0.034)	(0.024)	(0.036)	(0.038)	(0.047)	(0.062)
HS 5	-0.077***	0.127***	0.314***	0.136***	-0.310***	0.220***	-0.313***	0.027
	(0.018)	(0.022)	(0.021)	(0.022)	(0.032)	(0.037)	(0.043)	(0.044)
HS 6	0.019	0.128***	-0.306***	-0.014	0.126***	0.270***	0.321***	0.825***
	(0.025)	(0.041)	(0.030)	(0.033)	(0.044)	(0.042)	(0.050)	(0.083)
HS 7	-0.375***	0.032	-0.407***	0.089**	-0.496***	-0.174***	-0.232***	0.136**
	(0.024)	(0.031)	(0.033)	(0.045)	(0.029)	(0.035)	(0.067)	(0.054)
HS 8	-0.237***	0.102***	-0.356***	0.028	-0.329***	0.064**	-0.159***	0.503***
	(0.021)	(0.029)	(0.034)	(0.053)	(0.029)	(0.029)	(0.036)	(0.052)
HS 9	0.093***	0.182***	0.224***	0.034	-0.002	0.342***	-0.149***	0.017
	(0.024)	(0.032)	(0.030)	(0.030)	(0.038)	(0.052)	(0.048)	(0.035)
HS 10	-0.110***	-0.052**	-0.153***	-0.423***	-0.107***	-0.055	-0.621***	0.303***
	(0.028)	(0.025)	(0.051)	(0.046)	(0.041)	(0.034)	(0.068)	(0.058)
HS 11	-0.005	-0.001	0.103***	0.056***	0.013	-0.063*	-0.487***	-0.019
	(0.021)	(0.027)	(0.027)	(0.021)	(0.040)	(0.035)	(0.083)	(0.100)
HS 12	-0.058*	-0.223***	0.129***	-0.021	0.032	-0.283***	-1.297***	-0.311***
	(0.031)	(0.034)	(0.038)	(0.034)	(0.044)	(0.045)	(0.126)	(0.077)
HS 13	0.002	0.133***	0.109***	0.125***	-0.041	0.153***	-0.409***	-0.076*
	(0.021)	(0.020)	(0.033)	(0.033)	(0.027)	(0.025)	(0.032)	(0.040)
HS 14	-0.267***	-0.134***	0.192***	-0.122***	-0.471***	-0.009	-0.409***	-0.116**
	(0.029)	(0.026)	(0.037)	(0.045)	(0.036)	(0.037)	(0.063)	(0.058)
HS 15	-0.040**	-0.148***	-0.071***	-0.057*	-0.006	-0.225***	-0.457***	-0.034
	(0.017)	(0.022)	(0.026)	(0.033)	(0.030)	(0.029)	(0.068)	(0.045)
HS 17	0.040*	0.167***	0.053	0.052**	-0.054	0.012	0.072	0.466***
	(0.023)	(0.031)	(0.036)	(0.024)	(0.034)	(0.044)	(0.070)	(0.075)
HS 18	-0.034**	0.087***	-0.039*	0.042**	-0.035	0.130***	0.008	-0.033
	(0.017)	(0.016)	(0.020)	(0.020)	(0.031)	(0.029)	(0.037)	(0.046)
HS 19	-0.111***	-0.011	-0.058***	-0.035	-0.181***	0.044**	-0.129***	0.186***
	(0.017)	(0.020)	(0.022)	(0.025)	(0.025)	(0.022)	(0.041)	(0.038)
HS 20	-0.160***	0.069***	-0.134***	0.002	-0.314***	0.150***	-0.351***	0.213***
	(0.016)	(0.020)	(0.025)	(0.031)	(0.023)	(0.027)	(0.036)	(0.030)
HS 21	0.048***	0.101***	0.093***	0.079***	0.038**	0.116***	-0.104***	0.323***
	(0.013)	(0.017)	(0.017)	(0.024)	(0.019)	(0.020)	(0.031)	(0.036)
HS 22	-0.318***	0.102***	-0.464***	0.083***	-0.349***	0.078**	-0.005	0.170***
	(0.023)	(0.018)	(0.030)	(0.021)	(0.031)	(0.034)	(0.044)	(0.044)
HS 23	0.007	-0.021	0.208***	0.068***	-0.230***	-0.013	-0.725***	0.181***
	(0.019)	(0.022)	(0.024)	(0.023)	(0.039)	(0.044)	(0.068)	(0.048)
HS 24	0.201***	-0.130***	0.368***	-0.481***	-0.075*	0.063	-0.250***	0.027
	(0.036)	(0.037)	(0.057)	(0.059)	(0.041)	(0.045)	(0.039)	(0.045)

Note: Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10. FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.

of them, increasing IPRs strength is expected to be negative for the creation of new bilateral trade relations.

Both the effect on trade volumes and bilateral trade links are illustrated by Figure 2 for the full sample and three cases restricting the samples to DC-DC; DC-LDC; and LDC-LDC.

Red-color bars represent the effect on trade volumes (PPML estimation) or on bilateral trade links (Logit estimation) due to the IP index of the exporters and blue-color bars represent the effect due to the IP index of the importers. This figure allows to see graphically how a change in the index of IP protection of the importer and the exporter may have different effects. The combinations of these two effects, which are sometimes opposite, lead in our estimations to both positive and negative net results for different sub-sectors.

Table 8: IP Index Coefficients for Bilateral Trade Relations. Logit - Gravity Model Estimations for Sub-sectors

Sample	Full-Sample		DC-DC		DC-LDC		LDC-LDC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i
HS 1	0.122***	0.031***	0.179***	-0.002	0.085***	0.014	0.177***	0.108***
	(0.012)	(0.011)	(0.030)	(0.030)	(0.016)	(0.016)	(0.024)	(0.024)
HS 2	-0.016	0.093***	0.278***	0.151***	-0.014	0.067***	-0.216***	0.133***
	(0.010)	(0.010)	(0.030)	(0.030)	(0.014)	(0.014)	(0.020)	(0.021)
HS 4	0.089***	0.007	0.140***	0.076**	0.118***	-0.047***	-0.065***	0.046**
	(0.010)	(0.010)	(0.030)	(0.032)	(0.014)	(0.014)	(0.020)	(0.020)
HS 5	-0.064***	0.043***	-0.141***	0.057*	-0.037**	0.020	-0.159***	0.099***
	(0.011)	(0.011)	(0.032)	(0.031)	(0.015)	(0.015)	(0.022)	(0.022)
HS 6	-0.006	0.129***	0.106***	0.048	-0.100***	0.111***	0.108***	0.151***
	(0.010)	(0.010)	(0.029)	(0.029)	(0.015)	(0.015)	(0.020)	(0.019)
HS 7	-0.108***	0.095***	-0.069**	-0.032	-0.118***	0.009	-0.181***	0.181***
	(0.010)	(0.010)	(0.032)	(0.033)	(0.014)	(0.014)	(0.019)	(0.019)
HS 8	-0.179***	0.218***	-0.014	0.072**	-0.201***	0.133***	-0.227***	0.268***
	(0.010)	(0.010)	(0.030)	(0.031)	(0.014)	(0.014)	(0.015)	(0.016)
HS 9	-0.238***	0.136***	0.157***	0.114***	-0.244***	0.116***	-0.321***	0.169***
	(0.010)	(0.010)	(0.033)	(0.034)	(0.014)	(0.014)	(0.018)	(0.017)
HS 10	0.035***	0.061***	0.356***	-0.094***	0.027*	0.025*	-0.123***	0.152***
	(0.011)	(0.011)	(0.031)	(0.032)	(0.015)	(0.015)	(0.020)	(0.020)
HS 11	0.105***	-0.002	0.502***	0.095***	0.139***	-0.016	-0.169***	0.005
	(0.011)	(0.011)	(0.031)	(0.032)	(0.015)	(0.015)	(0.023)	(0.022)
HS 12	0.072***	0.096***	0.068*	0.138***	0.112***	0.062***	-0.012	0.080***
	(0.010)	(0.010)	(0.036)	(0.034)	(0.014)	(0.014)	(0.017)	(0.017)
HS 13	-0.009	0.091***	0.061*	0.119***	0.078***	0.093***	-0.171***	0.121***
	(0.011)	(0.011)	(0.033)	(0.033)	(0.015)	(0.015)	(0.021)	(0.021)
HS 14	-0.234***	0.062***	0.123***	0.261***	-0.311***	0.085***	-0.215***	-0.055**
	(0.013)	(0.013)	(0.031)	(0.031)	(0.019)	(0.019)	(0.025)	(0.025)
HS 15	-0.105***	0.035***	-0.247***	0.079**	-0.005	0.009	-0.242***	0.070***
	(0.010)	(0.011)	(0.035)	(0.036)	(0.014)	(0.015)	(0.018)	(0.019)
HS 17	-0.026**	0.100***	0.221***	0.068*	-0.027*	0.086***	-0.103***	0.139***
	(0.011)	(0.011)	(0.038)	(0.039)	(0.014)	(0.014)	(0.019)	(0.019)
HS 18	-0.010	0.030***	0.202***	-0.030	0.031**	0.026*	-0.146***	0.101***
	(0.010)	(0.011)	(0.034)	(0.035)	(0.014)	(0.014)	(0.019)	(0.020)
HS 19	-0.040***	0.025**	0.138***	0.070*	-0.034**	-0.021	-0.145***	0.082***
	(0.011)	(0.011)	(0.038)	(0.039)	(0.015)	(0.015)	(0.020)	(0.020)
HS 20	-0.080***	0.163***	-0.016	0.107***	-0.094***	0.104***	-0.123***	0.224***
	(0.010)	(0.010)	(0.037)	(0.036)	(0.014)	(0.014)	(0.018)	(0.018)
HS 21	0.001	0.189***	-0.075*	0.204***	0.022	0.145***	-0.076***	0.244***
	(0.011)	(0.011)	(0.045)	(0.046)	(0.015)	(0.015)	(0.018)	(0.019)
HS 22	0.084***	0.111***	0.084	0.274***	0.068***	0.077***	0.033*	0.080***
	(0.011)	(0.011)	(0.051)	(0.051)	(0.015)	(0.015)	(0.017)	(0.017)
HS 23	0.103***	0.111***	-0.077**	0.115***	0.126***	0.136***	0.121***	0.106***
	(0.011)	(0.011)	(0.038)	(0.035)	(0.014)	(0.015)	(0.018)	(0.019)
HS 24	-0.138***	0.068***	0.132***	0.100***	-0.159***	0.043***	-0.221***	0.097***
	(0.010)	(0.010)	(0.029)	(0.030)	(0.014)	(0.014)	(0.017)	(0.017)

Note: Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10. FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.

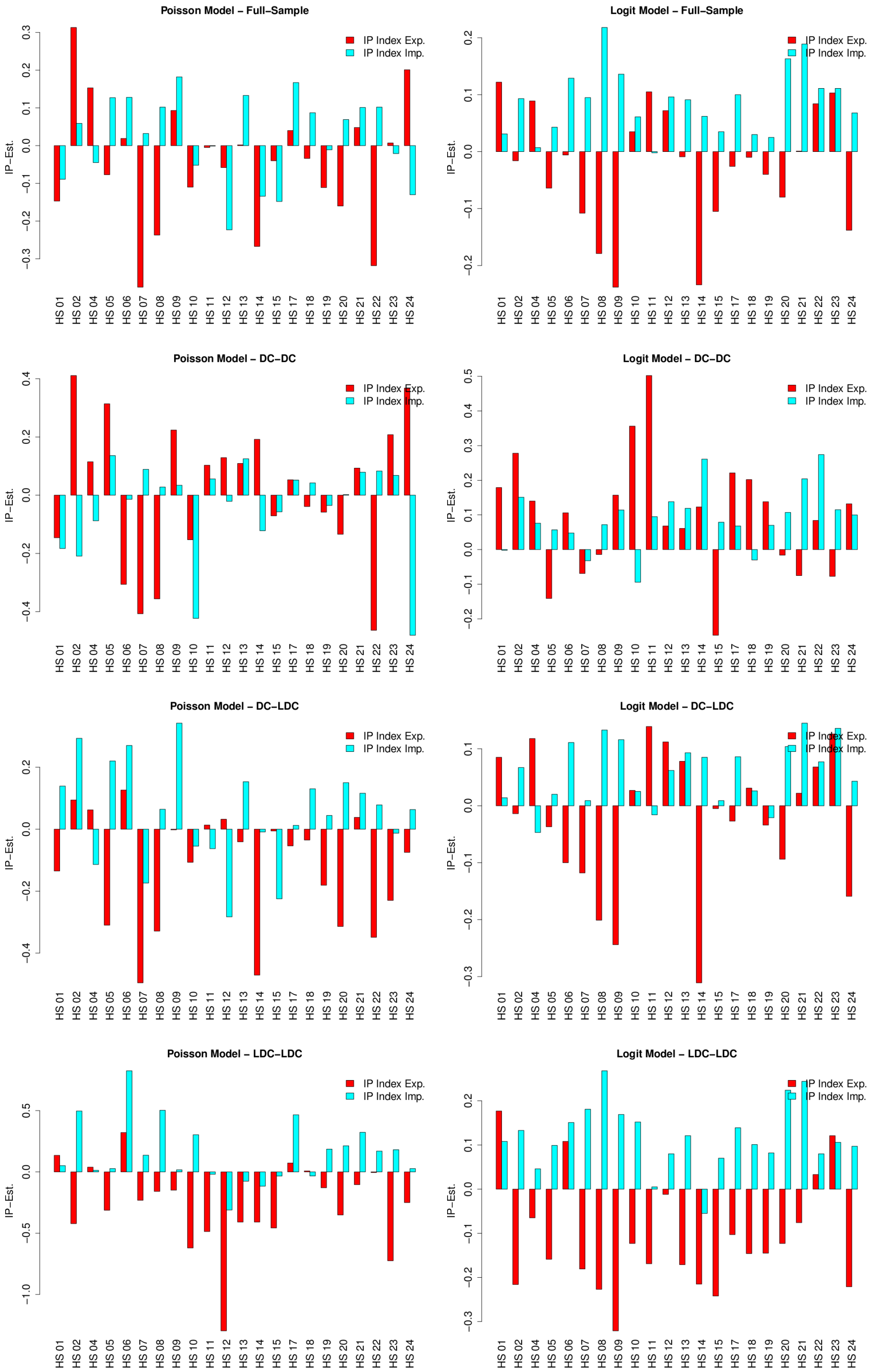

Figure 2: Different Samples Estimations of the Impact of IP Protection for Total Exports in Agricultural Sub-sectors

Notes: Top: bilateral trade among countries in the full sample; second from the top: bilateral trade among developed economies; third from the top: bilateral trade among developed and developing economies; and, bottom: bilateral trade among developing economies. Left: PPML estimations of trade flows; and, right column: Logit estimations of bilateral trade relations. Red-color bars represent the effect due to the IP index of the exporters and blue-color bars represent the effect due to the IP index of the importers.

6 Concluding Remarks

How strengthening IPRs affects trade volumes and bilateral trade links does not have a straightforward answer. Since contradictory effects may be expected, the final result turns out to be an empirical question. Empirically, the issue has been investigated mostly for developed countries and manufacturing sectors. This paper has investigated the effect of tightening IPRs systems since the signing of the TRIPS agreement on trade and bilateral trade links of the agricultural sector of 60 countries, including developed and developing countries.

We found evidence supporting the hypothesis that strengthening IPRs has a negative effect on traded volumes of agricultural products. The robustness of these results were checked for countries according to the development level and also for imports and exports. Next, we checked if these results were still present at a more disaggregated level. In this case, for the full sample and also for the samples of developed and developing countries, the effect of strengthening IPRs varies across sub-sectors. For some of them the effect is not statistically significant; for others, a positive and significant correlation was found; and finally, for most of the other sub-sectors, the coefficients turned out to be statistically significant and negative, meaning that, for those cases, stronger IPRs might decrease traded volumes.

In addition, the estimations of the gravity model confirmed the evidence of a negative effect of strengthening IP protection on trade volumes (intensive margin) and provided additional evidence regarding the effect on bilateral trade links. For the extensive margin, that is, whether strong IPRs facilitate the creation of bilateral trade relationships, we found for some cases that the strengthening of IP protection in the exporting country decreases the probability of creating new bilateral trade links, for the full sample of countries and the case that considers only relations between developed and developing countries. Meanwhile, we found that strengthening IP protection in the importing country, on the contrary, may have a positive effect in the probability of creating new bilateral trade links when considering the full sample and also for the case restricted to relations among developed and developing countries, and the case that considers only trade relations among developing countries. This may be due to a reduced threat of imitation for the exporter or also for less trade barriers in the importing countries given that the TRIPS were signed together with the creation of the WTO, which intends to supervise and liberalize international trade.

Finally, the analysis for a more disaggregated product level, showed also in the different GM estimations, that the effect turns out to be sub-sector specific as well as different for each sample considered. The case that includes bilateral trade relations of only developed countries shows for some sub-sectors a positive effect of stronger IP protection systems for the creation of new bilateral trade relations. However, this group deals with countries that are very integrated, making it less interesting to study. For the case of trade between developed and developing countries, the estimated effect is positive in some cases, negative in others and ambiguous in other. For the case of trade between developing countries, the effect is ambiguous in practically all the sub-sectors considered. However, in some sub-sectors, the extensive margin turned out to be positive.

All in all, the effect of stronger IP protection for the importer and exporter, may be contradictory. In addition, the level of development of the trading country also derives in different estimation results. Thus, the evidence supports previous findings relating the effect of strengthening IPRs on trade as being sector and country specific.

Therefore, further sectoral analysis is needed to disentangle the possible effects of strengthening IPRs on trade and bilateral trade. However, our results clearly show that for the case of agricultural trade, the strengthening of IPRs that is taking place since the signing of the TRIPS agreement has a negative effect for developed countries and, especially, for developing countries. In terms of policy implications, our results allow to draw two main conclusions. In the first place, we may assert that there is no unique system that might fit all countries and sectors such as the one advocated by TRIPS supporters. Secondly, the stronger IPRs systems adopted since the signing of the TRIPS agreement, have been affecting negatively agricultural trade.

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A Appendix

List of Countries

Developed Countries

Australia; Austria; Bulgaria; Canada; Czech Republic; Denmark; Estonia; Finland; France; Germany; Hungary; Iceland; Ireland; Italy; Japan; Latvia; Lithuania; Netherlands; New Zealand; Norway; Poland; Portugal; Slovakia (Slovak Republic); Spain; Sweden; Switzerland Liechtenstein; United Kingdom; United States of America

Developing Countries

Albania; Argentina; Bolivia; Brazil; Chile; China; Colombia; Costa Rica; Croatia; Dominican Republic; Ecuador; Israel; Jordan; Kenya; Republic of Korea; Kyrgyzstan; Mexico; Republic of Moldova; Morocco; Panama; Paraguay; Peru; Russian Federation; Singapore; Slovenia; South Africa; Trinidad and Tobago; Tunisia; Turkey; Ukraine; Uruguay; Viet nam

List of Variables

Table A.1: Variables Employed in the Estimation Exercises

Label	Related to	Description	Source
W	Link	Imports in constant (2000) US dollars by sub-sectors	BACI-CEPII (http://www.cepii.fr/) Gaulier and Zignago (2010)
texpa	Country	Total exports of agricultural products in constant (2000) US dollars	BACI-CEPII (http://www.cepii.fr/) Gaulier and Zignago (2010)
timpa	Country	Total imports of agricultural products in constant (2000) US dollars	BACI-CEPII (http://www.cepii.fr/) Gaulier and Zignago (2010)
open	Country	Openness to trade	Feenstra and Timmer (2013)
GDP	Country	Gross domestic product	Penn World Table (Feenstra and Timmer, 2013)
area	Country	Country area in Km^2	citesubramanian-wei
pop	Country	Country population	CEPII (http://www.cepii.fr/)
IP Index	Country	Index of IP protection for plant varieties	Campi and Nuvolari (2013)
hc	Country	Index of human capital	Feenstra and Timmer (2013)
remot	Country	Remoteness	Melitz (2007)
d	Link	Distance between two countries, based on bilateral distances between the largest cities of those two countries, weighted by the share of the city in the overall country's population	CEPII (http://www.cepii.fr/)
landl	Country	Dummy variable equal to 1 for landlocked Countries	CEPII (http://www.cepii.fr/)
contig	Link	Contiguity dummy equal to 1 if two countries share a common border	CEPII (http://www.cepii.fr/)
comlang_off	Link	Dummy equal to 1 if both countries share a common official language	CEPII (http://www.cepii.fr/)
comcol	Link	Dummy equal to 1 if both countries have had a common colonizer	CEPII (http://www.cepii.fr/)
colony	Link	Dummy equal to 1 if both countries have ever had a colonial link	CEPII (http://www.cepii.fr/)

GM Fixed-Effects Estimations Summary

Table A.2: IP Index Coefficients for Bilateral Trade Volumes. Fixed Effects - Gravity Model Estimations for Sub-sectors

Sample	Full-Sample		DC-DC		DC-LDC		LDC-LDC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variable	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i	IP index_e	IP index_i
HS 1	0.029	-0.062***	0.063**	-0.006	-0.023	-0.106***	-0.021	-0.028
	(0.018)	(0.017)	(0.030)	(0.030)	(0.027)	(0.024)	(0.049)	(0.044)
HS 2	0.044**	0.034**	0.123***	-0.036	-0.082***	0.071***	-0.175***	0.024
	(0.019)	(0.016)	(0.031)	(0.029)	(0.030)	(0.023)	(0.046)	(0.043)
HS 4	0.034**	-0.051***	0.108***	-0.077***	-0.015	-0.027	0.003	-0.063*
	(0.015)	(0.013)	(0.027)	(0.026)	(0.022)	(0.018)	(0.037)	(0.035)
HS 5	-0.048***	0.033**	0.034	0.025	-0.114***	0.045**	0.018	-0.036
	(0.015)	(0.014)	(0.028)	(0.027)	(0.021)	(0.020)	(0.040)	(0.036)
HS 6	-0.010	0.013	-0.025	-0.002	-0.013	0.024	-0.035	0.020
	(0.013)	(0.012)	(0.025)	(0.023)	(0.018)	(0.018)	(0.029)	(0.027)
HS 7	0.003	0.018*	-0.028	0.003	0.021	0.046***	-0.055**	-0.042*
	(0.011)	(0.011)	(0.022)	(0.020)	(0.015)	(0.015)	(0.027)	(0.025)
HS 8	-0.023**	-0.006	-0.079***	-0.071***	-0.032**	0.041***	-0.009	-0.036*
	(0.010)	(0.010)	(0.024)	(0.022)	(0.014)	(0.015)	(0.021)	(0.019)
HS 9	-0.058***	-0.035***	0.035	-0.043*	-0.046***	-0.020	-0.130***	-0.067***
	(0.011)	(0.011)	(0.028)	(0.026)	(0.015)	(0.015)	(0.021)	(0.021)
HS 10	0.112***	-0.089***	0.021	-0.069*	0.116***	-0.081**	0.002	-0.144***
	(0.022)	(0.020)	(0.041)	(0.036)	(0.035)	(0.032)	(0.044)	(0.040)
HS 11	-0.006	-0.078***	0.136***	-0.028	-0.060**	-0.069***	-0.084**	-0.168***
	(0.017)	(0.015)	(0.033)	(0.029)	(0.026)	(0.021)	(0.037)	(0.034)
HS 12	0.000	0.010	-0.019	-0.062***	0.004	0.056***	-0.029	-0.034
	(0.012)	(0.011)	(0.023)	(0.022)	(0.017)	(0.016)	(0.026)	(0.024)
HS 13	-0.092***	-0.003	-0.111***	0.025	-0.047**	0.012	-0.141***	-0.069**
	(0.016)	(0.014)	(0.032)	(0.028)	(0.023)	(0.018)	(0.035)	(0.032)
HS 14	-0.060***	-0.093***	0.040	-0.124***	-0.057**	-0.120***	-0.147***	-0.052
	(0.020)	(0.020)	(0.043)	(0.040)	(0.028)	(0.031)	(0.038)	(0.037)
HS 15	-0.075***	-0.106***	-0.027	-0.073***	-0.048**	-0.116***	-0.183***	-0.122***
	(0.015)	(0.013)	(0.027)	(0.026)	(0.022)	(0.019)	(0.030)	(0.029)
HS 17	-0.046***	-0.045***	-0.079***	-0.018	-0.013	-0.034*	-0.147***	-0.097***
	(0.013)	(0.012)	(0.024)	(0.023)	(0.020)	(0.018)	(0.029)	(0.028)
HS 18	0.001	-0.053***	-0.052**	-0.093***	0.010	-0.046**	-0.003	-0.042
	(0.014)	(0.013)	(0.026)	(0.024)	(0.021)	(0.018)	(0.029)	(0.028)
HS 19	0.054***	-0.081***	0.079***	-0.005	0.062***	-0.096***	-0.027	-0.088***
	(0.012)	(0.011)	(0.023)	(0.021)	(0.017)	(0.015)	(0.025)	(0.024)
HS 20	-0.067***	-0.072***	-0.046**	-0.020	-0.048***	-0.065***	-0.116***	-0.080***
	(0.010)	(0.010)	(0.022)	(0.020)	(0.014)	(0.013)	(0.020)	(0.020)
HS 21	-0.023**	-0.006	0.000	-0.004	-0.036**	-0.004	-0.092***	0.002
	(0.011)	(0.010)	(0.022)	(0.021)	(0.015)	(0.014)	(0.022)	(0.021)
HS 22	-0.067***	-0.126***	0.030	-0.093***	-0.084***	-0.109***	-0.194***	-0.209***
	(0.011)	(0.010)	(0.019)	(0.018)	(0.015)	(0.014)	(0.025)	(0.023)
HS 23	-0.019	0.012	0.028	0.058**	-0.065***	0.020	-0.067*	-0.026
	(0.015)	(0.013)	(0.026)	(0.025)	(0.023)	(0.019)	(0.034)	(0.029)
HS 24	-0.013	0.013	-0.021	0.027	0.006	-0.008	-0.146***	0.068**
	(0.018)	(0.017)	(0.046)	(0.041)	(0.026)	(0.025)	(0.031)	(0.031)

Note: Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10. FS: Full Sample; DC: Developed Countries; LDC: Developing Countries.