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WORKING PAPER SERIES

Intellectual Property Rights and International Trade of Agricultural Products

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2014/12 December 2014

ISSN (online) 2284-0400

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, for the period 1995-2011. It uses data of agricultural exports and a new yearly index of intellectual property (IP) protection, for 60 developed and developing countries. Also, the paper studies bilateral trade links and the intensive and extensive margins of trade using a gravity model. 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.

Keywords: Intellectual Property Rights; International Trade; Agriculture; Gravity Model; Intensive Margin; Extensive Margin

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 led to 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, trade and economic development. IPRs are theoretically considered as incentives to innovate and, therefore, are expected to have a positive effect on economic growth (Gould and Gruben, 1996). However, the role of IPRs as incentives to innovate has been both theoretically and empirically criticized. Moreover, the impact of strengthening IPRs was proved to be sector and technology specific (Dosi et al., 2006).

Regarding international trade, changes in IPRs may influence returns to innovation, affecting decisions of firms to trade in different markets. From a theoretical point of view, the net effect of increasing patent protection is unclear. Maskus and Penubarti (1995) discussed that stronger IPRs systems are expected to have contrary effects on trade. On the one side, firms should be encouraged to export patented goods to countries with stronger IP protection because the risk of imitation is lower. Simultaneously, stronger IPRs increase the market power of firms, which may encourage them to behave in a monopolistic way, increasing prices and reducing sales. The net result will depend on the sectors and the level of development of 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.

The use of IPRs in agriculture (plant breeders’ rights, plant patents and utility patents) has been increasing in the last decades for two main reasons: the signing of the TRIPS agreement, which demanded IP protection for plant varieties either by patents or a *sui generis* system; and, because of the development of biotechnology applied to agriculture and the related changes in the organization of the sector.

Therefore, taking advantage of the new IP protection index for plant varieties recently created by Campi and Nuvolari (2014), this paper explores the effect of strengthening IPRs systems in the agricultural sector after the signing of the TRIPS on traded volumes and bilateral trade flows, for a group of 60 countries, which includes 28 developed and 32 developing countries.

In order to explore the possible effects of stronger IPRs systems on trade we perform several econometric exercises. First, we study whether the recent tightening of

IPRs has had an effect on total trade of agricultural products, considering separately, imports and exports. Secondly, we use a gravity model to investigate the effect of IPRs on bilateral trade and on the probability for a country to increase the number of trading partners. Thirdly, we explore the effect of IPRs on the total number of sub-sectors with positive trade, which we define as the industry extensive margin, and on the average value of exports by sub-sector, defined as the industry intensive margin. Finally, we study the effect of strengthening IPRs at a more disaggregated level of agricultural products.

Overall, we found that the recent strengthening of IPRs systems has been affecting negatively agricultural trade. Moreover, the effect of stronger IP protection for the importer and exporter was found to be contradictory in several cases. Also, we found that the effect depends on the level of development of the trading country and the sub-sector considered, which suggests that there is no unique system that might fit all countries and sectors.

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. Section 5 explores the effect of IPRs on bilateral trade volumes and links, and the intensive and extensive margins of trade. Finally, section 6 presents the main conclusions.

2 How are IPRs and Trade Related?

The effect of stronger IPRs on total trade flows and bilateral trade links has recently spurred a great interest among economists. Economic theory and empirical studies have identified contradictory effects and the final result seems to be an empirical matter.

Different models have concluded that the effect of 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 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, cannot be answered theoretically. However, his model predicts that "if anyone benefits, it is not the South" (Helpman, 1993, 1274).

Also, 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 its exports to different countries, they argue that there is a trade-off between the enhanced market power for the firm created by stronger IPRs systems and the larger effective market size generated by reduced abilities of local firms to imitate the patentable product. The "market-power effect" would reduce the elasticity of demand faced by the foreign firm, inducing it to export less of its patentable product to the market with stronger IPRs. On the contrary, the "market-expansion effect" would increase the demand curve faced by the firm and attract larger sales. In addition, in larger markets, we may find a "cost-reduction effect" that would raise exports if stronger IPRs reduce the need of the foreign firm to undertake private expenditures to deter local imitation.

In turn, other factors may also affect market power and market size effects. 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). In other words, having stronger IP protection in a market could enhance licensing agreements or FDI instead of trade. Moreover, imitating is costly, time consuming and depends on capabilities that vary across countries. Thus, a weak IP protection system in a country with low imitation ability will not necessarily discourage 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 and the structure of trade barriers.

Several empirical studies have found evidence supporting the hypothesis that the effect of IPRs on trade flows varies according to product sectors. Maskus and Penubarti (1995) have 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, considering local patent laws. They concluded that changes in patent laws influence international trade depending on the sector and development level.

Fink and Primo Braga (1999) found that stronger IPRs increase bilateral trade flows of manufactured non-fuel imports, but they don't affect trade flows of high technology products. Delgado et al. (2013) investigated how the implementation of IPRs in developing countries under the TRIPS agreement has affected trade in knowledge-intensive goods. They found an increase in developing countries' imports, driven by the exchange with high-income countries. They also found that the effect on knowledge diffusion from high-income to developing countries varies across sectors.

Several authors have studied the interaction of imitation abilities and IPRs and their effect on trade. For the case of the United States (US), Smith (1999) found that the link between IPRs and 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 that the latter is more relevant for exports to countries with weak capacity of imitation. Co (2004) studied how sensitive are US exports to importing countries' IPRs regimes. She found that IPRs regimes matter when they are considered together with imitative abilities of importing countries. For a panel of countries, Falvey et al. (2009) found that imitative abilities influence the effect of IPRs on trade.

Other authors have investigated the issue for developing countries. For example, 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. In a similar direction, Shin et al. (2012) studied the role of IPRs in global trade considering the level of technology of the exporting countries. 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 exports of developing countries.

For the case of China, Awokuse and Yin (2010) found that the strengthening of Chinese patent laws have 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 agricultural sector. Yang and Woo (2006) studied 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 evident impact on planting seeds imports. Confirming these results, Eaton (2009) found no evidence that the adoption of the UPOV-approved system of plant breeders' rights benefits seed imports. However, this evidence was recently challenged by Galushko (2012) who found that stronger IPRs can foster international seed exchange.

Considering the mixed evidence, our paper contributes to the current debate investigating the effect of the strengthening of IPRs after the signing of the TRIPS agreement for trade of different products of agriculture, both raw material and manufactured products that use agricultural inputs. We use an indicator of IP protection especially built for agriculture and we try to address the specificities of the sector and countries.

The case of study has some relevant specificities. Many agricultural products are final goods, whose production may be more related with natural endowments of the producing country and, therefore, imitation abilities may not matter as much as in other types of products. In addition, innovation in this sector depends on the local necessities related with agro-ecological conditions. However, for other part of agricultural products, such as seeds (which have been growing in technical complexity), imitation abilities do matter, because the genetic information contained in seeds provides the necessary for their reproduction.

Besides, like in all other products, 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 has been increasing worldwide. But, 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, 2014). Thus, we may expect a different effect of IPRs for the early and the newly adopters of IPRs systems.

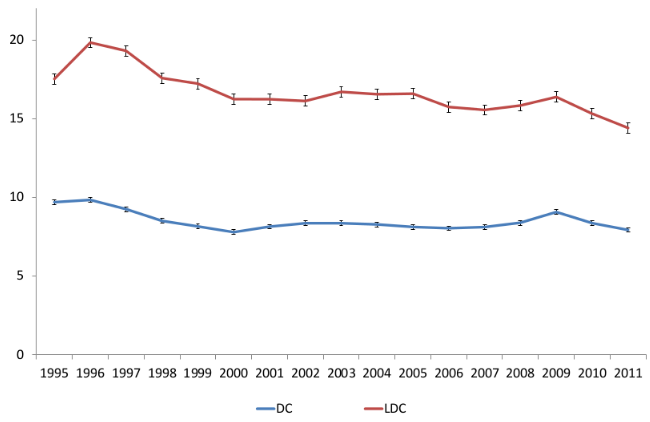

Figure 1: Share of Agricultural Exports on Total Exports.
Developed and Developing Countries

Finally, most authors addressing the effect of IPRs on trade, focus on the level of IP protection of the importing country. In contrast, we consider separately the effect of increasing IPRs in the importing and the exporting country of agricultural products, as 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). Secondly, IPRs may affect productivity and, thus, competitiveness of the sector, which may be reflected in exports. Accordingly, we consider both the effect of an increase of IPRs in the importing and the exporting country.

3 Data

We investigate the effect of IPRs on trade for the period 1995 to 2011 for 60 countries, including 28 developed and 32 developing economies (see Appendix, for the list of countries).

The data for trade are from Gaulier and Zignago (2010) (BACI). We have computed total trade of agricultural products by 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, and other categories in chapters 29 to 53, as defined by the World Trade Organization (WTO) (see Table A.1 in the Appendix).[1] We present the categories of chapters 29 to 53 aggregated in their three corresponding sections: 6, 8 and 11. Then, the agricultural sector includes grains and vegetables, but also animal products and food that use vegetable products as inputs.

We have transformed the original data from current US dollars into constant dollars (base 2000). As a proxy of changes in global prices, we used the US imports price index provided by the US Bureau of Labor Statistics.[2] Agricultural data used in our research aggregate products of several chapters and sections (we call them 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, we used a yearly index developed by Campi and Nuvolari (2014) for the agricultural sector, which aggregates five components that indicate the strength of each country's IP protection system for plant varieties (inda). 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 as developing countries have been adopting stronger IPRs systems during the last two decades. This reflects the process of strengthening and harmonization of IPRs systems.

[1] http://www.wto.org/english/docs_e/legal_e/14-ag_02_e.htm
[2] http://www.bls.gov/web/ximpim/beaexp.htm, accessed on February 2014.

4 IPRs and Total Trade. Econometric Estimations

In this section, we study the correlation between the index of IP protection and both total imports and exports of agricultural products. We expect that the increase in the levels of IPRs may have two possible effects in total trade. Firstly, they may have an effect on imports that will be determined by the interaction of the market expansion effect (lower risk of imitation) and the market power effect (monopolistic behaviour). But also, stronger IPRs may influence productivity and, thus, competitiveness of the sectors, which will, in turn, have an effect on exports of the country.

Since these simple correlations between IPRs and total trade may mask more complex relations, we included some control variables and carried on a multivariate regression. 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 included an indicator of human capital per person, which is based on years of schooling from Barro and Lee (2013) and returns to education from Psacharopoulos (1994) (hc). This variable is expected to have a positive effect on productivity and, therefore, also a positive impact on trade. In addition, it might capture heterogeneities in terms of countries' capabilities and also, it may be a proxy of imitative abilities. Finally, we considered 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 expected to facilitate and spur technology transfer and innovation. The source of the data is Feenstra and Timmer (2013) (Pen World Tables 8.0).

In some specifications, we also included two additional variables: the one-year lag of total agricultural exports ($\log(\text{texpa}_{t-1})$) and the one-year lag of total agricultural imports ($\log(\text{timpa}_{t-1})$). We have considered these variables to avoid an autoregressive effect and also to rule out a simultaneity issue because imports of *t-1* may have an influence on exports of t, and vice versa. In both specifications we considered the full sample, a sample of developed countries and a sample of developing countries. Table 1 displays the correlation matrix of the independent variables.

Table 1: Correlation Matrix of Independent Variables

Variable	inda	log(gdppc)	hc	log(open)	$\log(\text{timpa}_{t-1})$	$\log(\text{texpa}_{t-1})$
inda	1					
log(gdppc)	0.29	1				
hc	0.4125	0.6629	1			
log(open)	0.1809	0.5966	0.3937	1		
$\log(\text{timpa}_{t-1})$	0.2708	0.4551	0.3086	-0.0149	1	
$\log(\text{texpa}_{t-1})$	0.16	0.4504	0.1699	0.0117	0.6094	1

Taking advantage of the panel structure of the data, we applied a fixed effects 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,

$$x_i = \{1, \text{inda}_i, \log(\text{gdppc}_i), \text{hc}_i, \log(\text{open}_i), \log(\text{texpa}_{i,t-1}) \log(\text{timpa}_{i,t-1})\}. \tag{3}$$

Table 2 displays the results of the fixed effects estimations for the model using

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

Model	(1)	(2)	(3)	(4)	(5)	(6)
Sample	FS	DC	LDC	FS	DC	LDC
IP Index	-0.032***	-0.024	-0.056***	-0.009	-0.019*	-0.023**
	(0.011)	(0.017)	(0.013)	(0.008)	(0.010)	(0.012)
log GDP per capita	0.374***	1.018***	0.112	0.338***	0.630***	0.254***
	(0.066)	(0.109)	(0.078)	(0.057)	(0.071)	(0.082)
Human Capital	0.632***	0.060	1.150***	0.048	-0.066	0.357**
	(0.106)	(0.133)	(0.145)	(0.083)	(0.079)	(0.140)
log Openness	0.750***	0.812***	0.618***	0.389***	0.342***	0.392***
	(0.040)	(0.055)	(0.052)	(0.035)	(0.037)	(0.051)
log Imports$_{(t-1)}$				-0.148***	-0.190***	-0.132***
				(0.024)	(0.034)	(0.033)
log Exports$_{(t-1)}$				0.681***	0.778***	0.533***
				(0.023)	(0.028)	(0.037)
Constant	4.977***	-0.252	6.761***	1.276***	-1.905***	3.138***
	(0.455)	(0.857)	(0.487)	(0.358)	(0.507)	(0.480)
Observations	1,020	476	544	960	448	512
Number of countries	60	28	32	60	28	32
R-squared	0.647	0.779	0.596	0.820	0.935	0.714
Adjusted R-squared	0.624	0.764	0.568	0.807	0.930	0.692

Note: The dependent variable is total exports of agricultural products. 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.

total exports of agricultural products as the dependent variable. Models 1 to 3 present the estimations for the simpler specification and models 4 to 6 present the estimations of the specification that includes the two lagged variables. In all the models the control variables present the expected signs when they are significant: GDP per capita, human capital and openness are positive; the one year lag of imports is negative; and the one year lag of exports is positive. The index of IP protection is negative and significant for the full sample (model 1) and the sample of developing countries (model 3), in the first specification of the model. In the second specification, the index is significant and negative for the two samples that aggregate developed and developing countries (models 5 and 6).

Table 3 displays the results for the estimations using total imports of agricultural

Table 3: Total Imports of Agricultural Products. Fixed Effects Estimations

Model	(1)	(2)	(3)	(4)	(5)	(6)
Sample	FS	DC	LDC	FS	DC	LDC
IP Index	-0.035***	-0.052***	-0.022*	-0.026***	-0.023***	-0.024**
	(0.009)	(0.013)	(0.012)	(0.007)	(0.008)	(0.011)
log GDP per capita	1.188***	1.158***	1.266***	0.590***	0.437***	0.698***
	(0.054)	(0.080)	(0.074)	(0.050)	(0.058)	(0.075)
Human Capital	-0.396***	0.174*	-0.880***	-0.246***	-0.021	-0.550***
	(0.088)	(0.099)	(0.137)	(0.073)	(0.064)	(0.128)
log Openness	0.754***	0.662***	0.809***	0.565***	0.362***	0.686***
	(0.033)	(0.041)	(0.049)	(0.031)	(0.031)	(0.047)
log Imports$_{(t-1)}$				0.498***	0.657***	0.424***
				(0.021)	(0.028)	(0.030)
log Exports$_{(t-1)}$				-0.055***	-0.059**	-0.047
				(0.021)	(0.023)	(0.034)
Constant	0.275	-0.802	0.725	0.103	-0.321	0.335
	(0.377)	(0.635)	(0.461)	(0.315)	(0.413)	(0.438)
Observations	1,020	476	544	960	448	512
Number of countries	60	28	32	60	28	32
R-squared	0.797	0.850	0.778	0.883	0.944	0.859
Adjusted R-squared	0.783	0.839	0.763	0.874	0.939	0.848

Note: The dependent variable is total imports of agricultural products. 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.

products as the dependent variable. Also in this estimation, the control variables have the expected signs when they are significant: the GDP per capita and openness are positive, while human capital is negatively correlated with total imports, except for developed countries. This may be explained by different imitative abilities of countries and by the fact that an increase in human capital may imply an increase in imitative abilities. The index of IP protection results negative and statistically significant for all the samples in both specifications.

The effect of IPRs may be different when considering exports or imports at a more disaggregated level (see Awokuse and Yin (2010) for the case of industrial products). Therefore, we perform fixed effects estimations, in which the dependent variables are the quantity of exports or imports of each of the 25 sub-sectors; and the independent variables are those specified in Equation (3).[3]

For brevity, Table 4 displays only the coefficients of the IP protection index for the estimations performed for total exports and imports of each sub-sector. Once again, we checked the results for countries grouped according to development level.

[3]We present the estimations of the first specification (no lagged variables) to keep the maximum quantity of observations. The results are similar for the second specification and are available upon request.

Table 4: 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
Ch. 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)
Ch. 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)
Ch. 4 Dairy, Eggs, Honey, and Edible Products	0.123***	0.031	0.127**	-0.054***	-0.122***	-0.016
	(0.035)	(0.026)	(0.055)	(0.019)	(0.031)	(0.024)
Ch. 5 Products of Animal Origin	-0.099***	-0.011	-0.119**	0.023	0.062**	0.017
	(0.036)	(0.032)	(0.056)	(0.021)	(0.027)	(0.030)
Ch. 6 Live Trees and Other Plants	-0.003	0.011	-0.022	0.073***	-0.038*	0.140***
	(0.029)	(0.046)	(0.038)	(0.021)	(0.019)	(0.030)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 10 Cereals	-0.105*	0.094	-0.241***	-0.018	-0.019	-0.017
	(0.058)	(0.064)	(0.085)	(0.025)	(0.038)	(0.035)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 14 Vegetable Planting Materials	-0.119**	0.087	-0.227***	-0.022	-0.032	-0.085*
	(0.047)	(0.078)	(0.062)	(0.035)	(0.055)	(0.043)
Ch. 15 Animal or Vegetable Fats, Oils and Waxes	-0.079***	-0.053	-0.107**	-0.034**	-0.047**	-0.017
	(0.030)	(0.034)	(0.044)	(0.015)	(0.022)	(0.020)
Ch. 17 Sugars and Sugar Confecionery	0.024	-0.024	0.012	-0.066***	-0.019	-0.085***
	(0.033)	(0.033)	(0.050)	(0.020)	(0.026)	(0.029)
Ch. 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)
Ch. 19 Preps. of Cereals, Flour, Starch or Milk	-0.019	-0.053	-0.013	0.004	-0.061***	0.044**
	(0.028)	(0.033)	(0.041)	(0.015)	(0.017)	(0.023)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 23 Residues from Food Industries, Animal Feed	0.007	0.030	-0.034	0.043**	0.000	0.072**
	(0.032)	(0.033)	(0.048)	(0.019)	(0.022)	(0.028)
Ch. 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)
Sec. 6 Prod. of the chemical or allied industries	-0.049	-0.199***	0.017	0.006	0.020	0.035
	(0.033)	(0.048)	(0.044)	(0.017)	(0.022)	(0.022)
Sec. 8 Raw hides and skins, leather...	0.005	0.024	0.023	0.044	0.144**	0.050
	(0.037)	(0.035)	(0.057)	(0.054)	(0.062)	(0.078)
Sec. 11 Textiles and textile articles	-0.020	-0.088*	0.044	-0.100**	0.132***	-0.171***
	(0.042)	(0.046)	(0.062)	(0.040)	(0.047)	(0.054)

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.

At a more disaggregated level (2-digits), the index of IP protection displays different correlations, considering both exports and imports. The first remark is the heterogeneity observed. For some cases, the IP protection index results no statistically significant, When the estimated coefficients are significant, we observe both positive or negative effects on trade depending on the types of products. However, most of the significant regressors are negative.

For the case of exports, clearly, the effect is negative in most sub-sectors. For the full sample, the index of IPRs is negatively and significantly correlated with the exported quantities for 12 sub-sectors out of 25; and positively and significantly correlated with 2 sub-sectors. For developed countries, IPRs have a no significant correlation with exports for most of the sub-sectors (18 out of 25), in 2 sub-sectors there is a positive and statistically significant correlation; and in 5 sub-sectors, the correlation is negative and significant. Meanwhile, for developing countries, when the coefficients are statistically significant, the effect is positive for two sub-sectors and negative for 12.

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 9. For developed countries, we observe only 5 sub-sectors for which there is a statistically significant and positive correlation and 10 sub-sectors in which the significant coefficients are negative. Finally, for developing countries, when the coefficients are significant, 8 are positive and 5 are negative.

Figure 2 shows graphically these results. Red bars illustrate the coefficients of the IP index of the exporter in the regressions with total exports as the dependent variable while blue bars are the coefficients for the IP indexes of the importer when we estimated the model with total imports as the dependent variable. As mentioned before, for most sub-sectors, the regressors are in all samples negative when they turn out to be significant.

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, and also for some sub-sectors.

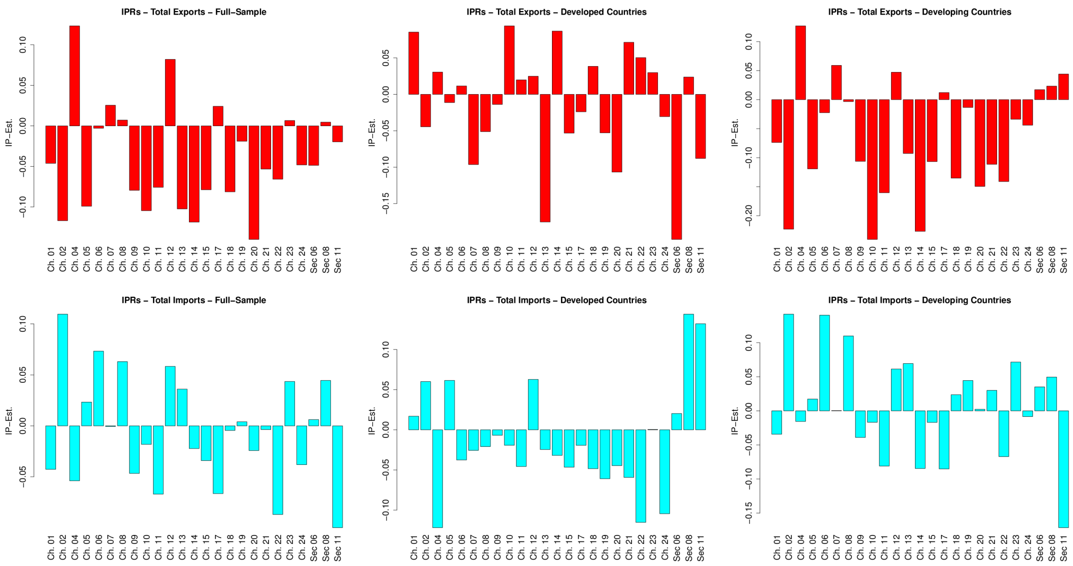

Figure 2: Impact of IPRs on Total Exports and Imports. Agricultural Sub-sectors

Notes: Top: IPRs regressors for the estimations using total exports for the full sample (left), DC (middle) and LDC (right). Bottom: IPRs regressors for the estimations using total imports for the full sample (left), DC (middle) and LDC (right).

5 Do Stronger IPRs Enhance Bilateral Trade?

IPRs might also 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 has generalized 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. 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).

In this section, we aim to explain bilateral total trade using the GM. We complement our analysis of the effect of IPRs on trade volumes, by investigating whether strong IPRs facilitate the creation of bilateral trade relationships and trade of new products. In addition, we study the intensive and extensive margins of trade.

Since we postulate different effects according to the development level, we split the data into four groups of analysis (Table 5). In the first group, we consider all trade relationships present in our data base. 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 among developing countries.

Table 5: 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

5.1 Total Bilateral Trade

For the estimation of the GM, we use the following benchmark specification. 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 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} is 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.2, in the Appendix, 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 applied to the log-linearized equation (Glick and Rose, 2002; Subramanian and Wei, 2007), the two-stage Poisson estimations, which considers the probability of having zero trade flows (Burger et al., 2009), and panel data techniques with instrumental variables (Awokuse and Yin, 2010). A common feature of all estimation techniques is that they achieve high R-squared coefficients of determination, i.e. a quite satisfactory goodness of fit, which explains the success of the gravity model.

To study the effect of IPRs on bilateral trade, we expand the standard GM specification 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 bilateral trade volumes and bilateral trade relations increase when the exporter and/or the importer increase their level of IPRs.

We estimate the GM under two different econometric techniques: i) panel data, assuming fixed effects (FE), and ii) zero inflated Poisson pseudo maximum likelihood (ZIP) with time dummies, pooling all cross-sections. The ZIP model preforms in the first stage a Poisson pseudo maximum likelihood (PPML),[4] which estimates total trade among positive observed trade volumes; and in a second stage, a Logit estimation with dummies, which considers zero trade flows. Notice that in both the FE and the PPML, the dependent variable proxies the observed trade volumes, while in the Logit estimation, the dependent variable is a binary variable representing the observed bilateral trade relationships. Table 6 presents the estimation results for the aggregated bilateral trade in agricultural products. The first point to notice is that FE and PPML provide statistically different results, suggesting heteroskedasticity.[5] 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 is rejected for both FE and PPML estimations.

In the estimations of trade volumes for the full sample (columns 1 and 2 in Table 6), we observe the gravity structure of trade, which is mirrored by the signs of the countries' size (positive) and distance regressors (negative). The country size effect must be seen considering jointly all country specific variables, GDP, GDPpc, and area; although in some estimations the regressors have negative signs, the overall effect of country size variables is positive. Regarding the effect of IPRs, we observe significance, in the FE estimation, in the multiplier related to the index of the

[4]The GM is usually estimated with a dependent variable in log form, not allowing to include data on zero trade flows. The estimation method proposed by Santos Silva and Tenreyro (2006) avoids possible biased coefficients by dealing with the problem of heteroskedasticity.

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

Table 6: 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	-0.025***	-0.012	0.009	-0.006	0.022	-0.171	-0.029***	-0.112***	-0.007	-0.059***	-0.339***	-0.052***
	(0.007)	(0.013)	(0.015)	(0.012)	(0.020)	(0.128)	(0.009)	(0.016)	(0.024)	(0.014)	(0.030)	(0.018)
IP Index_i	-0.046***	-0.006	0.284***	-0.050***	-0.035*	0.023	-0.034***	-0.002	0.204***	-0.035***	0.115***	0.272***
	(0.007)	(0.013)	(0.014)	(0.012)	(0.018)	(0.141)	(0.009)	(0.018)	(0.023)	(0.013)	(0.027)	(0.018)
log GDP_e	-0.293***	0.540***	0.891***	-3.302***	0.597***	0.538**	-0.135	0.460***	1.029***	0.378**	0.100***	1.025***
	(0.091)	(0.011)	(0.015)	(0.195)	(0.016)	(0.230)	(0.121)	(0.015)	(0.025)	(0.193)	(0.033)	(0.026)
log GDP_i	0.965***	0.853***	0.519***	2.821***	0.896***	0.752***	0.759***	0.922***	0.666***	0.736***	0.670***	0.540***
	(0.091)	(0.014)	(0.014)	(0.195)	(0.024)	(0.101)	(0.122)	(0.017)	(0.021)	(0.191)	(0.044)	(0.022)
log GDPpc_e	0.790***	0.304***	0.324***	4.703***	0.438***	2.115***	0.398***	0.353***	-0.103***	0.035	0.398***	-0.219***
	(0.094)	(0.020)	(0.020)	(0.193)	(0.046)	(0.402)	(0.129)	(0.027)	(0.038)	(0.191)	(0.049)	(0.037)
log GDPpc_i	0.506***	0.131***	0.519***	-1.383***	-0.066*	0.843***	0.458***	0.029	0.131***	1.128***	0.139**	0.086**
	(0.093)	(0.022)	(0.019)	(0.192)	(0.037)	(0.308)	(0.128)	(0.032)	(0.036)	(0.186)	(0.066)	(0.034)
log Area_e	-	0.070***	0.093***	-	-0.067***	0.966***	-	0.224***	0.098***	-	0.514***	-0.082***
	-	(0.011)	(0.011)	-	(0.018)	(0.178)	-	(0.012)	(0.019)	-	(0.039)	(0.016)
log Area_i	-	-0.165***	-0.077***	-	-0.219***	0.024	-	-0.189***	-0.152***	-	0.112***	-0.147***
	-	(0.009)	(0.012)	-	(0.018)	(0.128)	-	(0.012)	(0.019)	-	(0.029)	(0.017)
landlocked_e	-	-0.785***	-0.367***	-	-1.164***	0.974**	-	-0.603***	-0.475***	-	-0.083	-0.576***
	-	(0.034)	(0.032)	-	(0.051)	(0.426)	-	(0.049)	(0.048)	-	(0.083)	(0.052)
landlocked_i	-	-0.510***	-0.050	-	-0.629***	-0.035	-	-0.662***	0.014	-	-0.061	-0.391***
	-	(0.031)	(0.035)	-	(0.039)	(0.417)	-	(0.042)	(0.054)	-	(0.074)	(0.056)
log dist	-	-0.550***	-0.807***	-	-0.578***	-1.502***	-	-0.238***	-0.529***	-	-0.585***	-0.752***
	-	(0.016)	(0.018)	-	(0.021)	(0.114)	-	(0.024)	(0.028)	-	(0.030)	(0.027)
contig	-	0.923***	1.011***	-	0.664***	-	-	1.614***	-	-	0.247***	1.376***
	-	(0.044)	(0.228)	-	(0.044)	-	-	(0.070)	-	-	(0.091)	(0.227)
comlang_off	-	0.171***	1.652***	-	0.492***	-	-	0.478***	-	-	0.579***	1.996***
	-	(0.038)	(0.092)	-	(0.048)	-	-	(0.051)	-	-	(0.065)	(0.101)
comcol	-	0.351***	2.056***	-	1.747***	-	-	0.752***	3.499***	-	0.745***	1.390***
	-	(0.078)	(0.123)	-	(0.124)	-	-	(0.100)	(0.329)	-	(0.129)	(0.145)
colony	-	-0.022	0.352	-	-0.193***	-	-	0.260***	-	-	0.695***	0.038
	-	(0.036)	(0.272)	-	(0.047)	-	-	(0.058)	-	-	(0.107)	(0.306)
constant	yes			yes			yes			yes		
Time-dummies		yes	yes		yes	yes		yes	yes		yes	yes
Observations	62,900	62,900	72,930	12,746	12,746	10,432	32,901	32,901	33,796	17,253	17,253	23,902

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

exporter (IP index_e), which is low and negative, -0.025(0.007) and in the index of the importer (IP index_i), with a coefficient of -0.046(0.007). These results agree with our findings in the previous section and suggest that IPR systems have a negative effect on trade volumes. In the PPML estimations, the coefficients are no significant.

In the Logit estimations (column 3 in Table 6), we also found the expected structure 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. 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 in the importing countries.

Some differences arise on the countries' IP indexes coefficients if we instead sample on the restricted groups of countries. Regarding bilateral trade volumes, for the case of developed countries (see columns 4-5 in Table 6), once again the expected effect is negative for 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, for the IP index_e in both the FE and PPML models, and on the IP index_i in the FE model. Finally, for the case of trade between developing countries (see columns 10-11 in Table 6), 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, we did not find a significant effect for the case of developed countries (see column 6 in Table 6). It is worth noticing that, at the aggregated level, most developed countries are completely integrated so the probability of creating new bilateral trade links might be difficult to capture in the sample of developed countries. For the case of trade between developed and developing countries (see column 9 in Table 6) the strengthening of IPRs systems leads to an expected extension of bilateral trade relationships when IPRs increase in the importer. For the case of trade between developing countries (see column 12 in Table 6) 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.

These findings suggest that it may be beneficial for a given country that other countries increase their IP protection since this increases the probability of selling to those countries, but that there are no incentives for a country to increase its own IPRs since this does not increase the probability of trading with more countries.

Table 7: 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.	n.s.
DC-LDC	(-)	(-)	n.s.	(+)
LDC-LDC	(-)	ambiguous	(-)	(+)

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

Table 7 summarizes the main results of the gravity model estimations. In line with the evidence found before, the strengthening of IPRs in the importer or the exporter has a negative effect in total trade of agricultural products for all the samples considered. For the case of bilateral trade relations, the probability of creating new bilateral trade links seems to increase when the importer 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, considering 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 the creation of the WTO, which aims to supervise and liberalize international trade.[6]

5.2 Industry Intensive and Extensive Margins

Now, we move the attention to the effects of IPRs on the intensive and extensive margins of trade in agricultural products.[7]

We use the industries defined by the Harmonized Commodity Description and Coding System at 6-digits level of aggregation as reported in Gaulier and Zignago

[6]There is no consensus on the effect of WTO on trade. While Rose (2004) found little evidence that countries becoming members or belonging to the GATT/WTO changed their trade patterns compared with those who are not members; Subramanian and Wei (2007) found that the WTO has had a positive but uneven impact on trade. We have not included a variable indicating the signing of the WTO or the TRIPS (which were signed together) because of the period that we are considering (1995-2011, after the WTO/TRIPS). Including this variable would be interesting if the period of study would also include years before the signing of the WTO/TRIPS.

[7]The concepts of intensive and extensive margins of trade have been studied in different ways. For example, Berthou and Fontagné (2008), Dutt et al. (2011), Silva et al. (2014) and Klenow and Hummels (2005) define and estimate them differently. Foster (2014) also studied the effect of IPRs on the margins of trade and found a positive impact on imports driven by a positive effect on the extensive margin and a negative effect on the intensive margin.

(2010). For the period under study there was trade in 622 categories of agricultural sub-sectors (6-digits). The maximum number of bilateral traded agricultural products at 6-digits of disaggregation in our full sample and the sample of DC-DC was 622; in the DC-LDC sample, it was 613; and in the LDC-LDC sample it was 498.

Therefore, we decompose total bilateral trade in the agricultural sector as follows

$$W_{ij} = N_{ij} \times w_{ij}; \tag{6}$$

where N_{ij} is the total number of sub-sectors (6-digits) with positive trade exported by country i to country j, which we define as the industry extensive margin, and w_{ij} the average value of exports by sub-sector (6-digits) from country i to country j, which we define as the industry intensive margin.

In order to estimate Equation (6) we perform two independent estimations: a Poisson pseudo maximum likelihood (PPML) on the intensive margin (w_{ij}) and a Bernoulli pseudo maximum likelihood (FLEX) on the extensive margin (N_{ij}), i.e. we assume that both margins are independent.[8] Both N_{ij} and w_{ij} will be estimated by using the same variables of Equation (5) in exponential form. Note that the estimation of Equation (6) is different but complementary to the estimation of Equation (4) with respect to the effect of IPRs on market expansion. In other words, with the Logit estimation we capture the effect on the probability of finding new trading partners due to the increase in IPRs, while with the FLEX estimation we capture the effect in the quantity of sub-sectors on which a country has trade with the same partner due to a strengthening of IPRs. Table 8 presents the estimation of the margins of trade for our set of samples.

Regarding the intensive margin for the full sample (column 1 in Table 8), we might conclude that the average value of exports by sub-sector diminishes with the IPRs level of the exporter. In the case of the DC-DC sample, this average is expected to increase with the IPRs level of the exporter. For the DC-LDC sample, the average value of exports by sub-sector is expected to decrease with the IPRs of both the exporter and the importer. Finally, for LDC-LDC, the average value of exports is expected to be negatively affected only by an increase of the IPRs of the exporter.

The results complement what we have observed in Table 6. The fact that the expected effect of strengthening IPRs on the average value of bilateral trade by sub-sector takes a positive or negative sign implies heterogeneous effects at the disaggregated level. In other words, if IPRs affect all sectors in the same way, then we would observe the same effect on the average value and on the total trade.

[8]The FLEX estimation was recently introduced by Silva et al. (2014) showing a remarkable performance in the estimation of double bounded data.

Table 8: Estimations of the Intensive and Extensive Margins of Products

Sample	Full-Sample		DC-DC		DC-LDC		LDC-LDC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Model	PPML	FLEX	PPML	FLEX	PPML	FLEX	PPML	FLEX
IP Index_e	-0.090***	-0.009*	0.057***	0.088***	-0.159***	-0.028***	-0.122***	-0.142***
	(0.011)	(0.005)	(0.014)	(0.009)	(0.013)	(0.006)	(0.024)	(0.012)
IP Index_i	-0.004	0.025***	-0.004	0.033***	-0.029*	0.026***	-0.018	0.112***
	(0.013)	(0.005)	(0.013)	(0.008)	(0.016)	(0.007)	(0.028)	(0.011)
log GDP_e	0.086***	0.699***	0.239***	0.672***	0.037***	0.745***	-0.108***	0.903***
	(0.007)	(0.005)	(0.010)	(0.009)	(0.011)	(0.010)	(0.039)	(0.018)
log GDP_i	0.523***	0.323***	0.653***	0.253***	0.480***	0.445***	0.390***	0.469***
	(0.012)	(0.005)	(0.014)	(0.007)	(0.013)	(0.008)	(0.038)	(0.016)
log GDPpc_e	-0.023*	0.195***	0.339***	0.128***	-0.047***	0.098***	0.294***	-0.013
	(0.013)	(0.007)	(0.031)	(0.020)	(0.018)	(0.012)	(0.040)	(0.023)
log GDPpc_i	-0.156***	0.330***	0.009	0.187***	-0.115***	0.159***	-0.286***	0.106***
	(0.020)	(0.008)	(0.028)	(0.018)	(0.027)	(0.012)	(0.060)	(0.029)
log Area_e	0.214***	-0.095***	0.014	-0.116***	0.212***	-0.094***	0.461***	-0.107***
	(0.006)	(0.004)	(0.012)	(0.008)	(0.007)	(0.006)	(0.029)	(0.011)
log Area_i	-0.088***	0.004	-0.151***	0.048***	-0.135***	-0.048***	0.074**	-0.057***
	(0.008)	(0.004)	(0.011)	(0.007)	(0.010)	(0.006)	(0.029)	(0.011)
landlocked_e	0.203***	-0.283***	-0.855***	-0.426***	0.093	-0.206***	0.944***	-0.413***
	(0.060)	(0.013)	(0.033)	(0.018)	(0.084)	(0.020)	(0.155)	(0.045)
landlocked_i	-0.338***	-0.216***	-0.583***	-0.302***	-0.257***	-0.299***	-0.546***	-0.082*
	(0.028)	(0.013)	(0.026)	(0.019)	(0.041)	(0.019)	(0.099)	(0.043)
log dist	-0.151***	-0.709***	-0.256***	-0.744***	0.066***	-0.574***	-0.194***	-0.962***
	(0.012)	(0.005)	(0.016)	(0.013)	(0.016)	(0.010)	(0.042)	(0.022)
contig	0.556***	0.604***	0.635***	0.486***	1.050***	0.655***	-0.541***	1.277***
	(0.040)	(0.025)	(0.033)	(0.030)	(0.099)	(0.063)	(0.080)	(0.069)
comlang_off	0.235***	0.800***	0.496***	0.575***	0.041	0.971***	-0.061	1.202***
	(0.024)	(0.017)	(0.039)	(0.044)	(0.038)	(0.031)	(0.050)	(0.039)
comcol	-0.046	0.626***	0.547***	1.699***	0.269***	0.795***	-0.046	0.310***
	(0.048)	(0.049)	(0.071)	(0.045)	(0.091)	(0.050)	(0.091)	(0.065)
colony	-0.117***	0.269***	-0.272***	0.145***	-0.078*	0.343***	-0.008	1.025***
	(0.027)	(0.025)	(0.040)	(0.035)	(0.047)	(0.046)	(0.084)	(0.105)
omega		1.113***		0.681***		2.201***		6.750***
		(0.049)		(0.045)		(0.192)		(0.520)
Time-dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	62,900	72,930	12,746	12,852	32,901	36,176	17,253	23,902

Note: PPML corresponds to the intensive margin and FLEX corresponds to the extensive margin of trade. Standard errors are in parenthesis. Significance level: *** p<0.01, ** p<0.05, * p<0.10. DC: Developed Countries; LDC: Developing Countries.

However, we observe heterogeneous effects at this level of disaggregation supporting the hypothesis that the effect of IPRs depends on the specificities of the industries and products.

Regarding the extensive margin, we observe, for the full sample, that the total number of sub-sectors with positive bilateral trade is affected negatively by an increase on the level of IPRs of the exporter while positively by an increase on the level of IPRs of the importer. If we restrict our sample to only developed countries (column 4 in Table 8) the expected effect of stronger IPRs of both the exporter and the importer is positive. Unlike this, in both samples of DC-LDC and LDC-LDC (columns 6 and 8 of Table 8) we observe that an increase in the level of IPRs of the exporters affects negatively the number of sub-sectors with positive bilateral trade, while an increase in the level of IPRs of the importer has a negative effect.

Table 9 summarizes the main findings of the analysis of the intensive and extensive margins of agricultural trade.

Table 9: Summary of Intensive and Extensive Margins of Trade Estimations

	Intensive Margin		Extensive Margin	
Sample	IPRs Exporter	IP Importer	IP Exporter	IP Importer
Full-Sample	(-)	n.s.	(-)	(+)
DC-DC	(+)	n.s.	(+)	(+)
DC-LDC	(-)	(-)	(-)	(+)
LDC-LDC	(-)	n.s.	(-)	(+)

Note: n.s.: no significant; (+): positive coefficient; (-): negative coefficient.

5.3 Gravity Model Estimations on Sub-sectors

Considering the evidence found in the previous section, we estimated independently for different sub-sectors at a 2-digits level of disaggregation the expected effect of the index of IP protection. We perform ZIP estimations using as dependent variables the bilateral trade of each of the 25 sub-sectors in order to capture the effect of IPRs on total bilateral trade but also on the probability of creating new bilateral trade relations.

Table 10 displays the PPML estimators for 25 sub-sectors, which show the effect of IPRs on bilateral trade volumes.[9] Notice that, for brevity, the results of the other regressors were omitted, since we focus on the effect of IPRs on trade. Like in the previous estimations, the first thing to notice is the heterogeneity, which is observed in all the samples.

[9]Most of our observations are also robustly observed under the fixed effects estimator. The results are available upon request.

Table 10: 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
Ch. 1	-0.166***	-0.076*	-0.142**	-0.174***	-0.251***	0.115**	0.096	0.026
	(0.051)	(0.040)	(0.062)	(0.052)	(0.048)	(0.056)	(0.139)	(0.071)
Ch. 2	0.315***	0.050**	0.376***	-0.202***	0.189***	0.223***	0.148*	0.382***
	(0.025)	(0.023)	(0.032)	(0.028)	(0.042)	(0.039)	(0.076)	(0.053)
Ch. 4	0.140***	-0.044**	0.107***	-0.084***	0.015	-0.152***	0.011	-0.033
	(0.028)	(0.019)	(0.034)	(0.024)	(0.038)	(0.040)	(0.045)	(0.053)
Ch. 5	-0.062***	0.129***	0.321***	0.124***	-0.308***	0.214***	-0.258***	0.041
	(0.019)	(0.022)	(0.021)	(0.022)	(0.032)	(0.038)	(0.044)	(0.044)
Ch. 6	0.052**	0.127***	-0.307***	-0.009	0.242***	0.221***	0.322***	0.627***
	(0.025)	(0.041)	(0.029)	(0.032)	(0.052)	(0.043)	(0.050)	(0.056)
Ch. 7	-0.367***	0.029	-0.403***	0.087**	-0.492***	-0.193***	-0.168**	0.128**
	(0.024)	(0.031)	(0.032)	(0.044)	(0.030)	(0.035)	(0.067)	(0.052)
Ch. 8	-0.236***	0.092***	-0.356***	0.030	-0.334***	0.047*	-0.122***	0.345***
	(0.021)	(0.028)	(0.034)	(0.052)	(0.029)	(0.027)	(0.038)	(0.044)
Ch. 9	0.148***	0.148***	0.232***	0.023	0.046	0.319***	-0.007	-0.013
	(0.025)	(0.031)	(0.029)	(0.030)	(0.041)	(0.050)	(0.051)	(0.032)
Ch. 10	-0.106***	-0.072***	-0.151***	-0.419***	-0.084**	-0.071**	-0.642***	0.252***
	(0.028)	(0.025)	(0.050)	(0.045)	(0.041)	(0.034)	(0.068)	(0.059)
Ch. 11	-0.007	-0.022	0.096***	0.041**	-0.054	-0.097***	-0.461***	-0.002
	(0.021)	(0.027)	(0.025)	(0.021)	(0.039)	(0.033)	(0.096)	(0.093)
Ch. 12	-0.047	-0.236***	0.140***	-0.020	0.034	-0.298***	-1.293***	-0.371***
	(0.031)	(0.034)	(0.038)	(0.034)	(0.045)	(0.045)	(0.125)	(0.074)
Ch. 13	0.055**	0.112***	0.127***	0.118***	0.003	0.106***	-0.380***	-0.104**
	(0.022)	(0.020)	(0.032)	(0.032)	(0.029)	(0.025)	(0.043)	(0.042)
Ch. 14	-0.186***	-0.139***	0.238***	-0.152***	-0.385***	-0.032	-0.381***	-0.048
	(0.032)	(0.025)	(0.037)	(0.043)	(0.038)	(0.034)	(0.074)	(0.057)
Ch. 15	-0.011	-0.160***	-0.065**	-0.061*	0.023	-0.250***	-0.339***	-0.109**
	(0.017)	(0.022)	(0.026)	(0.032)	(0.029)	(0.029)	(0.063)	(0.044)
Ch. 17	0.069***	0.134***	0.053	0.042*	-0.042	-0.034	0.300***	0.337***
	(0.024)	(0.030)	(0.036)	(0.024)	(0.036)	(0.045)	(0.076)	(0.056)
Ch. 18	-0.026	0.071***	-0.042**	0.039**	-0.038	0.088***	0.036	-0.052
	(0.016)	(0.015)	(0.020)	(0.019)	(0.032)	(0.029)	(0.036)	(0.045)
Ch. 19	-0.093***	-0.022	-0.053**	-0.038	-0.158***	0.016	-0.130***	0.167***
	(0.017)	(0.019)	(0.021)	(0.025)	(0.026)	(0.021)	(0.041)	(0.036)
Ch. 20	-0.140***	0.053***	-0.129***	-0.003	-0.302***	0.123***	-0.341***	0.173***
	(0.016)	(0.020)	(0.025)	(0.031)	(0.024)	(0.026)	(0.038)	(0.029)
Ch. 21	0.056***	0.087***	0.094***	0.075***	0.049**	0.092***	-0.124***	0.273***
	(0.013)	(0.017)	(0.017)	(0.024)	(0.019)	(0.020)	(0.033)	(0.035)
Ch. 22	-0.322***	0.097***	-0.465***	0.081***	-0.362***	0.061*	-0.053	0.124***
	(0.023)	(0.018)	(0.030)	(0.021)	(0.032)	(0.033)	(0.042)	(0.042)
Ch. 23	0.027	-0.042*	0.209***	0.065***	-0.180***	-0.044	-0.699***	0.059
	(0.020)	(0.023)	(0.024)	(0.023)	(0.042)	(0.043)	(0.078)	(0.046)
Ch. 24	0.262***	-0.154***	0.360***	-0.482***	0.012	0.033	-0.164***	0.003
	(0.037)	(0.036)	(0.058)	(0.059)	(0.044)	(0.042)	(0.047)	(0.042)
Sec. 6	-0.013	0.054***	-0.078***	0.058***	0.044*	-0.017	-0.184	-0.123
	(0.017)	(0.016)	(0.023)	(0.021)	(0.025)	(0.020)	(0.134)	(0.091)
Sec. 8	0.203***	-0.363***	0.031	-0.447***	0.436***	-0.281***	0.192***	-0.458***
	(0.038)	(0.038)	(0.053)	(0.038)	(0.043)	(0.059)	(0.047)	(0.067)
Sec. 11	0.253***	-0.235***	0.554***	-0.252***	0.313***	-0.229***	-0.076	-0.080
	(0.045)	(0.044)	(0.044)	(0.050)	(0.083)	(0.065)	(0.059)	(0.058)

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

Table 11 shows the results of the Logit estimations, which predict how IPRs are

Table 11: 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
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Ch. 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)
Sec. 6	0.116***	0.035***	0.161***	0.139***	0.133***	0.003	0.069***	0.026
	(0.011)	(0.011)	(0.035)	(0.035)	(0.015)	(0.015)	(0.021)	(0.020)
Sec. 8	0.031**	-0.130***	0.091***	-0.025	0.020	-0.148***	-0.002	-0.168***
	(0.012)	(0.012)	(0.029)	(0.028)	(0.017)	(0.017)	(0.024)	(0.024)
Sec. 11	-0.019*	-0.006	-0.078***	0.013	0.016	-0.027*	-0.086***	-0.021
	(0.011)	(0.011)	(0.025)	(0.026)	(0.015)	(0.015)	(0.022)	(0.023)

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

expected to affect the probability of creating new bilateral trade relationships.

Once again, the estimated effect depends on the sub-sector. But, for most sub-sectors, an increase in the IP protection of the importer is expected to affect positively the creation of new bilateral trade relations, if we consider the index of the importer. When considering the index of the exporter, for most sub-sectors the effect is negative. For the full sample and the samples that include developed countries, the positive and negative significant effects are evenly distributed. However, for the sample of LDC-LDC, the effect of the IP of the exporter is clearly negative, while the effect of the IP of the importer is mainly positive.

The effects on bilateral trade volumes and trade links are illustrated by Figure 3. Red-color bars represent the effect on trade volumes (PPML) or on bilateral trade links (Logit) due to the IP index of the exporters and blue-color bars represent the effect due to the IP index of the importers. The figure shows graphically that a change in the index of IP protection of the importer and the exporter may have asymmetric effects. The combinations of these two effects lead, in our estimations, to both positive and negative net results for different sub-sectors.

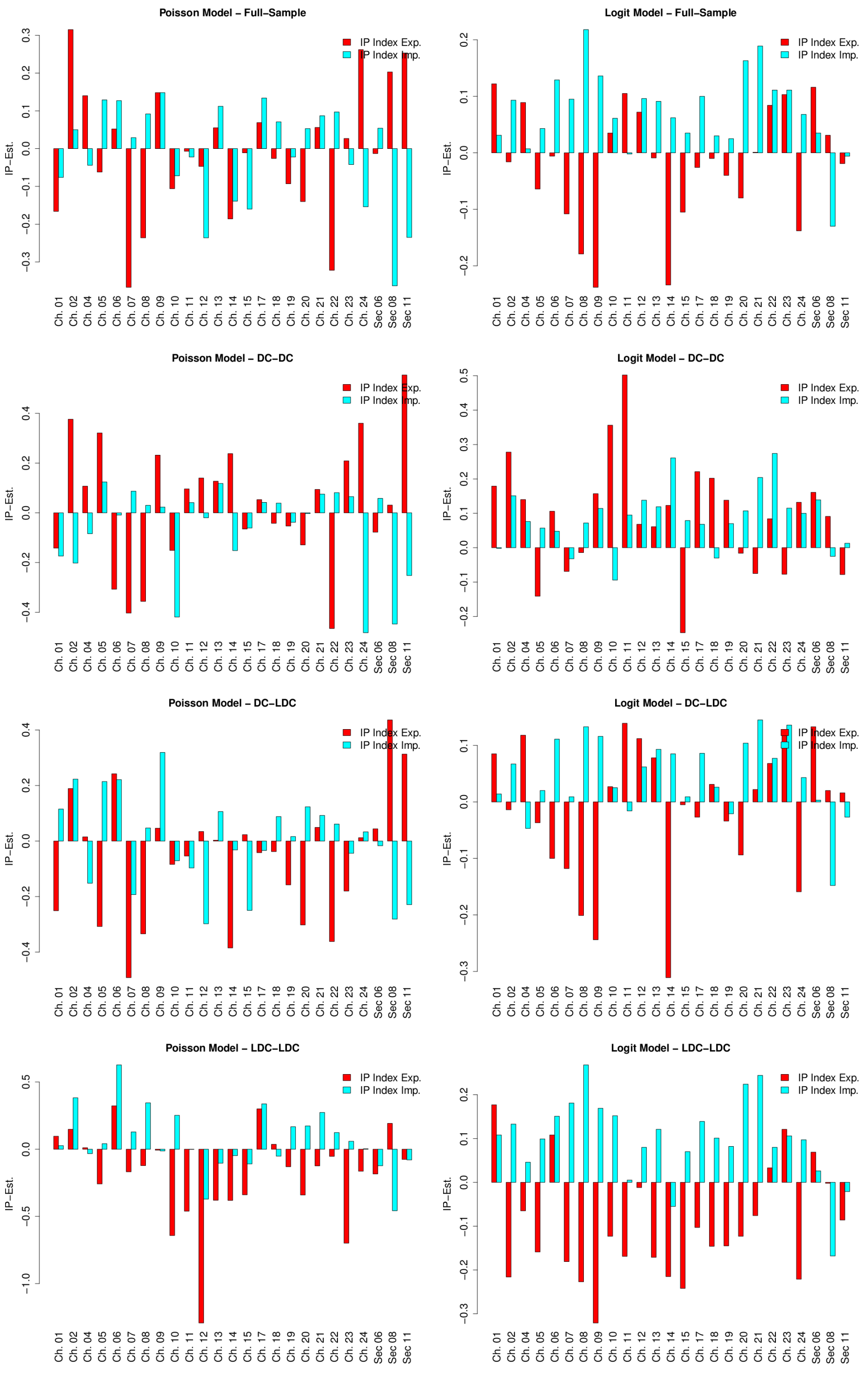

Figure 3: Different Samples Estimations of the Impact of IPRs on Trade. Agricultural Sub-sectors

Notes: Top: bilateral trade among countries in the full sample; second from the top: bilateral trade among DC; third from the top: bilateral trade among DC and LDC; and, bottom: bilateral trade among LDC. 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 the strengthening of 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 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 of different development levels and also for imports and exports. Also, we have checked if these results were still present at a more disaggregated level. For all the samples considered, the effect of strengthening IPRs varies across sub-sectors. For some of them the effect is not statistically significant; for others, the correlation is positive and significant; and finally, for most of the other sub-sectors, the coefficients turned out to be statistically significant and negative, meaning that, for most sub-sectors, 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 bilateral traded volumes (FE and PPML estimations), both considering the increase in IPRs of the importer and the exporter; and provided additional evidence regarding how IP protection affects the probability of finding new trading partners (Logit estimation). On this issue, when considering the IPRs of the exporter, the effect is negative for the cases of trade among developing countries. In the remaining cases, the effect is no significant. In addition, the effect of increasing IPRs of the importer has a positive effect on the probability of finding new trading partners for the full sample and the two samples that include developing countries (DC-LDC and LDC-LDC). This may imply that for exporting countries it may be beneficial that other countries increase their level of IPRs but negative to increase their own level of IPRs. This effect may be due to a reduced threat of imitation for the exporter, but also for a decrease in trade barriers in the importing countries given that the TRIPS were signed together with the WTO.

Regarding the intensive margin of trade, we found that, for the sample considering only developed countries, the effect of increasing IPRs on the exporter is expected to increase the average value of exports by sub-sectors but for the samples including developing countries (DC-LDC and LDC-LDC) we found that the effect of stronger IPRs is negative. For the extensive margin, we found that strengthening IPRs on the importer increases the number on sub-sectors with positive trade on the bilateral relation for all the samples. On the contrary, stronger IPRs were found to decrease the number of sub-sectors with positive trade in the bilateral relation for the samples involving developing countries (DC-LDC and LDC-LDC) and increase it for the sample restricted to developed countries.

Finally, the analysis at a more disaggregated sector level (2-digits), 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.

All in all, the effect of stronger IP protection for the importer and exporter may be contradictory. Also, the level of development of the trading country 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 effects of strengthening IPRs on trade and bilateral trade.

For the case of agricultural trade, our results clearly show that 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, this evidence allows 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.

References

Anderson, J. E. (1979). A theoretical foundation for the gravity equation. *American Economic Review 69*(1), 106–16.

Awokuse, T. O. and H. Yin (2010). Does stronger intellectual property rights protection induce more bilateral trade? Evidence from China's imports. *World Development 38*(8), 1094–1104.

Barro, R. J. and J. W. Lee (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics 104*, 184–198.

Bergstrand, J. H. (1985). The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics 67*(3), 474–81.

Berthou, A. and L. Fontagné (2008). The euro effects on the firm and product-level trade margins: Evidence from france. *Document de travail*, 2008–21.

Burger, M., F. v. Oort, and G. Linders (2009). On the specification of the gravity model of trade: Zeros, excess zeros and zero-inflated estimation. Research Paper ERS-2009-003-ORG Revision, Erasmus Research Institute of Management (ERIM).

Campi, M. and A. Nuvolari (2014). Intellectual property protection in plant varieties. a new worldwide index (1961-2011). *Research Policy* (in press), http://dx.doi.org/10.1016/j.respol.2014.11.003.

Co, C. Y. (2004). Do patent rights regimes matter? *Review of International Economics 12*(3), 359–373.

Delgado, M., M. Kyle, and A. M. McGahan (2013). Intellectual property protection and the geography of trade. *The Journal of Industrial Economics 61*(3), 733–762.

Dosi, G., L. Marengo, and C. Pasquali (2006). How much should society fuel the greed of innovators?: On the relations between appropriability, opportunities and rates of innovation. *Research Policy 35*(8), 1110–1121.

Dutt, P., I. Mihov, and T. Van Zandt (2011). Does wto matter for the extensive and the intensive margins of trade? *CEPR Discussion Paper no. dp8293*.

Eaton, D. J. (2009). Trade and intellectual property rights in the agricultural seed sector. Conference, August 16-22, 2009, Beijing, China, International Association of Agricultural Economists.

Falvey, R., N. Foster, and D. Greenaway (2009). Trade, imitative ability and intellectual property rights. *Review of World Economics 145*(3), 373–404.

Feenstra, Robert C., R. I. and M. P. Timmer (2013). The Next Generation of the Penn World Table, available for download at www.ggdc.net/pwt.

Fink, C. and C. A. Primo Braga (1999). *How stronger protection of intellectual* *property rights affects international trade flows.* World Bank, Science and Technology Thematic Group.

Foster, N. (2014). Intellectual property rights and the margins of international trade. *The Journal of International Trade & Economic Development 23*(1), 1–30.

Fratianni, M. (2009). The gravity model in international trade. In A. M. Rugman (Ed.), *The Oxford Handbook of International Business*. Oxford: Oxford University Press.

Galushko, V. (2012). Do stronger intellectual property rights promote seed exchange: evidence from us seed exports? *Agricultural Economics 43*(s1), 59–71.

Gaulier, G. and S. Zignago (2010). BACI: International Trade Database at the Product-Level. The 1994-2007 Version, Working Paper, CEPII research center, http://ideas.repec.org/p/cii/cepidt/2010-23.html .

Glick, R. and A. K. Rose (2002). Does a currency union affect trade? the time-series evidence. *European Economic Review 46*(6), 1125–1151.

Gould, D. M. and W. C. Gruben (1996). The role of intellectual property rights in economic growth. *Journal of Development Economics 48*(2), 323–350.

Grossman, G. M. and E. Helpman (1990). Trade, innovation, and growth. *American Economic Review 80*(2), 86–91.

Grossman, G. M. and E. L.-C. Lai (2004). International protection of intellectual property. *American Economic Review 94*(5), 1635–1653.

Helpman, E. (1993). Innovation, imitation, and intellectual property rights. *Econometrica 61*(6), 1247–80.

Ivus, O. (2010). Do stronger patent rights raise high-tech exports to the developing world? *Journal of International Economics 81*(1), 38–47.

Klenow, P. J. and D. Hummels (2005). The variety and quality of a nation's exports. *American Economic Review 95*(2), 704–723.

Lesser, W. (2001). The effects of TRIPS-mandated intellectual property rights on economic activities in developing countries. *World Intellectual Property Organization (WIPO) Studies 1*, 1–24.

Maskus, K. E. and M. Penubarti (1995). How trade-related are intellectual property rights? *Journal of International Economics 39*(3), 227–248.

Psacharopoulos, G. (1994). Returns to investment in education: A global update. *World Development 22*(9), 1325–1343.

Rose, A. (2004). Does the wto really increase trade. *American Economic Review 94*(1), 98–114.

Santos Silva, J. M. C. and S. Tenreyro (2006). The log of gravity. *The Review of Economics and Statistics 88*(4), 641–658.

Shin, W., K. Lee, and W. G. Park (2012). Export growth and the level of tehnology under intellectual property rights protection: a comparative analysis of developed and developing countries. Presented at the 13th International Convention of the East Asian Economic Association Grand Copthorne Waterfront Hotel Singapore Singapore, October 19-20.

Silva, J. S., S. Tenreyro, and K. Wei (2014). Estimating the extensive margin of trade. *Journal of International Economics 93*(1), 67 – 75.

Smith, P. J. (1999). Are weak patent rights a barrier to us exports? *Journal of International Economics 48*(1), 151–177.

Subramanian, A. and S.-J. Wei (2007). The WTO promotes trade, strongly but unevenly. *Journal of International Economics 72*(1), 151 – 175.

Tinbergen, J. (1962). *Shaping the World Economy: Suggestions for an International Economic Policy.* The Twentieth Century Fund.

Yang, C.-H. and R.-J. Woo (2006). Do stronger intellectual property rights induce more agricultural trade?: a dynamic panel data model applied to seed trade. *Agricultural Economics 35*(1), 91–101.

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; Vietnam

List of Agricultural Products

Table A.1: Agricultural Exports. Product Coverage

HS Classification	Number	Product
Chapters	1 to 24 (except 3 and 16)	
Section 6		
Code	2905.43	mannitol
Code	2905.44	sorbitol
Heading	33.01	essential oils
Headings	35.01 to 35.05	albuminoidal substances, modified starches, glues
Code	3809.1	finishing agents
Code	3823.6	sorbitol n.e.p.
Section 8		
Headings	41.01 to 41.03	hides and skins
Heading	43.01	raw furskins
Section 11		
Headings	50.01 to 50.03	raw silk and silk waste
Headings	51.01 to 51.03	wool and animal hair
Headings	52.01 to 52.03	raw cotton, waste and cotton carded or combed
Heading	53.01	raw flax
Heading	53.02	raw hemp

List of Variables

Table A.2: 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	Subramanian and Wei (2007)
pop	Country	Country population	CEPII (http://www.cepii.fr/)
IP Index	Country	Index of IP protection for plant varieties	Campi and Nuvolari (2014)
hc	Country	Index of human capital	Feenstra and Timmer (2013)
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/)