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Domestic Intellectual Property Rights Protection and the Margins of Bilateral Exports

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Abstract

How trade related is Intellectual property right (IPRs) protection? Extant studies examining the relationship between domestic Intellectual Property Rights (IPRs) protection and trade focus predominately on imports whilst neglecting exports. This paper focuses on the latter, further examining the effect of domestic IPRs on the margins of exports. Results from the study reveal that IPRs are trade-related and that it can be a tool for stimulating exports in both developed and developing countries. We also find that the level of IPRs in the exporting country matters more to the exporter than the level of IPRs in the importing country. Examining the different export margins, we obtain robust evidence suggesting that stronger IPRs in the exporter country works largely along the extensive margin, with coefficients on the intensive margin tending to be insignificant. We discuss the welfare and growth implications of these findings in the conclusion.

Keywords: Intellectual Property Rights (IPRs); Exports, Intensive and extensive margin

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1. Introduction

There has been a global trajectory towards stronger intellectual property rights (IPRs) protection since the agreement on Trade Related Aspect of Intellectual Property Rights (TRIPs) in 1994. Between the years 1990 and 2010 for instance, the level of IPRs increased by 33 percent in lower-income countries; 115 percent in lower-middle incomes countries; 91 percent in upper-middle income countries; and 24 percent in higher-income countries (Maskus, 2015). This trajectory towards more stringent IPRs has had mixed reactions among academics and policymakers. On the one hand, proponents of stronger IPRs argue that it increases the global rate of innovation and encourages technology transfer because it reduces the amount of imitation faced by innovators. Opponents of stronger IPRs on the other hand argue that innovation is cumulative and hence stronger IPRs only blocks innovation and increases economic inequality particularly by transferring rent from developing countries to developed countries. Moreover, they argue that it will reduce consumer welfare by enhancing the monopoly powers of innovators. These polarized views have given rise to an ongoing debate on the impacts of IPRs on variegated economic activities including its efficiency and equity gains given the different development stages of countries. Along this line, the extent to which the level of domestic IPRs determines the volume and composition of a country's imports has been extensively studied.

One of the underlying assumptions of studies on the import effect of IPRs is that technology is embodied in imports and the embodied technology can be perfectly protected through formal means of IPRs such as patents. In this case, an exporting country/firm is dis-incentivized to export to a country with weak IPRs. The empirical modelling strategy of these studies consists mostly of exporting developed countries and importing developing countries. Unwittingly, this thus symbolizes a verification of Article 66 of TRIPS which encourages technology transfer from developed to developing countries as a form of compensation to substitute imitation with more legitimate means of creating a viable technological base in developing countries (Yi & Naghavi, 2016). Although the forgoing discussion may suggest a linear relationship between the level of IPRs and imports, Maskus and Penubarti, (1995) argue otherwise, noting that how IPRs affects imports depends on two opposing forces: *"market-expansion"* and *"market-power"*. The market-expansion effect occurs when in response to an increase in the level of IPRs in a foreign market – and the reduced risk of imitation – an exporting firm increases its exports to that market. On the other hand, the market-power effect occurs when in a bid to make abnormal profit, an exporting firm reduces exports of its product to a foreign market that strengthens the level of IPRs. As it is theoretically ambiguous which effect dominates, empirical studies devoted towards shedding light on which factor dominates have found traces of both albeit market-expansion effects dominate when the importing country has high imitative capability (Smith, 1999; Falvey, Foster & Greenaway, 2009).

However, although the nexus between domestic IPRs and imports has been extensively studied, the relationship between domestic IPRs and exports has been neglected. Yang and Maskus (2009) remains the only study known to us with a theoretical treatment on how variations in the

level of domestic IPRs affect a country's exports. The study develops a theoretical model wherein strengthening domestic IPRs reduces the marginal cost of production by reducing technology transfer costs and ultimately, turns the country into an export platform after some adjustment periods. Beyond Yang and Maskus (2009) however, a literature has developed suggesting a link between domestic IPRs and exports. Among others, this includes studies suggesting that the level of domestic IPRs affects both the rate of innovation (Arrow, 1962; Chu & Puttitanum, 2005; Furukawa, 2010) and different sources of knowledge diffusion (Maskus & Penurberti, 1995; Yang & Maskus, 2001; Xu & Chiang, 2005; Yang & Maskus, 2009), which are found to determine the export performance of a country.[1] Moreover, if domestic IPRs affect different sources of technology inflows – i.e. trade, FDI and licensing – which has been the major interest of extant studies (Maskus & Penurberti, 1995; Yang & Maskus, 2001; Yang & Maskus, 2009) or the production capacity of the country (Helpman, 1993), the gains or banes of such effects should reflect on the country's level of industrial activities, including its exports. To the best of our knowledge only two studies – Delgado, Kyle and McGahan (2013) and Briggs and Park (2013) – have empirically examined the export effect of domestic IPRs. Among other things, Delgado, Kyle and McGahan (2013) examine the export effect of countries' compliance with the TRIPs agreement. Their study reports an increase in the exports of knowledge intensive goods for both developing and high-income countries that complied with the TRIPs agreement. Briggs and Park (2013) use micro level data of subsidiaries of US firms in 91 countries. Their study finds that exports of these subsidiaries respond positively to a tightening of patent rights in developed countries only.

The current study extends these earlier studies by employing a state-of-the art gravity model and different estimation strategies to assess the export effect of domestic IPRs. Moreover, our gravity model accounts for the importer's level of IPRs which extant studies found matters but that was not considered by both Delgado, Kyle and McGahan (2013) and Briggs and Park (2013). We also consider high- and low-IPRs-sensitive goods in order to account for the export of high IPR-sensitive goods being more susceptible to changes in the level of IPRs. Most importantly, we use a disaggregated product-level trade data to decompose the export effect of domestic IPRs along the extensive and intensive margins to underpin how IPRs affects exports. The justification for considering the two margins stems from heterogeneous firm trade models such as Chaney (2008) wherein trade policy changes not only affects how much that is traded of a certain good (i.e. intensive margin), but also affects the range of goods being traded (i.e. extensive margin). From a policy perspective, changes in the extensive and intensive export margins have different growth and welfare implications which further justifies studying them. On the one hand, increases in the variety of traded products (i.e. extensive margin) are assumed to be growth and welfare enhancing because they increase the market share of the exporter, diversify exports and protect against trade shocks, and reduce export earnings instability,

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[1] For studies on the export effect of innovation *see* Posner (1961), Vernon (1966), Krugman (1979), Dollar (1986), Lachenmaier & Wößmann (2006), Madssen (2008), Seker (2012), and Chen (2013). For studies on the export effect of inward FDI *see* Leichenko & Erickson (1997), Pain & Wakelin (1998), and Amighini & Sanfilippo (2014)

which in turn could increase investments by risk-averse firms and reduce macroeconomic uncertainty (Hummels & Klenow, 2005; Chen, 2013; Luong & Chen, 2016; Al-Marhubi, 2000; Hesse, 2008; Aditya & Acharya, 2013; Gozgor & Can, 2016). In addition, it is argued in the literature that expansion in the variety of traded products is associated with new techniques of production, new management, or marketing practices which can potentially benefit other industries through knowledge spillovers (Al-Marhubi, 2000; Hesse, 2008; Aditya & Acharya, 2013; Gozgor & Can, 2016). On the other hand, the growth and welfare effects of an increase in the intensive margin depend on whether they are driven by demand (quality) or production (costs) (Chen, 2013). As argued by Chen (2013), a demand driven increase in the intensive margin such as quality upgrading that simultaneously increases unit prices and export quantities will have a positive effect on welfare. However, an increase in the intensive margin that is driven by a fall in unit prices can lead to a deterioration in the terms of trade and possibly a negative effect on the welfare of exporters (p. 611). Along these lines, decomposing the export effect of domestic IPRs along the extensive and intensive margins not only enables us to underpin how IPRs affects exports but also determines the potential growth and welfare effects of IPRs by inducing exports.

To summarize our findings, we find that IPRs is indeed trade-related and that domestic IPRs can be a tool for stimulating exports in both developed and developing countries. Our result is therefore consistent with that of Delgado, Kyle and McGahan (2013) but differs from that of Briggs and Park (2013). We also find that the level of IPRs in the exporting country matters more for exports than the level of IPRs in the importing country. We argue that this finding may be due to the role domestic IPRs has on the fixed cost of organizing production (i.e. *what and how to produce*) in addition to influencing the decision of where to export since most countries (e.g. EU and USA) forbid the importation IPRs infringing goods. This is in contrast to IPRs in the importer which likely plays a stronger role in affecting the exporter's decision on how to serve the market. Examining the different export margins, we obtain robust evidence that IPRs in the exporter impact upon exports largely along the extensive margin, with effects along the intensive margin tending to be insignificant. More specifically, the results indicate that the extensive margin accounts for around 58-194 (84-204) percent increase in total manufacturing exports (high IPRs-sensitive goods exports) due to stronger IPRs. Our result therefore indicates a net positive export effect of IPRs that arises essentially through increases in new trading relationships at the product level.

The rest of the paper is organized as follows: Section 2 develops the hypotheses. Section 3 discusses the research methodology. Section 4 describes the data sources. Section 5 presents and discusses the results. Section 6 discusses the endogeneity issues while section 7 concludes.

2. Theory and Hypotheses Development

2.1. Domestic IPRs and Exports

Our theoretical arguments on the export effect of domestic IPRs draws inspiration from the product-cycle (Vernon, 1966; Krugman, 1979; Dollar, 1986) and the technology-gap (Posner, 1961) models of international trade. These models take innovation as exogenous and predict that innovation influences the export performance of a country. One of the explanations for this is that innovation serves as a source of firms' sustainable competitive advantage both domestically and abroad, which shifts outward a country's export demand curve. The theoretical conjectures of these models have been corroborated by copious empirical studies examining the export effect of innovation (Lachenmaier & Wößmann, 2006; Madssen, 2008; Seker, 2012; Chen, 2013; etc.). Along these lines, we would expect that the level of domestic IPRs affects exports through its effect on the rate of innovation which comes about by incentivizing the decision to invent and the commercialization of invented products (Mazzoleni & Nelson, 1998). The theoretical literature on how IPRs affects innovation remains hugely debated (Dosi, Marengo & Pasquali, 2006; Bessen & Maskin, 2009; Furukawa, 2010; Boldrin & Levine, 2010; Chu, Cozzi & Galli, 2012; Gangopadyay & Mondal, 2012). However, one of the stylized facts from this literature is that the effect of domestic IPRs on innovation varies with the type of innovation, the sector in which the innovation occurs, and a country's level of economic development. Relatedly, a deducible and testable hypothesis from this stream of research which we bring to the data in section 3 is that domestic IPRs matters more (i) in those sectors that are highly sensitive to IPRs compared to those that are less IPRs-sensitive (Mansfield, 1993), and (ii) in developed countries compared to developing countries (Chu & Puttitanum, 2005; Furukawa, 2010; Chu, Cozzi & Galli, 2014).

One of the reasons the effect of IPRs differs across sectors is because the Research and Development (R&D) investment cost required to innovate and the ease of imitability of such innovation substantially differs across sectors. In line with this, sectors will vary in the extent to which they depend on IPRs to recoup the cost of investment. It is often argued for example that firms in the pharmaceutical industry engage in large R&D investments and develop products that can be easily reverse engineered once launched onto the market. As a result it is expected that IPRs will matter more to this sector than to other sectors that do not rely on such an approach, such as the textiles sector for instance. The development argument is linked to the idea that the innovation capabilities of countries vary with their level of development. In this case, domestic IPRs should have a larger impact on developed countries' exports than those of developing countries for at least two reasons. First, the exports of developed countries compared to those of developing countries are more knowledge intensive and should therefore be more responsive to domestic IPRs changes. Second, developed countries have higher innovative capability than developing countries and stronger domestic IPRs should therefore encourage them to innovate more.

The level of domestic IPRs can also affect exports through its effect on different sources of knowledge inflow and technology diffusion (Javorcik, 2004; Xu & Chiang, 2005; Ivus, 2010). For instance, stronger IPRs can lead to FDI inflows, which in turn could increase production and lead to higher exports if FDI is intended to serve foreign markets. The FDI inflows associated with increased levels of IPRs can also reduce the marginal cost of production (Yang & Maskus, 2009) and expand the innovative capabilities (Khachoo & Sharma, 2016; Vahter, 2011; Gorodnichenko, 2015)[2] of domestic firms, thereby turning the IPRs reforming country into an export platform after some adjustment periods (Yang & Maskus, 2009). The underlying argument developed by Yang and Maskus (2009) is that whilst stronger domestic IPRs is commonly presumed to raise imitation costs and reduce access to knowledge (see for instance Helpman, 1993), it can also prevent technology masking (Vishwasrao, 1994) and reduce the costs of technology transfer to unaffiliated firms (Yang & Maskus, 2001) by allowing innovators to better appropriate the rents due to their invention. This inflow and sharing of knowledge will increase the innovative capability of domestic firms (He & Maskus, 2012) and may help facilitate exports. An exception to this argument is where technology traders (local or global) in a bid to gain monopoly profit exert *"market-power"* by limiting the transfer of (patented) technologies. More stringent IPRs provide innovators with greater market power in a country that may lead to monopoly behavior, with firms charging higher prices and reducing supply. In such a situation, the benefits of stronger IPRs mentioned above will be dampened and this may negate any export response. The combination of these different possible effects of stronger IPRs on knowledge inflows leads to an ambiguous effect of domestic IPRs on exports. We may however expect the effect of stronger domestic IPRs on exports to be positive (and/or larger) in high-income countries than in low-income countries. This is for a number of reasons. First, high-income countries are themselves innovators, meaning that they rely less on knowledge inflows and technology diffusion for exports. Second, market power effects are perhaps less likely in high-income countries because of the generally larger markets and the likely presence of domestic substitutes. In our analysis we are not able to adequately capture the impact of IPRs on technology inflows, focusing instead on the relationship between stronger IPRs and exports. We are thus unable to test some of the above relationships directly, but can examine whether the results we obtain are consistent with them.

2.2. IPRs and the Extensive and Intensive Export Margins

The international trade literature has shifted attention from a mere analysis of total trade (exports or imports) towards how trade is affected by examining the different trade margins. Copious reasons including the availability of disaggregated trade data and advances in the measurement of product variety explain this surge (Feenstra, 1994). Also, Chaney (2008) argues that it is ideal to decompose trade into the extensive and intensive margins in order to get a

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[2] Whilst we argue on a positive effect of FDI on innovation, it is imperative noting that some other studied find this effect to be negligible. See for instance Joel and Frank (2011) and Qu and Wei (2017).

clearer picture on how trade policy changes affect total trade. Along this line, Foster (2014) decomposes the imports of 109 developed and developing countries from 21 OECD countries into the extensive and intensive import margins and finds that the effect of domestic IPRs on imports is driven by a positive (negative) effect on the extensive (intensive) margin. We argue further that the level of domestic IPRs affects exports along the extensive and the intensive margins.

Drawing inspiration from the product cycle and technology-gap models of international trade wherein innovative firms dominate the export market (Krugman, 1979; Dollar, 1986) and the Melitz (2003)'s heterogeneous firm model wherein firms vary by productivity and only the more productive firms self-select into the export market, stringent IPRs affects the extensive and intensive export margins through its effect on production costs.[3] Consider a simple case of a monopolistically competitive market structure with firms that vary in their level of innovativeness and trade in differentiated products. Innovation evolves through two activities: blueprint R&D activities and the recombination of existing technologies.[4] Although these activities could occur at the same time, they are mutually exclusive such that innovation can evolve independent of existing technologies recombination. We assume that innovation in highly innovative firms mostly evolves through blueprint R&D activities whilst innovation in low innovative firms mostly evolves through a recombination of existing technologies. The firm's production cost function depends on autonomous R&D expenditures (which are incurred in blueprint R&D activities) and two exogenous factors: imitation costs and technology transfer costs (which are costs associated with the recombination of existing technologies). Other things equal, stringent IPRs raises firms' production cost by increasing the costs of imitation. This exerts a negative effect on the extensive export margin as it causes less innovative firms to exit the export market. This negative effect is however counteracted by a reduction in the technology transfer costs, and a fall in production costs: other things equal, an increase in the level of IPRs leads to a reduction in technology masking with firms being more open to transfer and share their technology as they are able to appropriate the rents due to their invention. This rise in knowledge and technology sharing would expand the exported varieties.[5] On the assumptions that; (i) stricter IPRs incentivizes R&D activities by increasing the expected returns; and (ii) firms' R&D activities expand product innovation, we also expect a net positive effect of effective IPRs on the extensive export margin by incentivizing blueprint R&D activities.

Besides the production cost channel discussed above, the level of IPRs can also affect the extensive export margin in a number of ways. First, as noted earlier, strengthening IPRs can

[3] See Mohnen and Hall (2013) for an extensive literature review documenting a positive correlation between innovation and productivity.

[4] Whilst firms can recombine only their old technologies to create a new product, we consider a case where it combines technologies from different firms or mixes them with its own technologies to create a new product.

[5] The implicit assumption here is that better knowledge is transferred under stronger IPRs regime. A validation for this claim is that in contrast to knowledge spillover, technology transfer is done under a formal contract setting hence a technology recipient can sue if a less efficient technology not contracted for is transferred.

increase inward FDI (or licensing or offshoring), which can lead to the production – and ultimately exports – of new products. Second, strengthening IPRs can lead to the expansion of existing varieties and/or the introduction of new varieties by incumbents in a bid to retain their market competitiveness or share. Third, strengthening IPRs can lead to the market entry of new firms with new products. New firm formation is a viable option for entrepreneurs to commercialize their innovation (Hamdan-Livramento & Forey, 2007) while the willingness to commercialize innovation depends on the ability to appropriate its value (Arrow 1962). As IPRs are a mechanism that facilitates the ability to appropriate value from ones' inventions, we expect it to encourage new firm formation and hence expand variety. A stringent IPRs regime also protects new firms from rival dominant large firms so that their intellectual assets are not unduly violated. In addition, it allows a new firm to compete with large, established firms on the basis of product differentiation rather than on the basis of costs (Shane, 2001). Third, in principle, strengthening domestic IPRs encourages the use of formal means of IPRs, such as patents. As this makes knowledge public, it eases learning for competitors and contributes to the expansion of existing products including to the pace of this process. Lastly, whilst weaker IPRs allow for copying, they also reduce variety in the export basket of the country since they cannot export such products, other things equal. The trade policy of the European Union and the USA, along with other countries that strongly enforces IPRs bans the importation of IPRs infringing goods into their respective regions.

How then does domestic IPRs affect the intensive export margin? Since stringent IPRs leads to the exit of (less innovative) firms or prevents different producers from producing the same type of a product (imitations), the average exported quantity falls, hence a fall in the intensive margin. However, stricter IPRs which improves product quality or reduces production cost will increase the intensive exports margin. Going back to our hypothetical example of a monopolistically competitive market structure, a decrease in the firm production cost due to a fall in technology transfer costs will raise export quantity of each firm with a reduction in the unit price. Second, higher levels of IPRs can also encourage firms to engage in quality differentiation in a bid to retain customer loyalties and/or retain market competitiveness. In addition, the increased knowledge inflows associated with stronger IPRs could also provide firms with the required knowledge and technologies to upgrade their products. In either case, these lead to a quality upgrade which works as a demand shifter that can simultaneously increase the export quantity and unit price. The forgoing therefore implies that the net effect of IPRs on the intensive export margins is ambiguous and hence, we leave it for data to decide in section 3. However, a net positive effect would imply that that the quality upgrade effect of IPRs dominates. On the other hand, a net statistically insignificant effect will mean that the negative effect associated with the exit of less innovative firms which bids down export quantities cancels out the positive effect associated with the quality upgrade.

3. Methodology

To estimate the exports effect of IPRs we employ the gravity model (GM) which has become the workhorse tool in the analysis of trade flows over the past 55 years. Although the typical GM predicts bilateral trade flows as a function of the economic sizes (often using GDP measurements) and distance (as a proxy for trade costs) between two units, the empirical specification of GM varies from study to study (Glick & Rose, 2002; Carrere, 2006; Baier & Bergstrand, 2007; Westerlund & Wilhelmsson, 2011; Dutt, Mihov & Zandt, 2013). For the current study therefore, we estimate a GM containing exporter and importer gross domestic products and a series of trade costs. We further augment the GM with variables for the exporter and importer IPRs. Against this backdrop, the starting point for our analysis is the following equation:

$$TF_{eit} = \beta_o + \tau_t + \beta_1 IPPE_{et} + \beta_2 IPPI_{it} + \beta_3 LGDP_{et} + \beta_4 LGDP_{it} + \gamma' Z_{ei} + \varepsilon_{eit} \qquad \dots (1)$$

where TF_{eit} is the value of exports from country e to country i in period t. β_o, ε_{eit}, and τ_t denote the intercept, the idiosyncratic error term, and time dummies, respectively. IPPE and IPPI are measures of exporter and importer IPRs, respectively. GDP_{et} and GDP_{it} are the exporter's and importer's gross domestic products and we expect β_3 and β_4 to be positive. $'Z_{ei}$ is a vector of trade costs which we capture using, bilateral distance (DIST); adjacency (CONTIG) which is a dummy and takes the value of one if the country-pair share a common border; Colony which is a dummy and takes the value of one if the country-pair has ever been in a colonial relationship; official common language (COMLAN) which is a dummy and takes the value one if the country-pair have the same official language; and FTA which is a dummy and takes the value of one for years in which the country-pair are both members of the same trade agreement. In estimating equation (1) however, four pertinent problems arise. They include multilateral resistance term (MRT), zero trade flows, heteroskedasticity, and endogeneity. We discuss how we address these in the subsequent paragraphs.

MRT are unobserved price indices which go beyond bilateral trade costs that influence trade. Put differently, they are barriers which each of countries e and i face in their trade with all their trading partners, including domestic or internal trade (Adam & Cobham, 2007). This is in contrast to bilateral trade resistance which is the size of the barriers to trade between countries e and i (Adam & Cobham, 2007; also see Anderson & van Wincoop, 2003). Different ways have been proposed in the literature on how to deal with this. Focusing on panel GM estimation, time-varying exporter and importer fixed effects and indicators of country's remoteness are often used to address the issue of MRT. Time-varying importer and exporter fixed effects however make estimation difficult to achieve particularly as the number of countries and time periods increases. Moreover, the approach negates the inclusion of time-varying country-specific variables alongside the time-varying exporter and importer fixed effects. It goes without saying that the policy variable of interest here, the level IPRs, varies both across space and time implying that using time-varying importer and exporter fixed effects will make it

impossible to estimate the effects of IPRs on exports. The use of a remoteness index has been criticized on the premise that it bears little resemblance to their theoretical counterpart (Head & Mayer, 2013). In a recent paper however, Baier and Bergstrand (2009) propose a linear approximation of the MRT, which results in a reduced form gravity equation that can be estimated by Ordinary Least Squares (OLS). In their approach, the average trade costs of all countries are subtracted from the sum of the average trade costs of the two countries. Consequently, a crucial advantage of this approach is that it is computationally friendlier as it only requires adjusting the set of variables capturing bilateral trade costs in order to account for MRT. We adopt this approach in dealing with MRT hence each element in the vector of trade costs in equation (1) is calculated as follow:

$$logDIST^{*}_{ei} = logDIST_{ei} - \sum_{e} \theta_e \, logDIST_{ei} - \sum_{i} \theta_i \, logDIST_{ei} + \sum_{e}\sum_{i} \theta_e \theta_i \, logDIST_{ei} \quad \ldots (2)$$

$$CONTIG^{*}_{ei} = CONTIG_{ei} - \sum_{e} \theta_e \, CONTIG_{ei} - \sum_{i} \theta_i \, CONTIG_{ei} + \sum_{e}\sum_{i} \theta_e \theta_i \, CONTIG_{ei} \quad \ldots (3)$$

$$COMLAN^{*}_{ei} = COMLAN_{ei} - \sum_{e} \theta_e \, COMLAN_{ei} - \sum_{i} \theta_i \, COMLAN_{ei} + \sum_{e}\sum_{i} \theta_e \theta_i \, COMLAN_{ei} \quad \ldots (4)$$

$$FTA^{*}_{ei} = FTA_{ei} - \sum_{e} \theta_e \, FTA_{ei} - \sum_{i} \theta_i \, FTA_{ei} + \sum_{e}\sum_{i} \theta_e \theta_i \, FTA_{ei} \quad \ldots (5)$$

Where θ are the geometric GDP-shares.

Zero bilateral trade flows are commonly observed when using GM. In our case this accounts for approximately 34 percent of the dyad trade links (see figure 1). One of the popular ways this has been dealt with in the literature is truncating the sample by dropping the observation with zero trade flows and estimating a log-linear version of equation (1) with OLS.[6] This approach can only be considered an appropriate solution if the zeroes are randomly distributed however. If this is not the case, throwing away zero observations can lead to the omission of important pieces of information. Santos and Tenreyro (2006) in a very influential paper proposed the Poisson-Pseudo Maximum likelihood (PPML) estimator which can be applied to unlogged trade data and delivers parameter estimates that are consistent under very general conditions. Interestingly, the estimates are also interpreted as elasticities as in OLS. As the trade variables are estimated in levels, we are also able to properly account for the zero trade flows. Moreover, the PPML method has the added advantage that it solves the problem of heteroskedasticity that is pervasive in trade data and which OLS and other estimators that require non-linear transformations fails to take care of. Premised on these, our analysis gives precedence to this method.[7]

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[6]For a more discussion on this see *https://www.wto.org/english/res_e/publications_e/wto_unctad12_e.pdf*.

[7]An alternative to this approach would be the 2-Stage modified Heckman selection model proposed by Helpman, Melitz & Rubinstein (2008). The assumptions of this approach have however come under strict criticism in the literature

Like most other econometric models, our specification in equation (1) is laden with omitted variables, which poses endogeneity problem when any of the omitted variables is correlated with the regressors. To address some of these problems, studies such as Baldwin and Taglioni (2006) suggest using country-pair dummies – i.e. the standard within-groups fixed effects estimator in the case of a panel data since a panel comprises time series for every pair's trade (p. 11). Although the gains for preferring this approach over OLS is widely acknowledged in the literature (e.g. see Glick & Rose, 2002; Carrere, 2006; Baier & Bergstrand, 2007), the approach does not solve the problem of heteroskedasticity that is pervasive in trade data. Along this line, Westerlund and Fredrik (2009) suggest using the Poisson fixed effects estimator. Consequently, in addition to the PPML, our analysis shall give precedence to the Poisson fixed effects (PPMPE) estimators. Lastly, we are not ignorant that the fixed-effects estimators only controls for omitted time-invariant factors. We reserve further discussion on this for section 5.4 where we introduce an instrumental variable approach developed by Rigobon (2003), Lewbel (2012) and Baum et al. (2013).

4. Data

The empirical analysis uses the Ginarte and Park patent right index (hereafter, GPI) as a measure of the strength of IPRs. The index was developed in 1997 by J. Ginarte and W. Park and has since been used extensively in the literature as a common cross-country measure of the degree of IPRs. The index is an un-weighted sum of five categories of national patent right laws including; (i) Extent of coverage; (ii) Membership in international patent agreements; (iii) Provisions for loss of protection; (iv) Enforcement mechanisms; and (v) Duration of protection (see Ginarte & Park, 1997). The data is available for 122 countries from 1960 to 2010. From this, it goes without saying that the index only captures patent rights. Notwithstanding this, studies that have explored other dimensions of IPRs such as trademarks and copyrights generally find patent rights to matter most (Park & Lippoldt 2008). We extract a sample of 115 developed and developing countries for which we have corresponding gravity model variables. A further drawback of the GPI is that it is a *de jure* and not a *de facto* measure. While this may not pose a problem for developed countries, it may be a concern for the developing countries in our sample as the latter are often characterized by strong IPR policies but weak enforcement. Notwithstanding this, one cannot understate the fact that it can also offer veritable insights as laws must first exist in books before they are implemented.

Our gravity model variables including, Dist (Bilateral Distance), CONTIG (Common Border), Colonial dummy; and COMMLAN (Common Official Language) are taken from the CEPII database, while GDP (Gross Domestic Product) is taken from the World Development Indicator

(Santos-Silva & Tenreyro, 2008). Moreover, the PPML has the added-advantage of solving the problem of heteroskedasticity that is pervasive in trade data.

(WDI) database.[8] The trade data is extracted from the UN COMTRADE database. As we are interested in data at the aggregate, sectoral, and product level – the latter used to construct the margins – the trade data is extracted at the Harmonized System (HS) 6-digit level of disaggregation from COMTRADE. The HS-classification only started in 1988 and is biased towards developed countries as they were the first to adopt it. To minimize this bias, the time period of our data starts from the year 1990 to 2010. As the HS classification has changed over time, we first use different concordance tables[9] to convert all the data to HS-0 classification to further minimize bias. To minimize zero trade flows, we adopt the mirror approach whereby we look at both the exporter and importer side to infer bilateral exports. To classify HS-0 products into high and low IPRs sensitive sectors, we follow Dalgado, Kyle and McGahan (2013) classification.

The trade margins have been defined in variegated ways (Evenett & Venables, 2002; Hummels & Klenow, 2005; Felbermayr & Kohler, 2006; Eaton et al. 2007; Helpman, Melitz & Rubinstein, 2008; Amiti & Freund, 2010; Dutt, Mihov & Zandt, 2013; Kehoe & Ruhl, 2013). Here, we follow Dutt, Mihov & Zandt (2013) to define the extensive export margins as a simple count of the number $N_{ei,t}^{HSO}$ of HS-0 products exported from e to i in period t. The intensive margin, $\bar{x}_{ei,t} = TE_{ei,t}^{HSO}/N_{ei,t}^{HSO}$, is the average value of exports per product traded. The total export $TE_{ei,t}^{HSO}$, is therefore given as the product of both margins:

$$TE_{ei,t}^{HSO} = \bar{x}_{ei,t} * N_{ei,t}^{HSO} \qquad \dots (6)$$

Equation (6) suggests that the construction of both margins follows a linear decomposition such that if both margins are in logs, any linear operator should give estimates which when summed will add-up to the corresponding estimate for total exports.

Before proceeding to the empirical analysis, table 1 displays the summary statistics of the dependent and explanatory variables. Most important is panel B which displays the level of domestic IPRs across the different exporter income groups. We observe interesting patterns. The mean, and maximum level of IPRs all increase simultaneously as we move from the low to the high-income group thereby suggesting that developed countries tend to adopt higher IPRs relative to developing countries. Since an important component of our analysis is the development stage-dependent export effect of IPRs, it only makes sense to understand the distribution of trade flows and level of IPRs adoption across different development levels. To this end, we use the World Bank classification to classify countries into three income groups as a proxy for the level of economic development. Figure 1 shows that the number of observed zero trade flows decreases as we move from the lower-income group (45 percent) to the high-income group (10 percent). This is expected as it can be safely argued that the economies of developed countries are more diversified and hence they are more likely to have positive trade with

[8] Available at *http://www.cepii.fr*

[9] Available at *https://wits.worldbank.org/product_concordance.html*

different countries in contrast to developing countries that trade in fewer products and hence have fewer trade partners.

Table 1: Summary Statistics

	No. of Observation	Mean	Standard Deviation	Minimum	Maximum
Panel A = Full Sample Descriptive Statistics					
Total Exports	65,550	4.29E+08	3.78E+09	0	2.15E+11
Extensive Margin	65,550	324.0772	707.3732	0	4308
Intensive Margin	65,550	344815.4	2157157	0	1.83E+08
log Total Exports	46,826	15.306	3.978	0	26.092
Log Extensive Margin	46,826	4.156	2.379	0	8.368
Log Intensive Margin	46,826	11.149	2.125	0	19.026
logGDP	65,550	24.317	2.179	18.719	30.336
Per Capita GDP	65,550	9355.064	14592.91	64.810	102857
FTA	65,550	0.100	0.300	0	1
Common Language	65,550	0.164	0.3708	0	1
Common Border	65,550	0.026	0.160	0	1
Log Distance	65,550	8.703	0.757	4.741	9.885
Colony	65,550	0.170	0.129	0	1
IPR Index	65,550	2.828	1.110	0	4.875
Panel B = IPRs Across Income Groups					
Low-Income	23,256	2.062	0.767	0	3.758
Middle-Income	26,334	2.732	0.890	0	4.475
High-Income	15,960	4.105	0.632	1.667	4.875

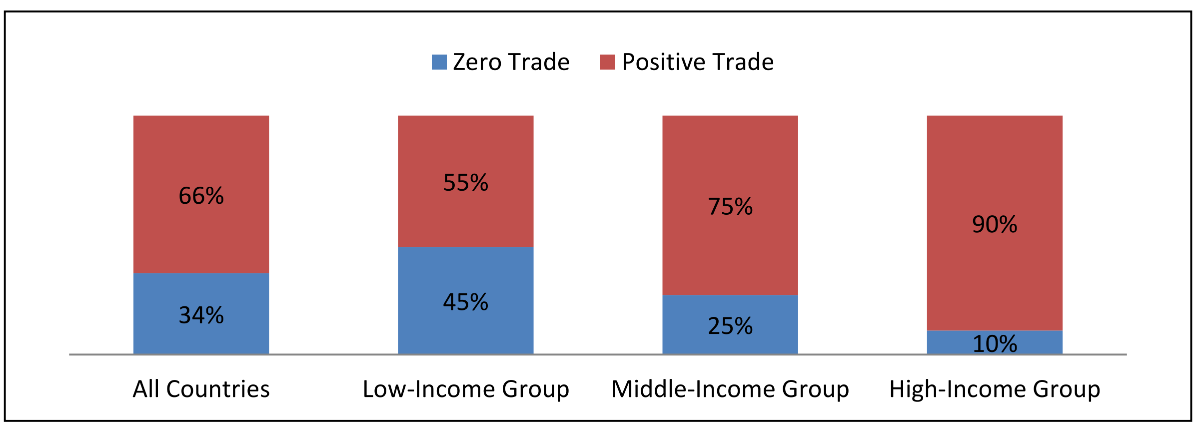

Figure 1: Bilateral Trade Flows and Income Levels

Table 2: The Effect of Domestic IPRs on Exports

	Panel A				Panel B							
	Total Exports				Extensive Margin				Intensive Margin			
	OLS	FEM	PPML	PPMPE	OLS	FEM	PPML	PPMPE	OLS	FEM	PPML	PPMPE
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
IPPE	0.547***	0.307***	0.176***	0.321***	0.473***	0.225***	0.342***	0.188***	0.074***	0.082***	-0.158***	0.024
	[0.020]	[0.023]	[0.053]	[0.035]	[0.013]	[0.013]	[0.015]	[0.014]	[0.014]	[0.020]	[0.035]	[0.072]
IPPI	0.259***	0.134***	0.151***	0.148***	0.293***	0.145***	0.104***	0.063***	-0.034**	-0.011	-0.077	-0.123
	[0.021]	[0.023]	[0.034]	[0.041]	[0.013]	[0.013]	[0.014]	[0.014]	[0.014]	[0.019]	[0.049]	[0.084]
LGDPE	1.162***	0.516***	0.756***	0.554***	0.689***	0.273***	0.442***	0.268***	0.473***	0.243***	0.292***	0.222
	[0.010]	[0.039]	[0.027]	[0.060]	[0.006]	[0.019]	[0.008]	[0.018]	[0.007]	[0.033]	[0.024]	[0.142]
LGDPI	0.783***	0.626***	0.713***	0.712***	0.340***	0.320***	0.237***	0.213***	0.443***	0.307***	0.465***	0.215***
	[0.010]	[0.033]	[0.023]	[0.046]	[0.006]	[0.017]	[0.007]	[0.016]	[0.007]	[0.028]	[0.032]	[0.079]
FTA	0.439***	0.066*	0.336***	-0.070	0.143***	-0.137***	0.255***	0.020	0.296***	0.203***	0.302***	0.202**
	[0.058]	[0.038]	[0.080]	[0.058]	[0.037]	[0.024]	[0.046]	[0.022]	[0.038]	[0.033]	[0.079]	[0.080]
LDIST	-1.391***		-0.802***		-0.876***		-0.483***		-0.515***		-0.238***	
	[0.034]		[0.045]		[0.022]		[0.034]		[0.021]		[0.051]	
CONTIG	0.929***		0.321***		0.507***		-0.121		0.422***		0.703***	
	[0.112]		[0.081]		[0.086]		[0.080]		[0.061]		[0.142]	
COLONY	0.687***		-0.217		0.540***		0.274***		0.147**		-0.016	
	[0.121]		[0.133]		[0.085]		[0.097]		[0.071]		[0.099]	
COMLAN	0.759***		0.464***		0.645***		0.347***		0.114***		-0.040	
	[0.059]		[0.094]		[0.037]		[0.041]		[0.039]		[0.123]	
Observations	46,826	46,826	65,550	61,760	46,826	46,826	65,550	61,760	46,826	46,826	65,550	61,760
R-squared	0.695	0.259	0.755	-	0.712	0.438	0.601	-	0.416	0.051	0.141	-
Clusters	12352	12352	13110	12,352	12352	12352	13110	12,352	12352	12352	13110	12,352

**** p<0.01, ** p<0.05, * p<0.10. Clustered standard errors in parenthesis. All models include year fixed-effects. OLS = Ordinary Least Squares; FEM = Fixed-Effect Model; PPML= Poisson Pseudo Maximum Likelihood; PPMPE = PPML with Country Pair-Effect; IPPE = Exporter IPRs; IPPI = Importer IPRs; LGDPE = log Exporter GDP; LGDPI = log Importer GDP; FTA = 1 if pair are in the same trade agreement; LDIST = log Bilateral Distance; CONTIG=Contiguity; COLONY = 1 if pair has ever being in a colonial relationship; COMLAN = Common Official Language*

5. Results and Discussions

This section proceeds in three steps including presenting and discussing the results for the (i) full sample; (ii) high and low IPRs-sensitive goods exports; and (iii) the different income groups.

5.1. IPRs and Exports – Full Sample

Table 2 displays the results on the export effect of IPRs for the full sample. Panel A displays the result for the effect of IPRs on total exports. Mode1 (1) emerges from an OLS regression with year fixed-effects and trade-costs adjusted for MRT as described in section 3. Model (2) emerges when we add country pair fixed-effects to the specification in Model (1) to account for pair-specific non-time-varying characteristics. Model (3) contains results when we implement the PPML without country pair fixed-effects. Models (4) emerges when we implement the PPML with country pair fixed-effects i.e. Poisson fixed-effect. For reasons discussed in section 3, models estimated with PPML are our preferred model specification. Notwithstanding this, when considering the IPRs of the exporter we observe a robust statistically significant positive coefficient across the different models. Other things equal, the results therefore suggest that strengthening domestic IPRs increases bilateral export flows. More specifically, the results from the preferred model specifications indicate that a unit increase in the level of IPR protection boots exports by about 18-32 percent. This estimate is largely different from the 96 percent increase in exports obtained by Briggs and Park (2013) which may be explained by the fact that we do not log the IPR index as in Brigg and Park (2013). Specifically, whereas Brigg and Park (2013) estimate is an elasticity, ours is a semi-elasticity. Consistent with Maskus and Penurbarti (1995), Ivus (2010) and Foster (2014), we also observe that total exports are sensitive to the IPRs of the importer. Interestingly, the sizes of the importer IPRs coefficients in Model (3) and (4) are largely similar to the Poisson estimates – i.e., 0.14 – 0.15 – obtained in Foster (2014). The OLS and FEM estimates for the importer IPRs are also within the intervals obtained by Falvey, Foster and Greenaway (2009) and Foster (2014). Now, notice that across each model presented in the panel, there are differences in the size of the estimates for the exporter's and importer's level of IPRs with that of the former being around twice as large, on average. Indeed, the hypothesis that the coefficients on IPRs for the exporter and importer are equal is rejected at the 1 percent significant level. This suggests that domestic IPRs matters more to the exporter, than the level of IPRs in the importing country. The prior literature has predominantly focused on the sensitivity of export flows to IPRs in the importing country (e.g. Maskus & Penurbarti, 1995; Smith, 1999; Falvey, Foster & Greenaway, 2009; Ivus, 2010; Foster, 2014) whilst the only study that comes close to ours, Briggs and Park (2013), focused only on the exporter's IPRs. Our finding thus provides the first piece of evidence that exporters are more sensitive to the level of IPRs in their country than in the importers. A plausible explanation for this is whilst exporters' own IPRs

affects its decision to produce and export (*i.e. what and how to produce and where to export*),[10] the importer's IPRs only affects the exporter's decision to export to that market (*i.e. where to export*). An exception to this latter argument would be where the size of the exporting country is small i.e. low domestic absorption capacity. In that case, producers produce mostly to serve the external market than the domestic market and are therefore *more* vulnerable to external policy dynamics.

Regarding our control variables, across each specified model in panel A we obtain coefficients that are in line with their a priori expected signs where statistically significant. Particularly, we obtain robust statistically significant positive coefficients on both the exporter and importer GDPs and a negative coefficient for bilateral distance. This suggests that bilateral trade between country pairs increases (decreases) with their country sizes (bilateral distances) as mirrored by the signs of GDPs (distance) coefficients. The coefficients for FTA and colony are positive where statistically significant implying that being part of trade agreement or having colonial ties increases bilateral trade. The positively signed coefficients for COMLAN and CONTIG indicate that trade between bilateral pair increases if they share an official language (COMLAN) and if they are adjacent to each other (CONTIG), consistent with existing results in the literature.

In Panel B, we decompose the aggregate export effect of our regressors observed in Panel A along the extensive and intensive margins. The definition of each estimated model follows the corresponding model in Panel A. As described in section 4, given that OLS is a linear operator the coefficients for a particular variable along the intensive and extensive margin should sum up to the corresponding coefficient for total exports. This conjecture is corroborated as summing Models (6) and (9) add up to the corresponding coefficients in Model (3).

For the extensive export margin, we observe a robust statistically significant positive effect of exporter IPRs across all estimated models. The results indicate that a unit increase in the level of IPRs boosts exports along the extensive margin by 19-34 percent which accounts for about 58-194 percent increase in total exports. This result corroborates our conjecture in section 2 that stricter exporter IPRs increases exports along the extensive margins. For the intensive margin however, we obtain somewhat mixed results. The coefficient is positive and statistically significant in Models (9) and (10), but in Model (11) it turns negative and is statistically significant whilst in Model (12) it loses its significance and becomes positive. These mixed results particularly in models (11) and (12) which are our preferred specifications suggest that exporter's IPRs either does not affect exports along the intensive margin or that its effect along this margin is unsystematic. Comparing the sizes of the coefficients for the exporter IPRs effect on the extensive and intensive margins we find that those of the extensive margin are consistently higher. This is unsurprising given that coefficients along the extensive margin are significant, while those along the intensive margin are insignificant. The results therefore

[10] For instance, a patent system can give precedence over process than product innovation and vice versa. A system that gives precedence over both will affect firms' decision on what and how to produce.

suggest that the extensive margin is more responsive to changes in domestic IPRs. Put differently, the effect of exporter's IPRs works mostly through the extensive export margin.

The trade literature is yet unsettled on which margin actually drives export growth. While some studies emphasize the intensive margin (Felbermayr & Kohler, 2006; Eaton et al. 2007; Helpman, Melitz & Rubinstein, 2008), others emphasize the extensive margin (Evenett & Venables, 2002; Hummels & Klenow, 2005; Amiti & Freund, 2010). To the extent that the arguments and findings of studies which advocate the extensive margin hold, our finding that stricter exporter IPRs increases exports *mostly* along the extensive margin has important economic implications. For instance, Romer (1994)'s theoretical model emphasizes the importance of product variety in order to realize growth and welfare gains of trade. In addition, Feenstra and Kee (2008) find in a sample of 48 countries that within the period 1980-2000, the total increase in export variety accounted for a 3.3 percent average productivity improvement for the exporter. Our results suggest that higher exporter IPRs increases the extensive export margin, and thus underpins a policy tool which can be used to achieve product diversification in order to realize the growth and welfare gains of trade including improving exporters' productivity.

For importer's IPRs, we observe a positive (negative) effect of IPRs on the extensive (intensive) margin. The coefficients for the intensive margin are however not statistically significant for the preferred model specifications thereby suggesting that the effect of importer IPRs on exports works mostly along the extensive margin. Quantitatively, these results for the importer IPRs are in line with Foster (2014) although in our case the negative effects of importer IPRs along the intensive margin are statistically insignificant. The results from the preferred model specifications however indicate that the extensive margin accounts for around 43-69 percent increase in exports due to stronger importer IPRs which is considerably lower than the 128 percent increase obtained by Foster (2014) who uses OLS and fixed-effect estimators. Interestingly, the results from the fixed-effect estimator (i.e. Model 6) indicate that the extensive margin accounts for around 108 percent which is much closer to that of Foster (2014). Among other things, this huge difference in parameter estimates suggests that we may be over-estimating the effect of IPRs on trade when we fail to account for zero trade flows. The current results further update the findings of Foster (2014) in three ways. First, whereas his sample comprises 21 OECD exporters and 109 importers that are both developing and developed countries, our sample include 115 exporters and importers that are both developed and developing countries, respectively. Second, his study uses 4 digits SITC2 classification to construct the import margins unlike the current study which uses 6 digits HS-0 classification meaning that we cover more product categories. Third, the current study uses more recent data. Our result of a robust positive effect of importers IPRs on total exports which works largely along extensive margin has also important growth and welfare implication for the importing country. The new growth model such as Romer (1990) emphasizes product variety as a source

of growth.[11] In a similar fashion, trade models such as Dixit and Stiglitz (1977) emphasizes product diversity over quantity as welfare-enhancing. Along this line, our results thus indicate that the level of importer IPRs are a growth and welfare increasing tool in the importing country. This argument is consistent with empirical studies which find a net positive effect of IPRs on economic growth (Gould & Gruben, 1996; Falvey, Foster, & Greenaway, 2006). It is also consistent with Saggi (2013) hypothesis that for TRIPs enforcement to increase global welfare it is imperative that developed countries' firms respond to such enforcement by selling more products in developing countries (Saggi, 2013 p.24). Lastly, given the statistically significant positive coefficient for the extensive margin and a statistically insignificant coefficient for the intensive margin, the results indicate the dominance of market expansion. This is in contrast to Foster (2014) which finds a statistically significant positive coefficient for the extensive margin and a statistically significant negative coefficient for the intensive margin, thereby suggesting that both market expansion (at the extensive margin) and market power (at the intensive margin) effects are in evidence.

Regarding our control variables, across each specified model in panel B, we obtain coefficients that are in line with their a-priori expected signs where statistically significant. The exception is the coefficient for FTA in model (6).

[11] Indeed, Maskus & Penurberti (1995) argues that the question on the effect of IPRs on trade is a single component of larger normative questions concerning the impact of IPRs on economic growth.

Table 3: Heterogeneous Effect of Exporter IPRs on the Export of High – and Low IPRs-Sensitive Goods

	Panel A						Panel B					
	High-IPRs Sensitive Goods						Low-IPRs Sensitive Goods					
	Total Exports		Extensive Margin		Intensive Margin		Total Exports		Extensive Margin		Intensive Margin	
	PPML	PPMPE	PPML	PPMPE	PPML	PPMPE	PPML	PPMPE	PPML	PPMPE	PPML	PPMPE
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
IPPE	0.180***	0.251***	0.371***	0.212***	-0.268***	0.082	-0.060	0.236***	0.267***	0.185***	-0.442***	0.027
	[0.037]	[0.032]	[0.018]	[0.016]	[0.041]	[0.073]	[0.039]	[0.035]	[0.016]	[0.015]	[0.047]	[0.079]
IPPI	0.027	0.167***	0.023	0.041***	-0.085	-0.152*	0.063**	0.045	0.115***	0.071***	-0.101*	-0.027
	[0.033]	[0.035]	[0.017]	[0.014]	[0.053]	[0.087]	[0.030]	[0.031]	[0.016]	[0.015]	[0.054]	[0.079]
LGDPE	0.655***	0.448***	0.487***	0.268***	0.226***	0.311***	0.674***	0.369***	0.466***	0.242***	0.281***	0.237*
	[0.020]	[0.048]	[0.011]	[0.020]	[0.020]	[0.101]	[0.021]	[0.050]	[0.009]	[0.019]	[0.024]	[0.136]
LGDPI	0.706***	0.544***	0.284***	0.201***	0.493***	0.281***	0.656***	0.691***	0.255***	0.238***	0.480***	0.285***
	[0.018]	[0.046]	[0.009]	[0.017]	[0.024]	[0.078]	[0.017]	[0.054]	[0.008]	[0.018]	[0.032]	[0.084]
FTA	0.341***	-0.030	0.327***	0.011	0.266**	0.037	0.310***	0.006	0.320***	0.023	0.356***	-0.090
	[0.083]	[0.048]	[0.056]	[0.023]	[0.109]	[0.091]	[0.074]	[0.068]	[0.052]	[0.023]	[0.107]	[0.086]
LDIST	-0.877***		-0.582***		-0.106*		-0.939***		-0.565***		-0.131**	
	[0.050]		[0.040]		[0.058]		[0.039]		[0.038]		[0.061]	
CONTIG	0.239***		-0.090		0.278**		0.423***		-0.116		0.398**	
	[0.082]		[0.090]		[0.123]		[0.083]		[0.084]		[0.160]	
COLONY	-0.124		0.242**		0.264*		-0.083		0.288***		0.029	
	[0.134]		[0.113]		[0.142]		[0.140]		[0.111]		[0.117]	
COMLAN	0.477***		0.356***		0.009		0.376***		0.342***		0.048	
	[0.088]		[0.049]		[0.123]		[0.087]		[0.045]		[0.141]	
Observations	65,550	55,240	65,550	55,240	65,550	55,240	65,550	56,020	65,550	56,020	65,550	56,020
R-squared	0.787	-	0.584	-	0.057	-	0.750	-	0.578	-	0.045	-
Clusters	13110	11,048	13110	11,048	13110	11,048	13110	11,204	13110	11,204	13110	11,204

**** p<0.01, ** p<0.05, * p<0.10. Clustered standard errors in parenthesis. All models include year fixed-effects. PPML= Poisson Pseudo Maximum Likelihood; PPMPE = PPML with Country Pair-Effect; IPPE = Exporter IPRs; IPPI = Importer IPRs; LGDPE = log Exporter GDP; LGDPI = log Importer GDP; FTA = 1 if pair are in the same trade agreement; LDIST = log Bilateral Distance; CONTIG=Contiguity; COLONY = 1 if pair has ever being in a colonial relationship; COMLAN = Common Official Language*

5.2. *IPRs and the Export of High and Low IPRs-Sensitive Goods*

Table 3 displays the results for the heterogeneous effect of IPRs on the exports of high- and low IPRs-sensitive goods, respectively. For reasons of brevity we focus only on results using PPML with and without country pair fixed-effects. The conclusions we reach are however robust to other methods adopted in the case of the full sample. In Panel A, we obtain robust and statistically significant evidence that stricter exporter IPRs increase exports of high IPRs-sensitive goods. The coefficients on the IPRs variable are elasticities of exports of high-IPRs sensitive goods with respect to the level of IPRs. Our result thus suggests that a unit increase in the strength of IPRs in the exporting country increases the export of high IPRs-sensitive goods by 18-25 percent. We also observe that having stronger IPRs increases the import of high IPRs-sensitive goods although this evidence is statistically significant only when we subject our data to PPML with pair fixed-effects. Decomposing this total effect along the different margins, we obtain results that do not qualitatively differ from those observed in table 2. Particularly, for IPRs of the exporter we observe a robust and statistically significant positive effect on the extensive margin and somewhat mixed results at the intensive margin. The results for the extensive margin indicate that a unit increase in the level of IPRs boots exports of IPRs-sensitive goods along the extensive margin by 21-37 percent which accounts for about 84-204 percent increase in total exports of IPRs-sensitive goods. Comparing the absolute values of the coefficients for the extensive and intensive export margins, they suggest that the effect of IPRs in the exporter is concentrated at the extensive export margin. For the level of IPRs in the importer we observe a positive (negative) effect on the extensive (intensive) margin although the result is only statistically significant when we subject our data to PPML with pair fixed-effect.

In Panel B, we obtain an ambiguous effect of exporter IPRs for the total export of low IPRs-sensitive goods: the coefficient is negative although statistically insignificant in Model (7) and turns positive and statistically significant in Model (8). Again, these mixed results suggest that either IPRs does not affect exports of low IPRs-sensitive goods or it does so in an unsystematic way. Notwithstanding this, we decompose total exports into the respective two margins. Doing so, we observe that the ambiguous effect arises from the intensive margin as we obtain consistent evidence that exporter IPRs exert a positive effect on the extensive export margin of low IPRs-sensitive goods. For importer IPRs we obtain a consistent positive effect on total exports and the extensive margin, and a negative effect on the intensive margin of low IPRs-sensitive goods, respectively.

Since we only obtain an unambiguous effect of exporter IPRs on the two types of goods along the extensive margin, it suggests that any heterogeneous effect of exporter IPRs should be assessed through that margin. Along this line, comparing the magnitude of the impact of exporter IPRs on the extensive margins of both types of goods, we observe that high-IPRs sensitive goods are more responsive to changes in the level of domestic IPRs. This thus corroborates our conjecture in section 2 that IPRs matters more in those sectors that highly IPRs-sensitive sector. For our control variables, they all meet their a priori expected signs where statistically significant.

Table 4: Domestic IPRs and the Exports of Different Income Groups

	Total Exports		Extensive Margin		Intensive Margin	
	PPML	PPMPE	PPML	PPMPE	PPML	PPMPE
	[1]	[2]	[3]	[4]	[5]	[6]
IPPE1	0.329***	0.372***	0.321***	0.420***	-0.128*	0.181***
	[0.081]	[0.044]	[0.021]	[0.014]	[0.068]	[0.062]
IPPE2	0.321***	0.436***	0.335***	0.390***	-0.153***	0.152**
	[0.047]	[0.034]	[0.017]	[0.013]	[0.044]	[0.074]
IPPE3	0.260***	0.458***	0.337***	0.370***	-0.155***	0.182**
	[0.034]	[0.036]	[0.014]	[0.013]	[0.038]	[0.085]
IPPI	0.156***	0.274***	0.104***	0.255***	-0.077	-0.004
	[0.034]	[0.030]	[0.014]	[0.013]	[0.049]	[0.066]
LGDPE	0.753***	0.292***	0.441***	0.136***	0.296***	0.328**
	[0.025]	[0.057]	[0.009]	[0.015]	[0.023]	[0.140]
LGDPI	0.712***	0.492***	0.237***	0.100***	0.465***	0.332***
	[0.022]	[0.051]	[0.007]	[0.012]	[0.032]	[0.084]
FTA	0.337***	-0.059	0.254***	-0.022	0.306***	0.113
	[0.079]	[0.075]	[0.046]	[0.024]	[0.078]	[0.079]
LDIST	-0.801***		-0.483***		-0.240***	
	[0.046]		[0.034]		[0.051]	
CONTIG	0.331***		-0.120		0.700***	
	[0.080]		[0.080]		[0.142]	
COLONY	-0.226*		0.274***		-0.016	
	[0.132]		[0.097]		[0.098]	
COMLAN	0.467***		0.347***		-0.039	
	[0.091]		[0.041]		[0.123]	
Observations	65,550	61,760	65,550	61,760	65,550	61,760
R-squared	0.764	-	0.602	-	0.141	-
Clusters	13110	12,352	13110	12,352	13110	12,352

**** p<0.01, ** p<0.05, * p<0.10. Clustered standard errors in parenthesis. PPML= Poisson Pseudo Maximum Likelihood; PPMPE = PPML with Country Pair-Effect; IPPE1 = Export response to strengthening domestic IPRs in low income countries; IPPE2 = Export response to strengthening domestic IPRs in middle income countries; IPPE3 = Export response to strengthening domestic IPRs in high income countries; IPPI = Importer IPRs; LGDPE = log Exporter GDP; LGDPI = log Importer GDP; FTA = 1 if pair are in the same trade agreement; LDIST = log Bilateral Distance; CONTIG=Contiguity; COLONY = 1 if pair has ever being in a colonial relationship; COMLAN = Common Official Language*

5.3. *IPRs and Exports - Level of Economic Development*

The analysis so far has proceeded without considering differences in the development level of the exporting countries. In section 2, we hypothesized that there is a non-linear export effect of domestic IPRs due to differences in the levels of economic development. To this end, we follow Smith (1999) and introduce interactions between exporter IPRs and different development levels dummies in our gravity model. We first create three dummy variables to identify the varying level of development across countries based on their per capita GDP. The dummy is created for each year following the World Bank classification, and as such a country can move

between different income groups in different years. Each dummy takes a value of one for countries within that development group and zero otherwise. The interaction variables are then the product of the different development level dummies and the strength of IPRs in the exporter. In line with Smith (1999), we interpret the interaction variables parameters as the response of exports to changes in the level of IPRs across countries within each development group. Table 4 displays the result of this exercise for aggregate manufacturing exports, including the different margins.

The results indicate a consistent positive export response across different income groups particularly for total exports and the extensive margin of exports. Parameters for the intensive export margins differ in sign and significance across specifications, a result that is similar to that observed in the full sample. Interestingly, across each model we observe that the size of the IPRs estimate for each group is larger than that of the importers thereby reiterating the relative importance of domestic IPRs. Focusing on total exports and the extensive export margin where we obtained unambiguous results, we observe that the size of the IPRs estimate for each group relative to the others is determined by the estimation strategy. Put differently, our result does not suggest that exports of developed countries are more responsive to changes in the level of domestic IPRs. The results therefore do not support our hypothesis on the development stage-dependent export effect of IPRs.

In summary, our results indicate a net positive trade gain from strengthening domestic IPRs for different income groups. As this IPRs-export gain comes largely from increasing the varieties of traded products, the results indicate that the growth and welfare gains associated with product varieties which we discussed earlier in the context of the full sample applies to both developed and developing countries. The result thus differs from Briggs and Park (2013) whom using micro level data of subsidiaries of US firms finds a net positive exports effect of tightening domestic IPRs in developed countries only. There is a huge discussion on the implication of promoting similar IPRs standards across developing and developed countries. Developing countries often rely on foreign technology absorption hence opponents of stronger IPRs in developing countries argue that it will limit their ability to absorb foreign technologies. Our analysis which focuses on the net export effect of domestic IPRs supports the opposite side to this argument. One explanation for this is that higher IPRs in developing countries leads to increased FDI inflows, which leads to higher exports and an increase in the extensive export margin. This argument is consistent with Branstetter and Saggi (2011) who theoretically show that although strengthening of IPRs in developing countries reduces the rate of imitation, it increases FDI inflows in to such countries. This increase in FDI inflows may then offset the decline in the extent of production undertaken by imitators in the developing countries so that the region's share of the global basket of goods increases.

5.4. Identifying Causal Effects of IPRs

Although the study so far has documented a "net" positive export effect of stricter domestic IPRs, the analysis ignored any concern of endogeneity. Since we adopt a panel gravity model,

some of these concerns have been addressed by exploiting the temporal and spatial dimension of our data. However, skeptics could still argue for endogeneity particularly due to reverse causality between domestic IPRs and exports. We expect this to be a problem mostly for developed countries because major changes in the level of IPRs in these countries are endogenous. This is in contrast to developing countries where changes in the level of IPRs are mostly exogenous either due to signing trade agreements with substantial IPRs chapters or as a consequence of ascending to the TRIPs agreement. Notwithstanding this, few studies on the IPRs-trade literature employ instrumental variable estimation technique in order to address the endogeneity concerns. For instance, Ivus (2010) uses the distinction between colonies and non-colonies for identification in her analysis whilst Maskus and Penubarti (1995) and Foster (2014) use indicators of development including, per capita GDP, primary exports as a share of total exports, infant mortality rate, secondary enrolment ratios, and colonial dummies. One of the limitations of using indicators of development is that it is unclear whether we are measuring a country's level of IPRs and not its level of development. On the other hand, using colonial dummies or legal origin as suggested in some studies faces two limitations. First, having a colonial tie can directly predict bilateral trade. Second, either colony or legal origin is time-invariant hence unsuited for our analysis. To this end, we subscribe to the identification strategy developed by Rigobon (2003), Lewbel (2012) and Baum et al. (2013). The approach allows the identification of endogenous variables in the absence of good external instruments by using heteroskedasticity present in the model to generate sets of instrument. Particularly, identification is achieved by having regressors that are uncorrelated with the product of heteroskedasticity errors, which is a feature of many models where error correlations are due to an unobserved common factor (Baum et al., 2013 p. 13).[12] It therefore goes without saying that adopting this approach saves us from the daunting task of looking for a valid instrument and circumvents some of the problems associated with using per capita GDP, primary exports as a share of total exports, infant mortality rate, secondary enrolment ratios, and/or colonial dummies as instrument(s) for IPRs. Since our data is a panel, we implement the panel data variant of the method. The result for this exercise for the full sample is reported in Table 6.

Again, the results indicate a net positive effect of domestic IPRs on total exports and on the extensive export margin. The coefficient for the intensive export margin is now negative and statistically significant although only at the 10 percent significance level. In absolute terms however, the magnitude of the effect at the extensive margin are much higher than that at the intensive margin. Our results thus indicate that if there is any hope that domestic IPRs affects exports, this effect works mostly through the extensive margin. We also observe that the magnitude of the exporter's level of IPRs is higher than that of the importers. Subjecting the coefficients to an F-test, the hypothesis that the values of the coefficients on exporter and importer IPRs are equal is rejected at the 5 percent significant level for both total exports and

[12] For a detailed explanation of the method and how the instruments are constructed see Baum et al. (2013).

the extensive export margin. Across each model, the orthogonality test for over-identifying restriction cannot be rejected.

Table 6: Identification Through Heteroskedasticity

	Total Export	Extensive Margin	Intensive Margin
	[1]	[2]	[3]
IPPE	0.278***	0.366***	-0.080*
	[0.050]	[0.031]	[0.043]
IPPI	0.146***	0.265***	-0.013
	[0.024]	[0.015]	[0.018]
LGDPE	0.528***	0.239***	0.297***
	[0.037]	[0.018]	[0.034]
LGDPI	0.621***	0.303***	0.308***
	[0.026]	[0.013]	[0.026]
FTA	0.065*	-0.179***	0.212***
	[0.035]	[0.021]	[0.032]
Observations	46,826	46,826	46,826
R-squared	0.259	0.427	0.049
Hansen P-Value	0.141	0.240	0.161

**** p<0.01, ** p<0.05, * p<0.10. Robust standard errors in parenthesis. IPPE = Exporter IPRs; IPPI = Importer IPRs; LGDPE = log Exporter GDP; LGDPI = log Importer GDP; FTA = 1 if pair are in the same trade agreement.*

6. Conclusion

The literature on the relationship between IPRs and trade focuses predominately on imports whilst neglecting exports. The current study contributes to this literature by focusing on the latter, further examining the effect of domestic IPRs on the margins of exports in a gravity model framework. In general, results from the study confirm that IPRs is trade-related and that exporters' IPRs can help stimulate exports, although the gains are more pronounced in higher-income countries. Our finding of net positive export effects of strengthening domestic IPRs for both developed and developing countries may therefore suggest an innovation gain for a country with high innovative capacity and technology transfer gain for a low innovating country. In whichever case, we re-emphasize the need for countries to fashion their national IPRs policy in tandem to their development needs. We also find that the level of IPRs in the exporting country matters more to the exporter than the level in the importing country. We allude this new evidence to the power domestic IPRs has over fixed cost of organizing production (i.e. what and how to produce) in addition to influencing the decision of where to export since most countries (e.g. EU and U.S.A) forbids the importation IPRs infringing goods. This is in contrast to IPRs in the importer which only affects exporters' decision on how to serve

the market. Examining the different export margins, we obtain robust evidence that exporter IPRs increase both the aggregate and different composition of manufacturing exports through the extensive margin. Results obtained for the intensive margin remain either insignificant or not robust when subjected to different methods. Our result thus suggests that if there is any hope of an export effect of IPRs, this effect goes through the extensive margin.

Our findings have important welfare and growth implications. In the trade literature, increases in the variety of products traded (i.e. extensive margin) improve welfare by increasing the market share of the exporter and diversifying exports against trade shocks whilst increases in the intensive margin reduces welfare by worsening the terms-of-trade (Hummels & Klenow, 2005; Luong & Chen, 2016). By finding that tightening domestic IPRs increases the extensive export margins, our results suggest improvement in domestic IPRs can secure a country against worsening terms-of-trade by expanding the basket of goods a country exports and a net welfare benefit to consumers whom enjoy wider variety of goods. The gains of this product diversification particularly in encouraging growth and in safe-guiding an economy against macroeconomic volatility has also been acknowledged in the literature. The theoretical model of Romer (1994) emphasizes the importance of product variety as a gain from trade openness. Feenstra and Kee (2008) in a sample of 48 countries finds that within the period 1980-2000, total increase in export variety accounted for 3.3 percent average productivity improvement for the exporter. By finding robust evidence that domestic IPRs increases exports along the extensive margin, our result thus further suggests a policy instrument to increase product diversification in order to realize the associated growth gains. Chu, Charles and Tang (2012) in a recent study find a small but non-negligible growth volatility-reducing effect of tightening domestic IPRs. Although their study emphasizes technological progress to be the channel, our result adds to their study in suggesting product diversification. On the other side of the coin, there is a burgeoning empirical literature examining the effect of domestic IPRs on economic growth (e.g. Gould & Gruben, 1996; Falvey, Foster, & Greenaway, 2006) but has essentially remained mute on the mechanism through which the growth-enhancing effect of IPRs materializes. The current findings contribute to this literature by suggesting a mechanism, expansion of product varieties, through which the growth-enhancing effect of IPRs they find can be realized.

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