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Preferential Trade Agreements, Intellectual Property Rights And Third-Country Trade: Assessing the Impacts of the New Multilateralism

William Ridley
University of Colorado Boulder

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Department of Economics

University of Colorado Boulder
Boulder, Colorado 80309

Preferential Trade Agreements, Intellectual Property Rights, and Third-Country Trade: Assessing the Impacts of the New Multilateralism*

William Ridley†
University of Colorado

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Abstract

Preferential trade agreements (PTAs) have proliferated with the ongoing rise in globalization. Beyond their traditional purview of liberalizing trade and encouraging market access between agreement members, the provisions included in newer PTAs encompass areas not explicitly related to trade in goods: areas such as intellectual property rights (IPRs), the focus of this paper. And while the main effects of the market access provisions of PTAs are felt foremost by the members of the agreements, IPR provisions have the potential to generate spillover effects on member countries' economic relations with non-members. This paper assesses the existence of these IPR policy spillover effects on members' third-country trade (trade with countries outside of the PTA) in industries that differ in the extent to which they rely on IPRs. Countries that enter into PTAs with the United States, the European Union, or the European Free Trade Association—economies that include the most substantive IPRs provisions in the PTAs that they negotiate—exhibit a significant restructuring of their patterns of trade relative to otherwise similar countries that do not. Most of these effects are concentrated in exports, but import effects are also evident, with the results being sensitive to PTA members' levels of development and the sectoral composition of trade. These findings suggest that IPRs provisions shape the effects of PTA formation in ways that have heretofore been unexplored.

Keywords: Preferential trade agreements, intellectual property rights, third-country trade, gravity
JEL Codes: F13, F14, F15, O34

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†256 UCB, Boulder, CO 80309 Email: william.ridley@colorado.edu.

1 Introduction

The rise in globalization in recent decades has tied national economies closer together, both through increased interdependence from trade and investment relationships, as well as countries' commitments to international agreements (such as preferential trade agreements (PTAs) and bilateral investment treaties) and multilateral institutions (such as the WTO). As the degree of international integration has risen, the scope of PTAs has expanded beyond their traditional purviews of market access concessions and trade liberalization. Increasingly, trade agreement negotiations venture into policy areas that, at first pass, might seem beyond the scope of the typical issues of tariff reductions and the lowering of non-tariff barriers to trade. This shift in focus has generally been towards the inclusion of policy provisions relating to other aspects of economic integration: trade in services, foreign investment rules, safety and sanitary standards, government procurement policies, and labor and environmental regulations, among others. One such policy area that these so-called "deep" agreements increasingly encompass is that of intellectual property rights (IPRs), an aspect of PTAs that shapes the way in which PTA members formulate their domestic IPR regimes. And while as recently as the early 1990s, PTAs were generally devoid of substantive language on IPRs, the PTAs negotiated in recent years—particularly those agreements with at least one advanced economy as a member—generally contain extensive chapters on IPRs de rigueur.

Since IPRs are the legal framework by which knowledge-creators are able to reap the rewards from their ideas and innovations, their effects are at essence an issue relating to the broader impacts of behind-the-border domestic regulatory regimes. However, the fact that new products, processes, creative works, and other knowledge assets cross borders at an ever-increasing rate implies that IPRs are as much an international issue as they are a domestic one. As they relate to international trade, IPRs fall under the broad umbrella of institutional quality acting as a source of comparative advantage (though I will later posit several mechanisms relating IPRs to trade). The literature in this area (e.g. work by Antràs 2005, Levchenko 2007, and Nunn 2007) describes countries' institutional quality, or the effectiveness of their regulatory regimes, as playing a role analogous to Heckscher-Ohlin-style endowments. Institutions determine the patterns of comparative advantage in the sense that the economic activities that are particularly intensive in their reliance on the existence of efficacious regulatory regimes—for example, the enforceability and specificity of contracts, well-defined property rights, or protections for investors—will be the activities in which countries possessing well-developed regulatory regimes will specialize.[1] IPRs are an integral component of this notion, in that the extent to which the creators and owners of knowledge assets in sectors that most rely on IPRs (generally, R&D-intensive industries such as pharmaceuticals, chemicals, electronics, and other advanced manufactures, or creative works such as music recordings, movies, printed media, or software) are able to realize the returns to their intellectual property (IP) will determine to a significant degree the extent to which countries specialize in particular economic activities. Certainly this could go both ways, as countries might maintain rigorous IPR regimes in the interest of protecting already-robust IP-intensive export industries, or encourage inward technology transfer from abroad, but the relationship between IPRs and trade remains apparent.

In this paper, I ask whether when a country enters into an IPR-related PTA, specifically, one with the US, the EU, or the European Free Trade Association (EFTA),[2] does the resulting upgrading of the country's IPR regime materially impact its trade with *other, non-PTA member third countries*? I will describe this as the "third-country effect" of IPRs-upgrading within PTAs, as the strengthening of domestic IPRs regimes has the potential to generate spillovers on member countries' interactions with trade partners outside of the PTA. I focus on the PTAs negotiated by the US, the EU, and EFTA because the PTAs enacted by these countries tend to be more substantive in their treatment of IPRs relative to the agreements signed by other advanced economies; namely, because of their emphasis on so-called "TRIPS-Plus" provisions. Appealing again to the notion of comparative advantage being shaped in part by IPRs, I will explore empirically whether countries party to IPR-related PTAs trade relatively more (or less) in commodities that are most (or least) intensive in their reliance on various aspects of IPRs by investigating the exports and imports of these countries along both the intensive and extensive margins of trade. That this paper investigates the third-country effects of IPR chapters within PTAs means that it will be exploring a novel channel through which PTAs impart their impacts, and shedding light on the effects of an

[1] See Nunn and Trefler (2014) for an overview of the literature on the intersection of institutions and comparative advantage.

[2] Though the EU and the European Free Trade Association are distinct entities, because of the degree of economic interdependence, cultural and economic similarities, and the similarity in the IPR language of the PTAs they negotiate with other countries, I describe their PTAs as "European" agreements.

increasingly important facet of globalization.

Setting aside the issue of IPRs, the literature on the effects of the formation of PTAs is broad and well-established. As framed in the early treatment by Viner (1950), PTAs engender competing effects: new trade might be created that did not exist prior to the PTA when trade liberalization makes importing from a fellow PTA member cheaper than sourcing particular commodities domestically (*trade creation*); on the other hand, a country's existing trade with non-PTA members might be reallocated to a PTA member country when intra-PTA tariffs fall and extra-PTA most-favored nation (MFN) tariffs remain the same (*trade diversion*). The analysis in this paper is similar in spirit to empirical explorations of the issue as conducted by, e.g., Rose (2004), Baier and Bergstrand (2007), and Romalis (2007), each of which estimate the effects of multilateral economic integration agreement membership on member countries' trade.[3] However, given that IPR regimes apply equally to fellow PTA members and non-members alike, the third-country trade effects considered here are distinct from the traditional trade-creating or trade-diverting effects of PTAs. The strengthening of domestic IPR regimes because of provisions in IPR-related trade agreements will thus have ramifications on trade that are distinct from those that manifesting from the generic narrative that arises from market accession concessions in PTAs.

Focusing on the third-country effects of IPRs provisions in PTAs further allows us to sidestep the selection bias that might arise with respect to the types of countries that enter into PTAs with the US, Europe, or other advanced economies (Baier and Bergstrand, 2009). What form might selection bias take in this setting? The principal concern might be that countries enter into PTA negotiations with advanced economies, fully anticipating the IPR policy provisions they will be required to adopt, because they already undertake a comparatively high (or low) level of trade in IPR-intensive commodities. In other words, the direction of causality might not be one in which IPR regimes influence the patterns of trade, but rather one in which domestic IPR regimes—particularly, as shaped by IPR-related PTA membership—are themselves determined by existing trade patterns. The potential for such a mechanism to distort any estimates of IPR effects is less credible when examining third-country trade, however. It is difficult to imagine that a country enters into a trade agreement with the express goal of affecting its trade with partners

[3]Specifically, WTO accession in Rose (2004), PTAs in general in Baier and Bergstrand (2007), and the North American Free Trade Agreement in Romalis (2007)

outside of the PTA. The IPR provisions required in PTAs thus offer a credibly exogenous policy change for the countries that accede to them.

The empirical findings can be summarized by several principal results. I first consider the effects of accession to an IPR-related PTA with either the US or Europe on the value of agreement members' trade with third countries using a gravity framework. I find that membership in such agreements—and the resultant upgrading of members' IPRs regimes—leads to significant impacts on members' bilateral trade with countries outside of the PTA (an effect on the intensive margin of trade). Exports in IPR-intensive industries (industries that are relatively more reliant on the protections afforded by IPRs) from PTA member countries at middle and high levels of development tend to increase significantly, while these same exports for countries at lower levels of development are largely unaffected. Conversely, IPR-related PTA accession is associated with a reduction in the value of relatively IPR-unintensive exports of middle- and high-income countries. Both results are consistent with changes in the broader pattern of comparative advantage stemming from improvements in institutional quality as determined by IPR regimes. In using a more disaggregated sectoral breakdown which considers trade in IPR-intensive subsectors such as pharmaceuticals, chemicals, and information and computer technology (among others), it becomes apparent that these effects vary substantially across industries. The value of the exports of developed countries in many of these IPR-intensive subsectors, and the imports of these commodities by less-developed countries, is larger than that of otherwise similar countries that are not party to IPR-related PTAs. This analysis is also conducted on the extensive margin of trade (as defined by the number of product varieties exported to or imported from a trading partner), which reveals that these effects are realized in most cases through an expansion in the number of varieties that PTA member countries export and import. Finally, the third-country effects are delineated according to the level of development of PTA members' trading partners, an exercise that sheds light on the distributive effects on trade of IPR chapters in PTAs. I find that the effects on third-country exports are largely concentrated in PTA members' trade with middle- and high-income countries, while any effects on imports generally arise in trade with low- and middle-income partners. This final analysis shows that a complete picture of the effects of IPR provisions in PTAs on trade is only apparent when considering the relative development levels of trading partners.

The remainder of the paper is organized as follows. Section 2 outlines the policy background at the intersection of PTAs and IPRs, emphasizing the recent history of the PTAs negotiated by the US or Europe, whose trade agreements generally contain the most rigorous provisions on IPRs. Section 3 gives a brief overview of the existing research linking IPRs and trade, and uses this motivates the third-country effect induced by IPRs-upgrading by detailing several channels through which stronger IPRs could affect trade. Section 4 describes the data and presents the empirical analysis of the third-country trade effects of IPR-related PTAs, considering the effects of accession to such agreements along lines of countries' development levels and the sectoral composition of bilateral trade. Section 5 considers the implications of the empirical results and provides a concluding discussion.

2 IPRs and the "Deep" PTAs of the US, the EU, and EFTA

The number of trade agreements in force has risen unabated over the last several decades. Correspondingly, the number of countries party to such agreements has risen, with nearly all of the world's countries party to at least one (and often many more than one) PTA. This, coupled with near-universal accession of countries to the GATT/WTO (with its founding principles of MFN, national treatment, and the abolition of distortionary trade policies) has effected a dramatic reduction in the average levels of the traditional barriers to trade (tariffs and other non-tariff instruments such as quotas). And as average tariff rates have fallen, the scope of trade agreements has increasingly turned towards other arenas relevant to international integration—items such as investment rules, trade in services, health and safety standards, environmental and labor regulations, and intellectual property rights, among others. The proliferation of these "deep" agreements, so-called because of their inclusion of substantive provisions on non-trade policy areas, has had far-reaching implications for the way in which domestic regulatory regimes are formulated, as economies increasingly engage in policy-setting in such multilateral venues (Limão, 2016).

Why should IPRs be a part of PTA negotiations? Several explanations can be advanced for their inclusion, but a complete understanding requires a brief survey of recent developments in the global system of IPRs. Prior to the 1990s, national IPRs regimes were an ad hoc affair: countries were free to enact their own policies towards IPRs, and aside from voluntary commitments to various international conventions, no uniform international system existed to harmonize policies across borders. The 1995 WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) upended this status quo, however, in its implementation of a consistent, minimum level of protection and coverage of IPRs for countries acceding to the agreement. TRIPS is expansive in what it requires: among other items, it mandates minimum coverage durations for rights such as patents and copyrights, the extension of patentability to biotechnology and plant varieties (as well as products and processes in all technology fields) and copyrightability to computer software, clarifies allowable practices with respect to trademarks, and prohibits practices such as compulsory licensing (in a which a government authority allows a non-patentholder to reproduce a patented product or process) and competitive abuses of IPRs. It further requires that countries maintain effective enforcement regimes, encompassing both civil and criminal measures and customs enforcement to deter IPRs violations, and allows for the invocation of the WTO's dispute settlement mechanism in international disputes over IPRs. Importantly, the extension of the principles of MFN and national treatment to IPRs addressed the international aspect of IPRs protection in mandating equal treatment of foreign knowledge assets regardless of the owner's origin, and requiring countries to treat the knowledge assets of foreigners no differently than the knowledge assets of domestic citizens.

TRIPS was the culmination of contentious negotiations at the WTO's Uruguay Round: as producers of a large share of the world's intellectual property, the interests of the US and Europe favored consistent and rigorous protection of IPRs across borders, while the concerns of negotiators from developing countries were that stronger IPRs would stifle access to new product varieties (particularly pharmaceuticals) and necessitate costly implementation efforts. The middle ground afforded by TRIPS offered developing countries considerable leeway in their timelines with which to comply with TRIPS (with least-developed countries effectively freed from hard deadlines on compliance). Further, developing countries were granted allowances with regard to how they were allowed to interpret and implement key provisions, such as exemptions in compulsory licensing prohibitions and fair use exceptions for copyrights. Certain provisions on patent granting processes in pharmaceuticals and chemicals that were negotiating objectives of the US and Europe, such as linkage rules deterring generic competition and test data confidentiality, were left out. From the point of view of the US and Europe, then, TRIPS was (and remains) an imperfect mechanism in ensuring that foreign IPR regimes are consistent and sufficiently comprehensive, and the difficulty of obtaining further IPRs concessions from other WTO members highlights the shortcomings of a global approach.

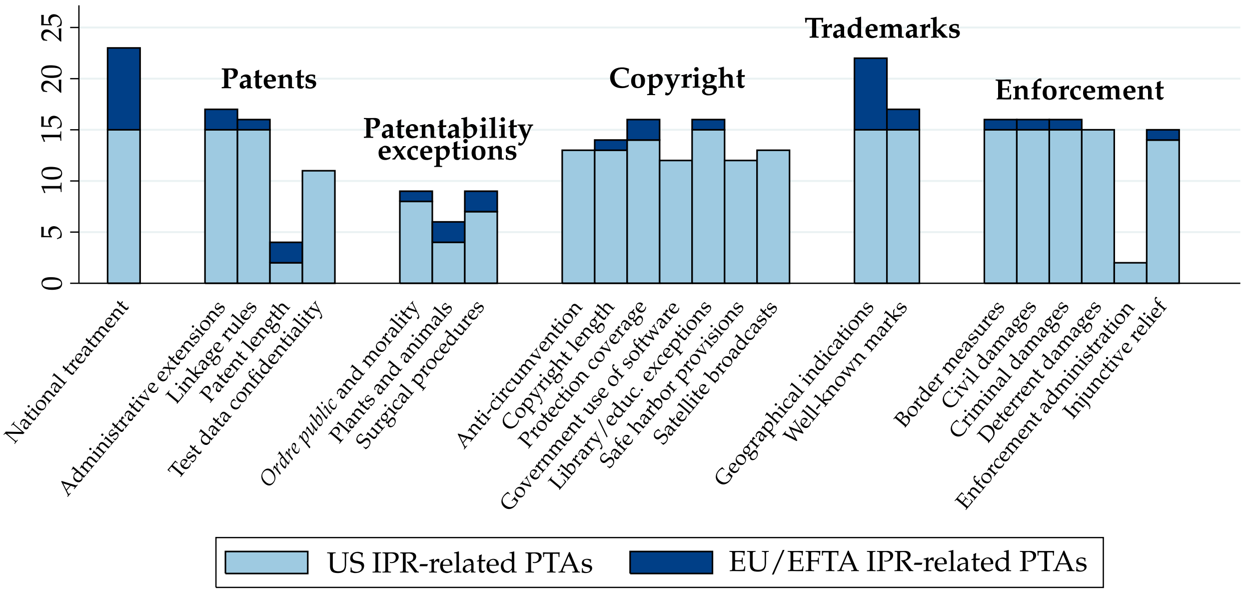
PTAs, then, offer an alternative venue in which the US and Europe are able to obtain IPR policy concessions from foreign governments in smaller settings. The prospect of bilateral trade concessions could sway foreign negotiators to agree to adopt rigorous IPR standards they would not agree to in a larger multilateral setting where economic interests evince less overlap (Maskus, 1997). One commonality underlying the recent PTAs negotiated by the US and Europe, as put by Horn et al. (2010), is that "an issue of particular interest with regard to [EU] and US PTAs is the extent to which they can be seen as a means of transferring the regulatory regimes of the [EU] and the US to other countries."

The origins of this "transferring of regulatory regimes" via PTAs can be ascribed to the mid-1990s, specifically to the implementation of the landmark North American Free Trade Agreement (NAFTA). NAFTA (at the behest of US negotiators) was the first agreement of its kind to devote substantive coverage to IPRs, with Mexico (and to a lesser extent, Canada) required to adopt specific standards and policies in IPRs: more specific rules on the allowable applications of copyrights than those offered by TRIPS, more rigorous prohibitions on compulsory licensing, stronger protections for pharmaceuticals, semiconductors, and trade secrets, and stricter enforcement requirements than TRIPS. Further, NAFTA required a swifter implementation schedule for members than did TRIPS.

In the two decades following NAFTA, the US enacted a number of bilateral and multilateral PTAs, with in-depth chapters on IPRs a mainstay of the agreements. And, while the language in these IPRs chapters has evolved, largely due to an increased emphasis on provisions relating to pharmaceuticals and chemicals (as well as a growing focus on the protection of IPRs for digital assets such as software), they exhibit noticeable consistency in their emphases and specific policy prescriptions, with a general focus on patent obligations, the treatment of copyrights, and requirements for effective enforcement. From Biadgleng and Maur (2011), these "TRIPS-Plus" (so-called for their requirements on IPR regimes that go beyond those of TRIPS) provisions required by the US include:

- **Patents**: the granting of patent term extensions resulting from delays in the patent applica-

Figure 1: Number of IPR-related preferential trade agreements by Presence of Specific Provisions



tion process and exclusivity on test data for pharmaceuticals and chemicals;

- **Copyrights**: the adoption of copyright terms 20 years longer than those required by TRIPS, accession to the World Intellectual Property Organization (WIPO) treaties on copyrights and performances/recordings, and adoption of rules on the anti-circumvention of digital rights management safeguards;

- **Enforcement**: no exceptions for implementation of IPR rules based on the partner's development level, the extension of border measures for counterfeit and infringing goods to include goods in transit to other destinations, and a broader definition of infringing activities subject to criminal measures.

The combination of sector-specific provisions, and more general enforcement and coverage measures, suggests that the countries that enter into a PTA with the US must adopt substantial changes to their domestic IPR regimes.

What can be said of the IPR provisions required by European PTAs? The large number of European products possessing specific geographical origins (typically, agricultural and food products where the location of production—e.g. Champagne, Gouda, or Cognac—is associated with the features of the product) means that European negotiators have adopted a focus on more rigorous

Table 1: US, EU, and EFTA IPR-related Preferential Trade Agreements

Agreement Name	**Entry-into-force Year**
US agreements	
North American Free Trade Agreement (NAFTA)	1994
Jordan-USA	2001
Chile-USA	2004
Singapore-USA	2004
Australia-USA	2005
Bahrain-USA	2006
Central American Free Trade Agreement (CAFTA)	2006[1]
Morocco-USA	2006
Oman-USA	2009
Peru-USA	2009
Colombia-USA	2012
Panama-USA	2012
South Korea-USA	2012
EU/EFTA agreements	
European Free Trade Association (EFTA)	Varies by member[2]
European Union	Varies by member
Bulgaria-EFTA	1993
Slovenia-EFTA	1995
Estonia-EFTA	1996
Turkey-EU	1996
Macedonia-EU	2001
Mexico-EFTA	2001
Latvia-EFTA	2006
CARIFORUM-EU	2008
Colombia-EFTA	2011
Canada-EU	TBD

[1] For most countries in CAFTA, the entry-into-force year was 2006; the entry-into-force years for the Dominican Republic and Costa Rica were 2007 and 2009, respectively.
[2] EFTA's membership has been fluid, with several countries entering and leaving the agreement over time (e.g. Sweden or the United Kingdom). Since the sample that will be used in the empirical analysis begins in 1995, and EFTA's four current members (Iceland, Liechtenstein, Norway, and Switzerland) joined in 1995, EFTA's membership remains fixed for the period of the analysis.

considerations of geographical indications in their PTAs. Such provisions mandate the recognition of particular indications and the phasing out of products that make improper use of a geographically-based appellation. With respect to other areas of IPRs, early European agreements were characterized by generalities or non-binding language, but more recent agreements are more specific in what they require. Like their US counterparts, European PTAs have recently emphasized the inclusion of TRIPS-Plus provisions. To illustrate, the 2008 CARIFORUM-EU agreement requires signatories to adopt language on patentability and minimum standards of enforcement and acceptable practices in their IPR regimes. Members must also accede to numerous treaties on multiple areas of IPRs, such as the World Intellectual Property Organization Copyright Treaty, the Rome Convention on performances, recordings, and broadcasts, the Patent Cooperation Treaty, and the Hague Agreement on industrial designs, among others. This approach of having partners accede to such treaties has marked many of the agreements that Europe has negotiated, but the general trend in European agreements has been towards more comprehensive standards in the same vein as the agreements negotiated by the US (Shabalala and Bernasconi, 2007).

Table 1 lists the US- and European-negotiated PTAs with IPR chapters that are currently in force (or in the case of Canada-EU—formally, the "Comprehensive Economic and Trade Agreement," or CETA, signed but yet to enter into force). The US agreements generally involve partners in Central and South America, the Middle East, and the Asian Pacific region, regions with which the US maintains deep economic, political, and strategic ties, while the European agreements have generally encompassed economies in Eastern Europe and the Caribbean/Central American region.[4] The current state of affairs for US- and European-negotiated PTAs is one in which IPRs are a central focus of the agreements. The recently concluded CETA possesses an extensive chapter on IPRs, with a strong emphasis on pharmaceutical protections (and reforms to Canada's rules on pharmaceutical patents), copyrights, geographical indications and trademarks.

What does the future hold for IPR-related PTAs? The impending (but, as of writing, in limbo) "mega" trade bloc—the Trans-Pacific Partnership (TPP) and the officially stalled Transatlantic Trade and Investment Partnership (TTIP) between the US and Europe—promise to be major milestones in how IPR policy is implemented within multilateral agreements. Before the departure of the US from the agreement, the TPP possessed some of the most comprehensive language on IPRs in any international agreement to date; specifically, robust TRIPS-Plus provisions on test data confidentiality and generic competition for pharmaceuticals, trademarks, copyrights, and IPR enforcement. Similar provisions can be expected to characterize TTIP. Despite the idiosyncratic policy objectives of the current US presidential administration, the long-term policy goals of the US and Europe suggest that these provisions are likely to appear in future agreements. Outside of the US and Europe, other countries increasingly negotiate PTAs with detailed IPRs provisions;

[4]Because of the degree of policy harmonization and regulatory upgrading induced by membership in EFTA or the EU, the analysis considers these agreements as themselves being IPR-related PTAs. In the empirical analysis I explore the robustness of the results to this assignment.

Australia, Chile, Japan, and Mexico, for instance, increasingly devote coverage to IPRs in their agreements, though with emphases that often differ from those of the US or Europe. PTAs offer the clearest path forward for regulatory harmonization between trading partners, and their role as such continues to expand.

3 IPRs, Trade, and the Third-Country Mechanism

3.1 Three Channels Linking IPRs and Trade

Clearly, IPRs have become an area of importance in the trade deals negotiated by advanced economies, particularly those of the US and Europe. A question that follows is: why should IPRs be relevant in international trade? This question has been explored in the theoretical and empirical literatures for some time, but at the broadest level, the link between the two can be characterized by the three channels that I will highlight below. These channels are, first, institutional quality as a source of comparative advantage, second, what the literature has dubbed market-power versus market-expansion effects, and third, the location and investment mode decisions of multinational enterprises (MNEs). The interplay of each of these make the system of IPRs a fundamental determinant of the direction and magnitude of trade.

First, IPRs are part of the broad interaction between institutional quality and trade, which casts the effectiveness of countries' institutions—contract enforcement and specificity (Antràs 2005; Levchenko 2007; Nunn 2007), the rule of law and efficaciousness of the legal system (Ma et al. 2010; Yu et al. 2015) the smoothness of credit markets (Rajan and Zingales 1998; Beck 2002), etc.—as a determinant of comparative advantage. Effective institutions facilitate the economic activities that require complicated legal relationships and well-defined property rights, incentivize innovation by ensuring that its returns can be effectively realized, and generally promote economic exchange. On the other hand, substandard institutional quality (e.g., the insecurity of property rights, capricious government rules and regulations, or pervasive corruption) acts as an impediment to trade (Anderson and Marcouiller 2002; de Groot et al. 2004). In the sense that they determine the rewards to innovation and establish clear ownership of knowledge assets, IPRs are a fundamental determinant of a country's institutional quality. And, related to this notion, IPRs help determine the extent of inward technology transfer (Yang and Maskus, 2009), which could further effect changes in the structure of a country's comparative advantage and the composition of its trade. In the classical sense of comparative advantage, countries with robust IPR regimes should be expected to specialize relatively more in those commodities that intensively rely on their protections, and thus export relatively more in industries that are intensive in their reliance on IPRs, and export less in IPRs-unintensive industries (and vice versa for imports).

The second channel is not entirely distinct from the first. To illustrate, consider the role that patents—temporary legal monopolies on a specific process or product—play in allowing innovators to realize profits from their inventions (analogous logic can be extended for the issues underlying copyrights, trademarks, geographical indications, and other rights). When an inventor of a new product obtains a patent, they are effectively granted the right to act as a monopolist in their particular variety for the duration of the patent, assuming the patent is actively enforced by the granting authority. This creates rewards for innovators that might not otherwise exist, which could take the form of larger profit streams or reductions in the costs of efforts to deter imitation. Thus, on one hand, the prospect granted by IPRs of being able to behave more monopolistically create a *market power effect*, where patent-holders are able to constrain the supply of their product to a particular market and inflate prices. On the other hand, the bolstered incentives for innovators afforded by effective patent rights lead to extensive margin effects, expanding the dynamic flow of new product varieties and improving the incentives to export to markets where the costs of deterring imitation might otherwise make the market unprofitable—the *market expansion effect*. In an international setting, innovators' ability to realize these profits will determine their optimal decision with regard to several outcomes: the optimal level of R&D and innovation to undertake (and where to undertake it), where to locate production, which markets to sell their products to, and importantly, how much of their product to sell to particular markets. The overall direction of these countervailing effects is theoretically ambiguous and depends on which effect dominates. Their interaction, however will to some extent determine the value of a destination market's imports of IPR-intensive commodities.

Finally, another key aspect of the mechanisms linking IPRs and trade relates to the foreign investment decisions of MNEs, as exporting versus foreign direct investment offer alternative means by which to serve destination markets. IPRs serve a fundamental role in determining which markets MNEs choose to serve, and how to serve them. These decisions are determined in part by

Table 2: Three Mechanisms and Potential Impacts of IPRs-upgrading on PTA Members' Third-Country Trade

	IPR-intensive industries	**IPR-unintensive industries**
IPRs as a source of comparative advantage	Exports ↑ Imports ↓	Exports ↓ Imports ↑
Market power (MP) versus market expansion (ME)	MP > ME: Imports ↓ ME > MP: Imports ↑	?
Decisions of MNEs as they relate to IPRs	Exports ? Imports ↓	?
Implied total effects	Exports ↑? Imports ↑↓?	Exports ↓? Imports ↑?

the likelihood that imitation or appropriation of a multinational's proprietary knowledge assets or production processes will take place; strong IPRs and their effective enforcement signal to owners of IP that these sorts of actions are less likely to occur (see, e.g., Markusen 2001 or Javorcik 2002). With an increase in the rigor of a country's IPRs, multinationals might be more inclined to serve a market through local production or licensing versus exports, which would reduce the destination market's imports of IPR-intensive commodities. FDI might also increase competitive pressures on local firms operating in these particular industries, who might as a result export less to other markets. At the same time, it could also be the case that MNEs establish production in a target market and then export from there to nearby markets—e.g. a foreign firm constructing a new plant in Chile to sell to the Argentinean and Peruvian markets. The effect on exports is thus ambiguous. While this analysis focuses on the relationship between IPRs and trade, FDI remains a crucial component of the nexus between the two, and even though the estimation approach will be unable to delineate the specific mechanisms underlying the results, the FDI versus exporting decisions of MNEs are inherently interlinked.

The exact effects of stronger IPRs on trade are thus ambiguous, but the mechanisms outlined above offer some guidance on what impacts are to be expected. Table 2 summarizes the potential effects of these three channels on the third-country exports and imports of IPR-related PTA members. Overall, positive export effects might be anticipated in IPR-intensive sectors depending on the direction and relative size of the MNEs channel, while impacts on imports are theoretically ambiguous. Industries that are relatively unintensive in their reliance on IPRs, however, are expected to be minimally impacted, with the only clear prediction arising from the comparative advantage channel. These effects could be manifested along the intensive margin, the extensive margin, or both. The sector-specificity of many of the agreements' provisions also suggests that any empirical impacts are likely to vary across industries. And further, the three channels outlined above are not the only potential explanations for the relationship between the IPR provisions of PTAs and members' trade. More broadly, when countries enter into PTAs, they effectively signal their adherence to a policy orientation that is unlikely to change abruptly (owing to the cost of breaching international commitments), which enhances the attractiveness of the country's markets for trade and investment (Fernández and Portes, 1998). This is in contrast to unilateral domestic policy decisions, which Büthe and Milner (2008) note can easily be changed at the expense of foreign economic agents. The predictability and consistency of trade policy has been shown to be an important determinant of trade patterns (Handley 2014; Handley and Limão 2015), and the "lock-in" effects of a consistent policy orientation with regard to IPRs should translate to trade in industries where such rights are front and center.

3.2 IPRs and Trade: Empirical Findings

The ambiguous predictions from the theory on the role of IPRs in determining the patterns of trade suggest that the real-world relationship can be uncovered only through empirical investigation. The earliest work in this direction, that of Ferrantino (1993), considered the role of countries' accession to international treaties on IPRs (such as the Paris Convention for the Protection of Intellectual Property) in influencing the exports and overseas affiliate sales of US multinationals. Ferrantino failed to find significant links between destination market IPRs and US multinationals' exports to their affiliates or foreign affiliates' sales. In contrast, the findings of Maskus and Penubarti (1995) established the empirical existence of a link between trade and the extent of countries' patent protection. Increases in the level of patent protection were correlated with higher levels of manufacturing imports by developing countries, and when imports were further disaggregated by industry, this effect turned out to be exclusive to trade in the least patent-sensitive industries, rather than industries most reliant on patents.

Following Maskus and Penubarti (1995), several other noteworthy studies have approached the issue of IPRs and trade. Smith (2001) further explored the relationship between foreign patent rights and trade, examining the behavior of US multinationals with regard to their decisions vis-à-vis exporting versus selling through an affiliate versus licensing. Exports tended to be positively associated with stronger foreign patent rights, likewise affiliate sales and licensing, particularly in destination markets with strong imitative capacities, where stronger IPRs did more to mitigate the risk of imitation. Extending on this notion, Co (2004) found that foreign patent rights were unimportant on their own; rather, it is the interaction of foreign patent rights and destination markets' imitative abilities that mediates the link between IPRs and trade. In a gravity model of US exports to 71 countries from 1970 to 1992, Co found that for countries of average imitative abilities, US exports of R&D-intensive commodities were expected to increase by 9% for every unit increase in the country-level patent rights index of Ginarte and Park (1997). Co rationalized this finding using the logic that the foreign markets that offered the greatest threat of imitative competition for US multinationals—i.e. those with the greatest imitative ability—are the markets where strong foreign patent rights would be most strongly related to trade flows. Conversely, US exports of non-R&D-intensive goods were anticipated to fall by 8–11% for a unit increase in this index, potentially reflecting the underlying changes in comparative advantage wrought by IPRs regimes.

Particular focus has been paid to the effects of TRIPS on trade and investment flows, and since the analysis will consider the implementation of policies that generally coincided with countries' implementation of the TRIPS agreement—and which might evince similar effects on trade—it will be essential in the analysis to disentangle the effects of TRIPS from the effects of IPR-related PTA accession. Ivus (2010) examined whether developing countries' accession to TRIPS, and resulting upgrading of their IPRs regimes, led to increased imports of IP-intensive commodities from developed economies. The study accounted for the potential endogeneity of countries' IPR regimes with the composition of trade by using colonial origin as an instrument for IPR strength, as countries with British or French colonial backgrounds generally inherited the comparatively advanced legal frameworks of their metropoles. Her empirical evidence suggested a substantial increase in developing countries' imports—an estimated $35 billion in value—resulting from TRIPS implementation, and further, found this expansion to have resulted from an increase in quantities, rather than prices; evidence in favor of a significant market-expansion effect.

Of relevance to this research is the work of Delgado et al. (2013), who investigated the effect of TRIPS on countries' aggregate trade (both in terms of exports and imports) in IPR-intensive commodities. Delgado et al. (2013) exploited the effective exogeneity of TRIPS accession (based on the fact that TRIPS is a mandatory component of WTO membership for most countries), and further, considered whether the effects of IPRs-upgrading might vary across levels of development. They specifically considered whether developing countries were impacted differently by TRIPS than were advanced economies, based on the idea that advanced economies already possessed well-developed IPRs regimes by the time they began to implement TRIPS. In essence, their results showed that TRIPS compliance exerted a significant impact on the trade of knowledge-intensive goods relative to a control group of knowledge-unintensive goods. Further, they found evidence of an increase in the imports of knowledge-intensive goods of developing countries from high-income countries. What they did not consider, however, was whether a contemporaneous policy change was systematically implemented alongside TRIPS; namely, the IPR-related PTAs that will be considered here.

Given that IPRs determine the structure of costs and benefits in a wide array of economic activities, a holistic view of the issue in an international setting would consider each of the potential outcomes of changes in domestic IPR regimes in conjunction: foreign direct investment, innovation, and product/trade decisions are generally made jointly. I will focus on trade flows in the empirical analysis for two reasons. First, that PTAs are inherently about trade. Investment, innovation, and other activities are certainly influenced by the structure of PTAs, but one would expect the first order effects of trade agreements to be on trade. Second, data availability constraints the extent of any empirical analysis that can be conducted on every potential facet of the issue. Detailed bilateral investment data at the sector level is not readily available; likewise data on innovation activities—such as patenting or research and development—is not readily available to the same extent that detailed data on trade flows is.

3.3 The Third-country Mechanism

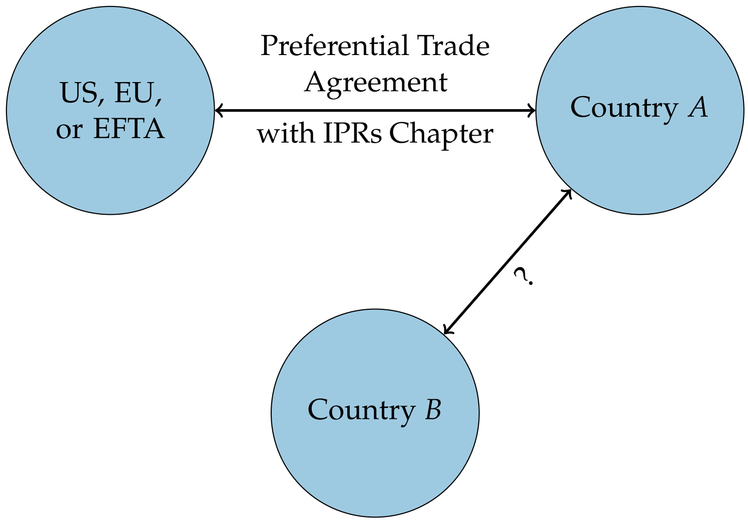
The survey of the literature should make it apparent that IPRs and trade are interrelated—and despite the agnostic predictions from theory, the empirical literature seems to have coalesced around the notion that stronger IPR regimes are generally correlated with expanded trade in R&D- or IPR-intensive products, with effects breaking down along lines of countries' levels of development as well as their imitative abilities. In light of the discussion in Section 2, what can be hypothesized about the effects of IPR-related PTAs? These multilateral agreements effect changes in the IPR regimes of member countries, and given the numerous potential links between IPRs and trade, the effects of such policy-upgrading should be expected to generate spillovers on linkages with countries outside of the trade agreements: the third-country effect of IPRs on PTA members' trade.[5]

Figure 2 illustrates this hypothesized effect. When some Country *A* enters into a PTA with the US or Europe, trade between member countries will be expected to increase, with potential differential effects across sectors depending on the scope of the trade liberalization/where tariff cuts are directed—this is the standard Vinerian idea of trade creation resulting from PTAs. The third-country effect, however, suggests that Country *A*'s trade with Country *B* (where *B* could denote any trade partner outside of the PTA) is materially impacted—when Chile signs its IPR-related PTA with the US, is its trade with Argentina also impacted as a result of the policy change, particularly in IPR-intensive industries? If IPRs are indeed a determinant of the patterns of trade—for any of the reasons outlined above—the systematic upgrading of national IPRs regimes for PTA members should evince an effect on the composition and magnitude of trade with non-PTA member countries.

This third-country mechanism will be central to the empirical identification strategy. In thinking about threats to credible estimation, it may be that countries endogenously select into IPR-related PTAs with the US, the EU, or EFTA (or other advanced economies) because they already undertake a high (or low) level of IPRs-intensive trade; that is, selection into the policy "treatment" is nonrandom with respect to the outcome of interest. On the other hand, it is more difficult to

[5]PTA membership might expand FDI flows from third countries into PTA member countries, but for a different reason than the one this paper considers with respect to IPRs and trade. PTAs expand the size of the effective market that foreign investors face, which may bolster the incentives for horizontal FDI (see, e.g., Dee and Gali 2003 or Levy Yeyati et al. 2003).

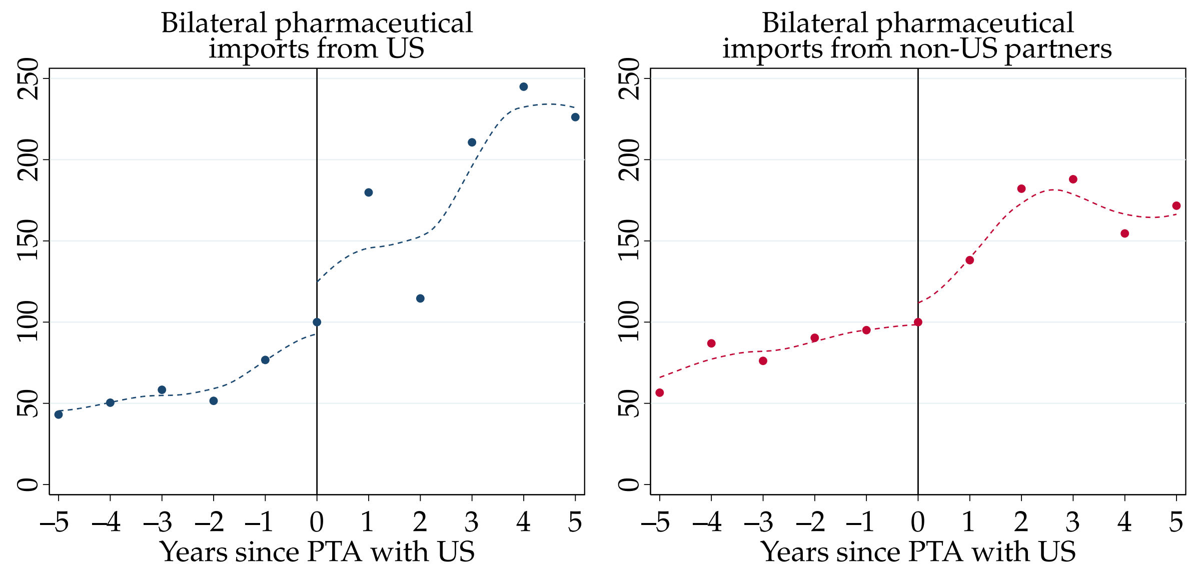
Figure 2: IP-Related PTA Accession and Third-Country Bilateral Trade



imagine that Country A enters into an IPR-related PTA, thus upgrading its IPRs regime, with the explicit purpose of affecting its trade with Country B—if that were the case, Country A could unilaterally improve its IPRs standards without the effort of negotiating and enacting a PTA: for instance, by acceding to international treaties on IPRs or adopting TRIPS-Plus standards of its own volition. The policy treatment of IPR-related PTA accession is thus arguably exogenous with respect to members' trade with non-PTA members. This third-country mechanism in the context of PTAs with IPRs chapters is a novel contribution to the existing literature.

Figure 3 presents a specific case where the existence of a third-country effect is evident in the data by portraying the average bilateral trade in biopharmaceuticals of low-income US IPR-related PTA partners in an event-study framework. Here, the year 0 is the year in which each country entered into an IPR-related PTA with the US, with the value of imports in each panel normalized to equal 100 in this year. The first panel depicts imports from the US, an increase that is expected to be one of the first-order effects of PTA accession, IPRs-related or otherwise. On average, low-income partners' imports of biopharmaceuticals from the US increases in the wake of the formation of the PTA—a reduction in barriers to trade leads to more trade, and the trend in the growth of trade is elevated after the agreements are enacted. The second panel, however, presents a more surprising finding. This series depicts average bilateral trade with all non-US partners (or, in the case of multilateral PTAs such as NAFTA or CAFTA, all non-PTA partner trade). Strikingly, average imports from countries besides the US increase substantially after the enactment of the

Figure 3: Bilateral Pharmaceutical Trade of Low-income US IPR-related PTA Members: Imports with US and Other Partners



Notes: Each point represents the average value of PTA members' bilateral imports (averaged across all non-US partners in the second panel) in the indicated number of years before or after the formation of each country's PTA with the US., with a local polynomial smoother fitted over the first and second halves of the 10-year interval. The value of trade flows with each partner type (US versus average non-US) is normalized such that the value of bilateral trade in the year that the PTA with the US entered into force is equal to 100.

PTA, with imports departing dramatically from their pre-PTA trend. This phenomenon is at odds with a notion of trade diversion, and goes against the idea that the effects of the PTA are confined principally to trade between PTA members. And, unless the represented PTA member countries systematically cut their MFN tariff rates, entered into other trade agreements, or enacted other trade- or IPR-related policies at the same time they entered into a PTA with the US, then on its face, this is strong evidence for the existence of the third-country mechanism.[6] Whether this effect persists for other sectors and partner types after controlling for other factors will be the focus of the next section.

[6]To echo the argument from earlier, it could be that PTA formation tended to coincide with countries coming into compliance with TRIPS, and that TRIPS was the driver of this change in IP-intensive commodity trade. Thus, I control for the timing of TRIPS compliance in the econometric framework, both by directly controlling for TRIPS compliance and through the definition of the IPR-related PTA treatment.

4 Empirical Analysis

In this section, I employ a panel of sector-level bilateral trade data for 187 countries (and thus $187 \times 186 = 34{,}872$ potential country-pair linkages), with coverage over the years 1995 to 2014 (a period over which numerous US and European IPR-related preferential trade agreements were negotiated and entered into force), to examine the role that IPR-related PTAs play in determining the composition and magnitude of members' third-country trade flows. I construct the dependent variable—unidirectional trade flows between bilateral country pairs in a given year/sector—in the following way. For bilateral linkages between countries that will enter into an IPR-related PTA (as defined above) at any point in the sample, or have entered into an IPR-related PTA, I omit these linkages' observations from the analysis. In the context of the mechanism depicted in Figure 2, I discard all observations on trade between each Country A and the US, the EU, or EFTA (depending on which set of partners Country A forms a PTA with), both before and after the formation of the PTA—this includes trade in both directions. This means that identification of the third-country effect is based on observations of bilateral trade between Country A and extra-PTA countries such as Country B. Observations on all other linkages are preserved, which includes trade flows for bilateral pairs in which neither country is an IPR-related PTA member, as well as trade between third countries and the US, the EU, or EFTA. This approach exploits variation in countries' accession to IPR-related PTAs with the US or Europe, and considers whether the policy effects vary across industrial sectors or along lines of national development levels, exploiting the third-country mechanism to isolate the impact of PTAs' IPR provision on extra-PTA trade. In estimating the effect of the policy of interest on bilateral trade, the gravity framework is a natural approach, and I take efforts to tailor the methodology to address the pitfalls with the gravity approach outlined in, for instance, Anderson and van Wincoop (2003), Baier and Bergstrand (2007), and Head and Mayer (2014).

The policy treatment of IPR-related PTA accession is defined by the indicator variables IPA_{it} and IPA_{jt}, which, within an observation, will denote respectively exporter i's or importer j's membership in year t in an IPR-related PTA with the US or Europe that entered into force after the country's compliance with TRIPS.[7] The variables switch from zero to one in the year that a particular

[7] I define the timing of the policy relative to TRIPS implementation in such a way to disentangle the effects of TRIPS compliance from the provisions of the PTA, and because pre-TRIPS agreements generally possess weaker language

country enters into such an agreement, and remain equal to one as long as the country remains party to the agreement.[8] For example, since Chile's PTA with the US entered into force in 2004, then for all observations for the year 2004 and later in which Chile is an exporter, IPA_{it} is equal to one, and for all observations in which Chile is an importer, IPA_{jt} is equal to one. To emphasize the interpretation of the IPA variables, it is important to note once more that they correspond to third-country effects, which give the impact of i's (j's) membership in an IPR-related PTA on i's (j's) trade with some extra-PTA member j (i)—hence the variable's definition being specific to a single country in a bilateral linkage.[9]

There are several factors (both observable and unobservable) that might confound the estimates, and I take steps to mitigate their influence. Given the time frame over which the IPR-related PTAs in the sample were implemented, the concern could be raised that a contemporaneous policy change was effected for nearly all of the countries in the sample in the form of the TRIPS agreement. After its enactment as a result of the Uruguay Round of WTO negotiations, WTO member countries gradually undertook the process of implementing and complying with its provisions, and if IPRs indeed influence trade flows, and if TRIPS implementation is correlated in some way with IPR-related PTA accession (e.g., because member countries systemically undertake an assortment of efforts to upgrade their IPRs), then neglecting to control for the impact of TRIPS would bias the estimate of the effect of IPR-related PTA membership.[10] I thus control for countries' compliance with the TRIPS agreement as of year t with the indicator variables $TRIPS_{it}$ and $TRIPS_{jt}$, defined analogously to the IPA variables, estimating compliance dates based on the methodology

on IPRs than their post-TRIPS counterparts. Even though NAFTA contains IPR standards that are stronger than those of TRIPS, this policy definition precludes NAFTA's consideration as a pre-TRIPS IPR-related PTA (though I find that the results are not sensitive to this particular treatment of the NAFTA countries). If the analysis instead considers any IPR-related PTA negotiated with the US or Europe, either pre- and post-TRIPS, the results are qualitatively similar.

[8]Since no countries exited any of the IPR-related PTAs during the sample, the variable effectively switches on once and stays that way for the remainder of the sample. A handful of countries—Chile, Mexico, Peru, and Colombia—have entered into agreements with both the US and Europe. Treatment status for these countries is defined in the same way as countries party to only one IPR-related PTA; the policy variable switches from zero to one and stays equal to one, even after a second IPR-related PTA is entered into.

[9]A separate exercise would be to consider trade between countries belonging to the same IPR-related PTA (i.e., to introduce a variable IPA_{ijt}), but such an exercise would identify a different effect. It would also be difficult in such an exercise to disentangle the generic effects of PTAs from the IPR effects. See Campi and Dueñas (2017) for work in this direction.

[10]While developed countries were able to comply with TRIPS quickly (with most advanced economies in compliance by 1995), countries identifying as developing were given more leeway in their timelines for compliance. In general—but with several notable exceptions—developing economies were given until 2001 to be in compliance with the IPRs standards required by TRIPS. Even so, for many economies nominally in compliance with the agreement, adherence to its provisions is often imperfect. Least-developed countries were exempted from any compliance deadline, and even today many of these countries are not in compliance with TRIPS.

used in Park (2008), Hamdan-Livramento (2009), and Delgado et al. (2013).

4.1 Data

The data on bilateral trade flows is based on the BACI dataset from *Centre d'Études Prospectives et d'Informations Internationales* (CEPII, see Gaulier and Zignago 2010), which contains the value of bilateral trade flows at the 6-digit level by Harmonized System (HS) classification for every potential country pair from 1995 onward. I initially assign each HS commodity code as belonging to either an IPR-intensive ("high-IP") or IP-unintensive ("low-IP") Standard International Trade Classification (SITC) Revision 3 code, based on the categorization by Delgado et al. (2013) of SITC industries based on the extent to which they depend on IPRs. Since the original trade data is classified by HS commodities and the industry categorization of Delgado et al. (2013) is based on SITC, each 6-digit HS commodity is assigned to an SITC code based on the HS-SITC correspondence prepared by the Eurostat RAMON database (Eurostat, 2017). High-IP industries are industries that are generally most reliant on different forms of IPRs (patents, copyrights, trademarks, and others) to safeguard their knowledge assets—industries including, for example, chemicals and pharmaceuticals (patent-intensive), beverages and automobiles (trademark-intensive), or printed matter and recorded media (copyright-intensive). Low-IP industries are ones that rely relatively less on such rights: for instance, industries such as food and live animals, manufactures of leather or wood, or inedible crude materials. To have a clearly defined treatment and control set of industries, those industries that are classified as being neither high-IP nor low-IP are not assigned to either category, and are not included in the estimation.[11]

I further divide the high-IP industries into several IPR-intensive subsectors to measure the effects of IPR-related PTA accession at a more refined industrial level. Industries are assigned to the IPR-intensive subsectors defined by Delgado et al. (2013) based on a classification of IPR-intensive US industries by the US Department of Commerce (2012). These subsectors include analytical instruments (AI), biopharmaceuticals (BIO), chemicals (CHEM), information and communications technology (ICT), medical devices (MED), and production technology (PT), and other

[11] See the Appendix for a description of the data sources and data construction process. Appendix Table A1 presents the sources for each variable used in the analysis. Table A2 lists the countries used in the empirical analysis as well as their respective income group classifications. For a full list of high-IP industries broken down by mode of IPR-intensiveness, as well as the low-IP industry definitions, and associated SITC codes, see Appendix Table A3.

high-IP goods belonging to none of the above categories (Other). Given results from the existing literature, along with the numerous sector-specific emphases embedded in IPR-related PTAs, noticeable differences might materialize in the extent to which trade in different sectors is affected by IPRs-upgrading.

Finally, since much of the existing literature focuses on the differential effects of IPRs on economies at different stages of development, I assign countries to one of four different income groupings based on per capita incomes, taken from the World Bank's classification (World Bank, 2016): low income (denoted LI), lower-middle income (LMI), upper-middle income (UMI), and high income (HI). To account for the potentially endogenous relationship between the value of trade and per-capita incomes, I fix countries' income classification at their levels at the beginning of the sample (1995).

Table 3 briefly summarizes the features of the countries in the data at the start of the sample, broken down by income groupings. I denote those countries that enter into an IPR-related PTA with the US or Europe at any point in the sample as "member countries," and those that do not as "non-member countries." Included in the table are averages of countries' GDPs as well as aggregate values of exports and imports in high-IP and low-IP industries (defined in more detail in the next subsection), commodities the production of which is respectively intensive in or unintensive in the use of different types of IPRs.

Within income groups, member countries are generally similar to non-member countries with respect to economy size, with the exception of the upper-middle income group, in which non-members tend to be larger at the beginning of the sample in a statistically significant way. In terms of the volume of trade that the two types of countries undertake, no statistically significant systematic differences exist, again with the exception of the upper-middle income countries—though much of this difference is likely explained by the disparity in the average sizes of these countries. Whether these differences exist after controlling for factors such as economy size and other country-level characteristics will be revealed in the econometric analysis. Though on their face, these summary statistics can only reveal a limited amount of information, they are reassuring in that the countries that select into IPR-related PTAs do not seem to do so because they initially undertake high or low levels of trade in IPR-intensive commodities.

Table 3: Sample Summary Statistics (1995)

	Member countries		Non-member countries		Difference	
Variable	Mean	Std. dev.	Mean	Std. dev.	Mean	t-stat
High income (HI, 38 countries)						
GDP	499.74	648.38	825.51	2,179.54	−325.77	−0.65
High-IP trade	113.81	121.86	77.51	177.25	36.30	0.75
Low-IP trade	58.26	57.12	40.21	80.66	18.05	0.81
Upper-middle income (UMI, 25 countries)						
GDP	24.53	38.68	158.33	225.58	−133.80	−2.11*
High-IP trade	5.77	7.31	22.91	29.28	−17.14	−2.05*
Low-IP trade	4.95	5.74	18.85	17.17	−13.90	−2.76**
Lower-middle income (LMI, 61 countries)						
GDP	22.88	34.70	41.84	79.53	−18.96	−1.03
High-IP trade	3.67	5.17	5.91	13.07	−2.25	−0.77
Low-IP trade	4.42	4.89	7.30	12.60	−2.88	−1.02
Low income (LI, 63 countries)						
GDP	2.89	1.97	25.33	108.02	−22.44	−0.36
High-IP trade	0.64	0.51	3.53	20.65	−2.89	−0.24
Low-IP trade	1.35	1.23	3.87	16.45	−2.52	−0.26

Notes: Data and income classifications are for the year 1995 (the beginning of the sample period). "Member countries" are those countries that enter into a post-TRIPS IPR-related PTA with the US or Europe at any point in the sample, while "Non-member countries" do not. High-IP and low-IP trade values are the sum of total exports and imports of the respective sectors. GDP and trade values are presented in current billion USD. The t-statistic in the rightmost column gives the statistic on the test of common means between member and non-member countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

4.2 Trade in High-IP vs. Low-IP Commodities

There are several issues with typical formulations of gravity that I address in the empirical approach. First, the omission of zeroes in bilateral trade flows has been highlighted as a potential source of bias in OLS estimates of the gravity equation, given that the natural logarithm of zero is undefined. Several approaches have been suggested to address this while preserving the log-linearity of the estimation, such as adding one to each observation and estimating a tobit regression to account for the leftward censoring of the data, or the introduction of a correction term for selection bias following Heckman (1979).[12] Alternatively, some researchers have pro-

[12] Implementing the Heckman selection correction in a gravity framework can be problematic, since in the first stage of estimating selection into a zero versus non-zero trade linkage, the inclusion of at least one instrumental variable is required such that the variable (i) predicts whether a trade flow is zero or not, and (ii) is uncorrelated with trade

posed estimating the underlying structural gravity model via a non-linear least squares approach, though the assumptions necessary to ensure the consistency of such estimates can be unrealistic. A second issue, as detailed in Santos Silva and Tenreyro (2006), is that the log-linearization of the underlying structural gravity relationship introduces heteroskedasticity which can potentially bias the estimates of gravity coefficients, including those on policy variables such as trade agreement membership. The estimator described by Santos Silva and Tenreyro (2006) addresses both of the above issues, wherein the underlying gravity relationship is not log-linearized for estimation via OLS, but rather, estimated with trade flows in their original levels via a Poisson Pseudo-Maximum Likelihood (PPML) estimator, an approach first outlined in Gourieroux et al. (1984). PPML estimates of the gravity equation have been shown to produce consistent estimates of gravity coefficients and are robust to various forms of heteroskedasticity, with the estimates generated using PPML often deviating drastically from those produced with a more traditional log-linear gravity approach.[13]

In the baseline specification, I consider the relationship between the value of bilateral trade in high-IP versus low-IP industries and IPR policies. To motivate the estimation approach, consider the following formulation of the gravity equation as depicted in equation (1), which describes unidirectional bilateral trade flows as a function of economy sizes, the IPA and $TRIPS$ policy variables, and other terms:

$$\begin{aligned} T_{ijst} = \exp\Big\{ & \beta_1 \log\left(GDP_{it}\right) + \beta_2 \, High\text{-}IP_s \times \log\left(GDP_{it}\right) \\ & + \beta_3 \log\left(GDP_{jt}\right) + \beta_4 \, High\text{-}IP_s \times \log\left(GDP_{jt}\right) \\ & + \beta_5 \, Low\text{-}IP_s \times IPA_{it} + \beta_6 \, High\text{-}IP_s \times IPA_{it} \\ & + \beta_7 \, Low\text{-}IP_s \times TRIPS_{it} + \beta_8 \, High\text{-}IP_s \times TRIPS_{it} \\ & + \beta_9 \, Low\text{-}IP_s \times IPA_{jt} + \beta_{10} \, High\text{-}IP_s \times IPA_{jt} \\ & + \beta_{11} \, Low\text{-}IP_s \times TRIPS_{it} + \beta_{12} \, High\text{-}IP_s \times TRIPS_{jt} \\ & + \alpha_i \, t + \alpha_j \, t + \alpha_{g_i st} + \alpha_{g_j st} + \alpha_{ij} \Big\} + \nu_{ijst}. \end{aligned} \tag{1}$$

flows. Variables that satisfy such an exclusion restriction are generally difficult to find; see Burger et al. (2009).

[13] On the differences in results between the two approaches, see, for instance, Burger et al. (2009), Egger and Tarlea (2015), or Larch et al. (2017).

The dependent variable is the unidirectional value of bilateral exports from exporter i to importer j in sector s in year t, which is denoted by T_{ijst}. In the baseline, s indexes IPR-intensive (high-IP) versus IPR-unintensive (low-IP) sectors. $High\text{-}IP_s$ and $Low\text{-}IP_s$ are indicator variables that respectively denote which sector s a particular observation represents. Given the gravity approach, I control for the size of each economy in a bilateral linkage by including both importer and exporter GDPs. I further allow for scale effects to vary across traded sectors through the sector-GDP interaction terms. The sector-specific income elasticities of trade, then, are given by β_1 for low-IP exports, $\beta_1 + \beta_2$ for high-IP exports, β_3 for low-IP imports, and $\beta_3 + \beta_4$ for high-IP imports. To be clear, since the approach estimates a third-country trade effect, the dependent variable here is unidirectional bilateral trade between countries that are not, and will not be, partners with the US or Europe in an IPR-related PTA. For instance, recalling again the example of Chile, the observations on Chilean bilateral trade exclude *all* of Chile's trade with the US, including trade in years before the signing of the agreement.[14]

The terms on the third line of equation (1) measure the impact of IPR-related PTA accession on the exports of country i in low-IP (β_5) and high-IP (β_6) industries.[15] Analogously for TRIPS, the fourth line of equation (1) depicts the effects on exporters of TRIPS compliance on both their low-IP (β_7) and high-IP (β_8) exports. The expressions on the fifth and sixth lines mirror the exporter terms, showing the respective effects on the importer j in a particular bilateral linkage of IPR-related PTA accession or TRIPS compliance.

I design the econometric specification in such a way that it controls for a wide range of unobserved factors. First, importer- and exporter-specific linear time trends ($\alpha_i\, t$ and $\alpha_j\, t$) are included, which capture disparities in trade flow dynamics across countries. It could be that countries that join IPR-related PTAs are countries whose openness to trade grows over the duration of the sam-

[14]I also perform the estimation using two other alternative samples: one in which no such restriction is applied to the data (and thus *all* bilateral trade flow observations are used), and one in which, rather than discarding all trade with current/future IPR-related PTA partners, I omit all bilateral trade with the US/EU/EFTA, even for countries that never enter into an IPR-related PTA with these countries. Results that estimate equation (2) using these alternative samples are presented in Appendix Table A5.

[15]Note that this specification yields equivalent results to one with a main effect common across all industries and an industry specific interaction, but with a slightly different interpretation; e.g. if instead of $\beta_5\, Low\text{-}IP_s \times IPA_{it} + \beta_6\, High\text{-}IP_s \times IPA_{it}$, the relevant terms were instead $\beta_5\, IPA_{it} + \beta_6\, High\text{-}IP_s \times IPA_{it}$. In this alternative case, β_5 would be the total effect of IPR-related PTA accession on low-IP exports (the main effect), and $\beta_5 + \beta_6$ would be the total effect of IPR-related PTA accession on high-IP exports (the main effect plus the interaction effect). In the more detailed specifications, such an assortment of main effects and interactions would make interpretation extremely cumbersome; hence, I adopt this specification which yields the total sector-income group-specific effect with a single term.

ple for reasons unrelated to IPR-related PTA accession. By controlling for these trends I account for differences in the dynamics of trade flows that might otherwise be attributed to the policy of interest. I further include importer and exporter income group-sector-year fixed effects ($\alpha_{g_i st}$ and $\alpha_{g_j st}$, where g_i and g_j denote respectively the income group of the exporter and importer in a given bilateral pair), which encompass year-specific shocks that could vary across income groups and sectors—these factors could include, for instance, supply shocks that are common across sectors, income group-specific demand shocks, global macroeconomic fluctuations, or some combination of either. Finally, it is generally the case that traditional gravity approaches control for determinants of bilateral trade costs such as geographical distance or whether a trading pair shares a common border, language, or colonial history. I sidestep the choice of variables to include in this direction with the inclusion of a country-pair fixed effect α_{ij}, which controls for all unobserved, time-invariant factors that affect bilateral trade flows.[16] Finally, ν_{ijst} is an error term.

What should the effects of the IPR policy variables above be based on the earlier discussion and results from the existing literature? When countries upgrade their IPR regimes, either via PTAs or TRIPS, insignificant or negative estimates on the low-IP export effects β_5 and β_7 and positive coefficients on the high-IP export effects β_6 and β_8 might materialize as stronger IPRs shift comparative advantage towards specialization in IPR-intensive industries and away from IPR-unintensive industries. Ultimately, the effects are likely to vary across levels of development. For many reasons (including imitative capacity or the quality of other institutions besides IPRs), the effects of stronger IPRs might be different for least-developed countries, versus countries in the middle of the income distribution, versus advanced industrial economies. Thus, while I introduce equation (1) (which implicitly assumes homogeneous policy impacts across countries at different levels of developments, as assumption generally rebutted in the literature) to motivate the empirical analysis, the estimates of this equation are not presented here. Instead, I expand on this basic specification by allowing for the effects of IPR-related PTA and TRIPS accession to vary between low income, lower-middle income, upper-middle income, and high-income countries.[17]

[16]Note that in addition to controlling for time-invariant bilateral variation, α_{ij} also encompasses the inclusion of country-level fixed effects α_i and α_j, as α_{ij} is perfectly collinear with a linear combination of α_i and α_j terms. Intuitively, controlling for the time-invariant features of each bilateral pair also controls for the time-invariant features of the countries themselves.

[17]I further test whether the results are sensitive to the choice of income groupings, i.e., the 1995 World Bank classification. As alternatives, I employ (i) the World Bank classification for the year 2000, (ii) quartiles of GDP per capita levels in 1995 and 2000, and (iii) terciles of GDP per capita levels in 1995 and 2000. The findings are qualitatively

Equation (2) is similar to equation (1), but now, the IPA and $TRIPS$ variables are interacted with the income group of the importer or exporter—thus, the policy effects originally captured by coefficients β_5 through β_{12} are now allowed to differ across income groups:

$$\begin{aligned}
T_{ijst} = \exp\Big\{ & \beta_1 \log\left(GDP_{it}\right) + \beta_2\, High\text{-}IP_s \times \log\left(GDP_{it}\right) \\
& + \beta_3 \log\left(GDP_{jt}\right) + \beta_4\, High\text{-}IP_s \times \log\left(GDP_{jt}\right) \\
& + \sum_g \beta_{5g}\, Group_i^g \times Low\text{-}IP_s \times IPA_{it} + \sum_g \beta_{6g}\, Group_i^g \times High\text{-}IP_s \times IPA_{it} \\
& + \sum_g \beta_{7g}\, Group_i^g \times Low\text{-}IP_s \times TRIPS_{it} + \sum_g \beta_{8g}\, Group_i^g \times High\text{-}IP_s \times TRIPS_{it} \\
& + \sum_g \beta_{9g}\, Group_j^g \times Low\text{-}IP_s \times IPA_{jt} + \sum_g \beta_{10g}\, Group_j^g \times High\text{-}IP_s \times IPA_{jt} \\
& + \sum_g \beta_{11g}\, Group_j^g \times Low\text{-}IP_s \times TRIPS_{jt} + \sum_g \beta_{12g}\, Group_j^g \times High\text{-}IP_s \times TRIPS_{jt} \\
& + \alpha_i\, t + \alpha_j\, t + \alpha_{g_i st} + \alpha_{g_j st} + \alpha_{ij} \Big\} + \nu_{ijst}.
\end{aligned} \tag{2}$$

$Group_i^g$ and $Group_j^g$ are indicator variables that denote whether exporter i or importer j belongs to income group $g \in \{\text{LI}, \text{LMI}, \text{UMI}, \text{HI}\}$. With three dozen coefficients of interest to interpret (2 sectors $\times$ 4 income groups $\times$ 2 policies for both importers and exporters), this is a complicated regression equation.[18]

Turning to estimation, the results from estimation of equation (2) are shown in Table 4.[19] Columns (1) and (2) respectively display the exporter and importer coefficients, both of which are generated by the same regression. Because of the inclusion of the bilateral pair fixed effect α_{ij}, observations on bilateral linkages where trade is always zero—e.g. Afghanistan is never recorded as exporting to Zimbabwe during the years in the sample—must be omitted, since this fixed effect perfectly predicts trade between such pairs. It is important to note that the estimates in both columns are from the same regression, with exporter and importer effects "unstacked" to facilitate

unchanged with the use of these alternative definitions.

[18] To illustrate the correct interpretation, consider the impact of exporter i's accession to an IPR-related PTA on its high-IP exports. The exact effect depends on the income group of i, and is given by either β_{6LI}, β_{6LMI}, β_{6UMI}, and β_{6HI}; for instance, a low-income country will see a difference of β_{6LI} on its high-IP exports. Similar interpretations will apply to the other sector, group, and policy combinations.

[19] Only recently have algorithms been developed to efficiently estimate relationships with a large number of high-dimensional fixed effects such as ours. I implement the PPML estimation using a modification of the iterative Gauss-Seidel algorithm of Guimarães and Portugal (2010) based on the `reghdfe` module for Stata by Sergio Correia (2014).

their presentation.[20]

I first focus on the results for exporters in column (1). The income elasticities of exports are significantly positive, and broadly conform to previous estimates from the literature. The income elasticity with respect to high-IP exports ($0.129 + 0.373 = 0.512$) is larger than for low-IP exports (0.129), suggesting that larger economies tend to specialize more in IPR-intensive industries. With regard to the *IPA* policy variable interactions, I find statistically significant effects that broadly conform to might be expected to arise from the strengthening of IPR regimes. The low-IP exports of low-income countries to third countries do not seem to be impacted, but countries at middle and high levels of development (LMI, UMI, and HI) see their exports of low-IP goods decline, with respective coefficients for LMI and UMI countries of -0.265, -0.748, and -0.222, each of which is significant at the 95% level. These estimates correspond to average reductions in low-IP bilateral trade with third countries of -23.3% ($= \left(e^{-0.265} - 1\right) \times 100\%$), -52.7% ($= \left(e^{-0.748} - 1\right) \times 100\%$), and -19.9% ($= \left(e^{-0.222} - 1\right) \times 100\%$) for PTA members in these respective income groups.[21]

That low-IP exports to third-countries decline for certain types of PTA members accords with ex ante intuition on the structure of comparative advantage as it relates to IPRs; what, then, can be said about high-IP exports, which might be expected to increase when PTA members implement stronger IPRs? As with their low-IP exports, the exports of low-income countries in high-IP industries do not seem to be impacted in a statistically significant way. However, the decline in low-IP exports for members three highest income groups is accompanied by a profound increase in high-IP exports. These estimates imply increases in high-IP exports of 47.4% for LMI countries, 60.2% for UMI countries, and 18.9% for HI countries. While it is not possible from the reduced-form analysis to determine the precise origin of these effects, the relative magnitudes of the coefficients across income groups hint at a potential explanation beyond a basic restructuring of comparative advantage.

First, it could be the case that LI countries are unequipped to realize the impacts of IPRs-

[20] A version of equation (2) is also estimated without controls for TRIPS compliance, with the results shown in Appendix Table A4. Estimates on the *IPA* interactions are largely similar, but dramatic differences in certain coefficients suggests that omitting TRIPS compliance would bias the results.

[21] This percentage change expression of the coefficients results from the exponential relationship between T_{ijst} and the binary policy variables. For some $y = \exp\{\beta_1 x_1 + \beta_2 x_2\}$, where x_1 is an indicator variable, the percentage difference in the value of y when $x_1 = 1$ versus when $x_1 = 0$ is given by $\left(\frac{\exp\{\beta_1+\beta_2 x_2\} - \exp\{\beta_2 x_2\}}{\exp\{\beta_2 x_2\}}\right) \times 100\%$, which, after manipulation, simplifies to $\left(e^{\beta_1} - 1\right) \times 100\%$.

Table 4: Bilateral Trade in Low-IP and High-IP Sectors (excluding trade with current or future IPR-related PTA partner)

	(1) Exports	(2) Imports
log(GDP)	0.129***	0.533***
	(0.036)	(0.032)
High-IP × log(GDP)	0.373***	0.023
	(0.033)	(0.034)
LI × Low-IP × IPA	−0.131	−0.264*
	(0.107)	(0.154)
LMI × Low-IP × IPA	−0.265***	−0.003
	(0.097)	(0.066)
UMI × Low-IP × IPA	−0.748***	−0.062
	(0.143)	(0.099)
HI × Low-IP × IPA	−0.222**	0.029
	(0.100)	(0.079)
LI × High-IP × IPA	−0.064	0.298**
	(0.215)	(0.134)
LMI × High-IP× IPA	0.388***	0.019
	(0.111)	(0.078)
UMI × High-IP × IPA	0.471***	0.258***
	(0.155)	(0.082)
HI × High-IP × IPA	0.173***	−0.031
	(0.067)	(0.068)
LI × Low-IP × TRIPS	−0.298***	0.230**
	(0.077)	(0.107)
LMI × Low-IP × TRIPS	−0.561***	0.146**
	(0.084)	(0.058)
UMI × Low-IP × TRIPS	−0.488***	−0.173**
	(0.077)	(0.078)
HI × Low-IP × TRIPS	0.451***	0.068
	(0.102)	(0.096)
LI × Low-IP × TRIPS	0.595***	0.354***
	(0.115)	(0.097)
LMI × Low-IP × TRIPS	1.428***	−0.079
	(0.154)	(0.049)
UMI × Low-IP × TRIPS	1.130***	0.137**
	(0.163)	(0.055)
HI × Low-IP × TRIPS	0.150**	0.012
	(0.074)	(0.059)
Observations		1,055,276
No. of country pairs		27,892
Country trends		✓
Group-sector-year FEs		✓
Pair FEs		✓

Notes: The dependent variable is bilateral trade flows excluding trade with future/current IPR-related PTA partners. Columns (1) and (2) present exporter and importer coefficients from the same regression. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

upgrading—other impediments to trade, such as underdeveloped institutions in areas besides IPRs, impede these countries' ability to develop and maintain robust export sectors in IPR-intensive industries. Exports of LMI countries, however, are affected by IPRs-upgrading, but these countries seem to be able to only imperfectly benefit from their effects: as with LI countries, it might be that other institutional features of these countries inhibit the role of improved IPRs in influencing comparative advantage. The exports of UMI countries, on the other hand, are significantly impacted: the twin facts that the magnitude of increase in high-IP exports is larger than the reduction in low-IP exports ($60.2\% > |-52.7\%|$), and that these countries tend to have higher levels of exports in high-IP industries than low-IP industries, means that these countries see their overall trade with countries outside of their PTA increase—the exact opposite of trade diversion. Finally, HI members also see their high-IP exports rise and their low-IP exports fall, but much less so than LMI and UMI PTA members. The reasons for this could be twofold. HI countries tend to be large economies, and large changes in exports (in percentage terms) are comparatively more difficult to realize (for instance, it is likely easier to effect a 10% increase in $10 billion of exports than it is $10 trillion of exports). Further, these economies—countries such as Australia, South Korea, or Singapore—tend to already possess relatively advanced domestic IPR regimes, and for such countries, the impacts of the IPR provisions in PTAs are likely to be marginal. All-in-all, the effects on exports seem to be consistent with a pronounced effect on the structure of comparative advantage as determined by IPRs.

Turning now to the importer effect estimates of IPA (column (2) in Table 4), I estimate a significantly positive income elasticity on imports (with an estimate of 0.533), with no significant difference between the low-IP and high-IP income effects. Significant effects on imports of IPR-related PTA accession fail to arise to the same degree as with exports, with the exceptions of weakly negative effects on the low-IP imports of LI countries, and positive effects on the high-IP imports of LMI and HI countries. This (lack of a) result suggests several interpretations. First, that any effects of IPR-related PTA accession are concentrated on the export side, and the countervailing effects described earlier make it difficult to observe systematic impacts on imports. Or, it could be that importer effects do exist, but are masked by the level of aggregation in this specification. In the next section, the high-IP sector is disaggregated into a more detailed sectoral breakdown, which will shed more light on the seemingly absent importer effects.

Though TRIPS is not the primary focus of the analysis, it is worthwhile to briefly describe what the estimates of the associated coefficients convey (in the empirical exercises to follow, discussion of the TRIPS estimates will be omitted for the sake of exposition). The export results in column (1) seem to mirror the estimates of the IPA export coefficients. Across all levels of income, TRIPS compliance corresponds to substantial decreases in low-IP exports (though only in a statistically significant way for LI, LMI, and UMI countries) and substantial increases in high-IP exports (for all income groups). This has an important implication for the results on IPA: it is not TRIPS alone, nor IPR-related PTAs alone, that impact trade via the IPRs channel. The policies seem to operate in tandem, and IPR-related PTA accession offers a channel for IPRs upgrading with marginal impacts that go beyond those of TRIPS.

4.3 Trade in IPR-intensive Subsectors

The most important takeaway thus far is the finding of significant effects of IPR-related PTA accession on exports to extra-PTA third countries in low-IP and high-IP sectors consistent with an IPRs-induced restructuring of comparative advantage. This was coupled with nebulous effects on imports, which, despite their ambiguity, were also consistent with the predictions from earlier. A natural question that follows, then, is how these effects break down along more disaggregated sectoral breakdowns. Based on the discussion in Section 2, the specific nature of the provisions in each agreement suggest that the impacts might be manifested more strongly in particular sectors (e.g., for provisions such as test data confidentiality and prohibitions on generic competition, the most apparent impacts on trade might arise in biopharmaceuticals and chemicals, while expanded protections for integrated circuit designs might imaginably be most applicable to trade in ICT-related commodities). Further, beyond the sector-specificity of certain provisions, IPR-intensive sectors vary in just how intensively they rely on certain rights; stronger patents, copyrights, and trademarks, or more effective enforcement, for instance, might affect certain industries more than others. Along these lines, I modify the specification from equation (2) to allow for a more refined breakdown of the high-IP sector. To do this, I divide the high-IP commodities into seven IPR-intensive subsectors (in a categorization based on Delgado et al. 2013 and US Department of Commerce 2012): these subsectors include analytical instruments ("AI"), biopharmaceuticals

("BIO"), chemicals ("CHEM"), information and computer technology ("ICT"), medical devices ("MED"), production technology ("PT"), and a residual category of high-IP commodities that fall under none of these categories ("other").[22] The estimating equation that I now employ is otherwise the same as before, but I can now delineate the effects of IPR-related PTA accession in the following way:

$$
\begin{aligned}
T_{ijst} = \exp\Big\{ & \beta_1 \log\left(GDP_{it}\right) + \sum_s \beta_{2s}\, Sector_s \times \log\left(GDP_{it}\right) \\
& + \beta_3 \log\left(GDP_{jt}\right) + \sum_s \beta_{4s}\, Sector_s \times \log\left(GDP_{jt}\right) \\
& + \sum_g \beta_{5g}\, Group_i^g \times Low\text{-}IP_s \times IPA_{it} + \sum_g \sum_s \beta_{6gs}\, Group_i^g \times Sector_s \times IPA_{it} \\
& + \sum_g \beta_{7g}\, Group_i^g \times Low\text{-}IP_s \times TRIPS_{it} + \sum_g \sum_s \beta_{8gs}\, Group_i^g \times Sector_s \times TRIPS_{it} \\
& + \sum_g \beta_{9g}\, Group_j^g \times Low\text{-}IP_s \times IPA_{jt} + \sum_g \sum_s \beta_{10gs}\, Group_j^g \times Sector_s \times IPA_{jt} \\
& + \sum_g \beta_{11g}\, Group_j^g \times Low\text{-}IP_s \times TRIPS_{jt} + \sum_g \sum_s \beta_{12gs}\, Group_j^g \times Sector_s \times TRIPS_{jt} \\
& + \alpha_i\, t + \alpha_j\, t + \alpha_{g_i st} + \alpha_{g_j st} + \alpha_{ij} \Big\} + \nu_{ijst}.
\end{aligned} \tag{3}
$$

Here, s indexes the seven high-IP subsectors, with $s \in \{\text{AI}, \text{BIO}, \text{CHEM}, \text{ICT}, \text{MED}, \text{PT}, \text{Other}\}$. $Sector_s$ is an indicator variable for whether a specific observation belongs to a particular high-IP subsector. As before, each of the coefficients on the policy interactions reveal the total policy impact of either IPA or $TRIPS$, separately for exporters and importers, broken down along lines of countries' income levels and across the low-IP and high-IP subsectors. The triple interactions are admittedly even more cumbersome than the double interactions in the previous specification, but the interpretation will hopefully be no more difficult.[23]

Tables 5A and 5B show the results from estimating equation (3), again omitting trade between current and future IPR-related PTA partners.[24] Note again that each of the columns in the table are from the same regression, with the columns depicting the coefficients for each sector-specific

[22] See Appendix Table A3 for a full list of the industries and associated SITC codes comprising each of these subsectors.

[23] For instance, to obtain the effect of IPR-related PTA accession on the BIO imports of a lower-middle income country, the relevant coefficient would be the estimate of $\beta_{10LMI,BIO}$.

[24] Results from estimating equation (3) using all bilateral trade observations for this sectoral breakdown, including trade between current and future PTA partners, are shown in Appendix Tables A6A and A6B. Results using a sample that omits all trade with the US, the EU, or EFTA countries as partners are depicted in Appendix Tables A7A and A7B.

policy interaction, and that as before, both the exporter and importer effects are from the same regression (with the exporter effects given in Table 5A and the importer effects given in Table 5B). To facilitate interpretation of the numerous coefficients, I also graphically present the corresponding coefficient estimates—estimates of the effect on exporters or importers of IPR-related PTA accession, by sector and income group—with corresponding 95% confidence interval bands.

Turning to the results for the exporter effects, I estimate income elasticities of exports that are generally strongly and significantly positive, but which vary by sector. The elasticity with respect to low-IP exports is estimated to be only 0.124, but the elasticities for the high-IP subsectors range from 0.466 ($= 0.124 + 0.282$) for ICT to 0.747 ($= 0.124 + 0.623$) for MED. The estimates for the exporter coefficients for IPA offer a more nuanced picture than the one found in the simple high-IP versus low-IP sectoral breakdown. As before, the low-IP exports of LMI, UMI, and HI countries in IPR-related PTAs are lower on average, but these export losses are offset by sizable export gains in most of the high-IP subsectors, a result that is again consistent with IPRs playing a role in determining comparative advantage. While the exports of every high-IP subsector (aside from ICT exports, estimates for which are either statistically insignificant, or in the case of HI countries, exhibit a significant decline) are estimated to expand, the most sizable gains are to be found in biopharmaceutical trade. This should come as no surprise: the interests of the pharmaceutical industry coincide strongly the implementation of a strong international system of IPRs, given the R&D- and patent-intensive nature of the industry. When a country has a system of IPRs that favors creators and owners of knowledge assets—and pharmaceuticals are undoubtedly a commodity that embodies significant R&D and proprietary knowledge—on average its pharmaceutical sector sees its exports expand considerably (with estimated average increases of 644.1% for LMI countries, 604.3% for UMI countries, and 209.9% for HI countries). The fact that the PTAs negotiated by the US and Europe emphasize this sector so strongly leads to effects that spill over beyond the membership of the PTAs in profound ways. Other positive export effects arise in analytical instruments, chemicals, medical devices, production technology (aside from LI exports, which are surprisingly found to evince a negative effect), and other high-IP sectors, and the disparities in the estimates suggest that the impacts are highly sector-specific.

On the import side, significant results are again scattered across various income group-sector permutations, but certain results merit particular interest. The most striking result here is on

Table 5A: Bilateral Trade in Low-IP and High-IP Subsectors (excluding trade with current or future IPR-related PTA partner)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exporter effects								
log(GDP)	0.124***							
	(0.036)							
Sector × log(GDP)		0.610***	0.362***	0.405***	0.282***	0.623***	0.532***	0.383***
		(0.043)	(0.065)	(0.039)	(0.039)	(0.055)	(0.038)	(0.032)
Sector × LI × IPA	−0.079	0.092	0.272	−0.113	−0.791	1.260**	−0.655**	0.274
	(0.111)	(0.334)	(0.532)	(0.383)	(0.546)	(0.602)	(0.279)	(0.264)
Sector × LMI × IPA	−0.246**	0.939***	2.007***	0.338*	−0.121	0.995***	1.045***	0.482***
	(0.099)	(0.215)	(0.211)	(0.186)	(0.221)	(0.224)	(0.150)	(0.108)
Sector × UMI × IPA	−0.716***	1.534***	1.952***	0.325*	0.271	1.844***	0.624***	0.485***
	(0.146)	(0.230)	(0.254)	(0.186)	(0.279)	(0.288)	(0.193)	(0.110)
Sector × HI × IPA	−0.212**	0.461***	1.131***	0.523***	−0.453***	0.313***	0.586***	0.181**
	(0.099)	(0.099)	(0.158)	(0.086)	(0.098)	(0.116)	(0.113)	(0.072)
Sector × LI × TRIPS	−0.319***	0.380**	−0.469*	−0.216	1.698***	−0.493**	0.146	0.223*
	(0.078)	(0.167)	(0.283)	(0.183)	(0.160)	(0.207)	(0.157)	(0.120)
Sector × LMI × TRIPS	−0.559***	0.985***	1.227***	0.875***	2.812***	2.137***	1.207***	1.066***
	(0.083)	(0.289)	(0.254)	(0.223)	(0.180)	(0.253)	(0.201)	(0.147)
Sector × UMI × TRIPS	−0.489***	1.273***	1.451***	1.341***	1.624***	1.310***	1.732***	0.773***
	(0.077)	(0.252)	(0.229)	(0.173)	(0.198)	(0.224)	(0.173)	(0.145)
Sector × HI × TRIPS	0.432***	0.166	0.360*	0.149	−0.065	0.566***	0.376***	0.219***
	(0.102)	(0.134)	(0.191)	(0.108)	(0.116)	(0.197)	(0.113)	(0.071)
				⋮				

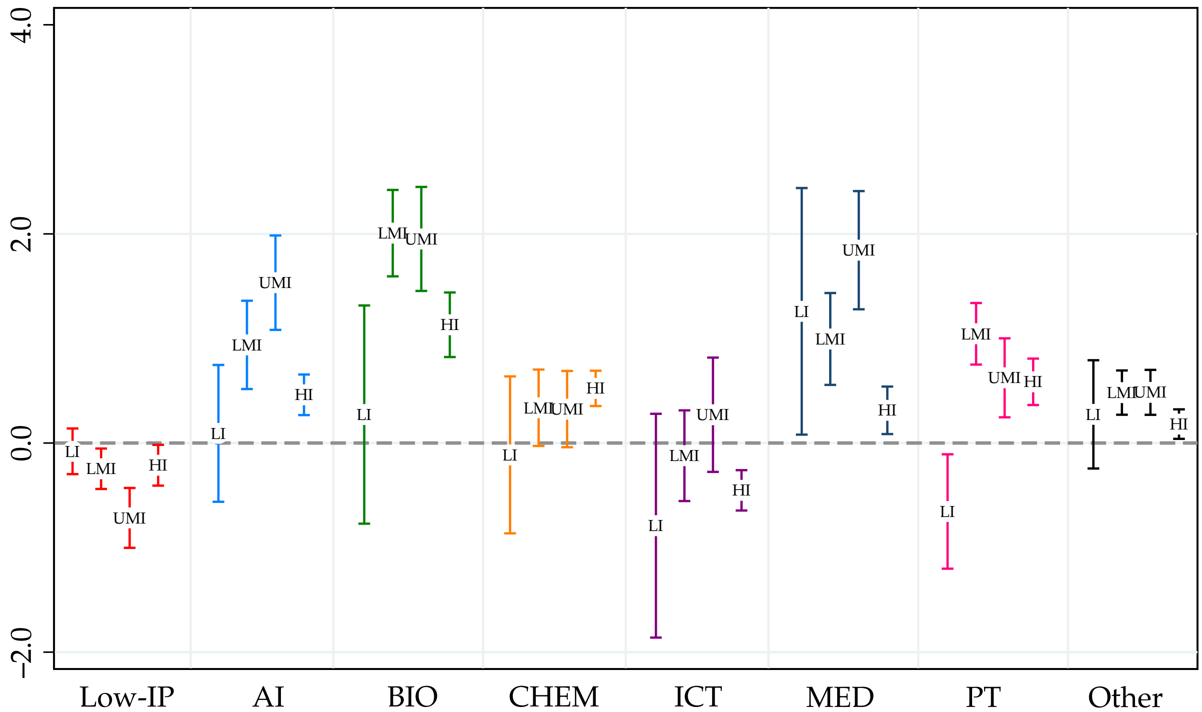
Table 5B: Bilateral Trade in Low-IP and High-IP Subsectors (excluding trade with current or future IPR-related PTA partner, cont.)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Importer effects								
log(GDP)	0.527***							
	(0.032)							
Sector × log(GDP)		0.142***	0.146***	0.070**	−0.046	0.159***	0.079**	0.032
		(0.033)	(0.045)	(0.028)	(0.053)	(0.038)	(0.033)	(0.030)
Sector × LI × IPA	−0.139	0.065	2.893***	0.585**	−0.858***	1.147***	0.213	0.652***
	(0.168)	(0.218)	(0.365)	(0.250)	(0.248)	(0.273)	(0.190)	(0.136)
Sector × LMI × IPA	−0.004	−0.018	0.388*	−0.123	0.022	0.511***	−0.132	0.017
	(0.068)	(0.175)	(0.211)	(0.127)	(0.162)	(0.150)	(0.105)	(0.080)
Sector × UMI × IPA	−0.082	0.080	0.225	−0.358***	0.629***	0.037	0.082	0.086
	(0.102)	(0.110)	(0.218)	(0.137)	(0.174)	(0.149)	(0.113)	(0.076)
Sector × HI × IPA	0.027	0.102	0.498***	0.358***	−0.155	0.211*	0.069	−0.063
	(0.079)	(0.104)	(0.166)	(0.116)	(0.127)	(0.115)	(0.121)	(0.063)
Sector × LI × TRIPS	0.207*	0.078	−1.414***	0.213*	1.376***	−0.501***	0.144	0.094
	(0.106)	(0.137)	(0.271)	(0.129)	(0.175)	(0.160)	(0.147)	(0.089)
Sector × LMI × TRIPS	0.141**	−0.064	−0.331**	0.309***	0.455***	−0.478***	−0.290***	−0.157***
	(0.058)	(0.120)	(0.161)	(0.070)	(0.131)	(0.108)	(0.081)	(0.050)
Sector × UMI × TRIPS	−0.171**	0.251***	−0.019	0.312***	0.526***	−0.018	0.025	−0.018
	(0.078)	(0.078)	(0.156)	(0.088)	(0.125)	(0.122)	(0.058)	(0.046)
Sector × HI × TRIPS	0.052	−0.022	0.150	−0.197**	0.162	0.428***	−0.259**	−0.023
	(0.095)	(0.114)	(0.145)	(0.099)	(0.141)	(0.107)	(0.113)	(0.066)
Observations								4,220,144
No. of country pairs								27,886
Country trends								✓
Group-sector-year FEs								✓
Pair FEs								✓

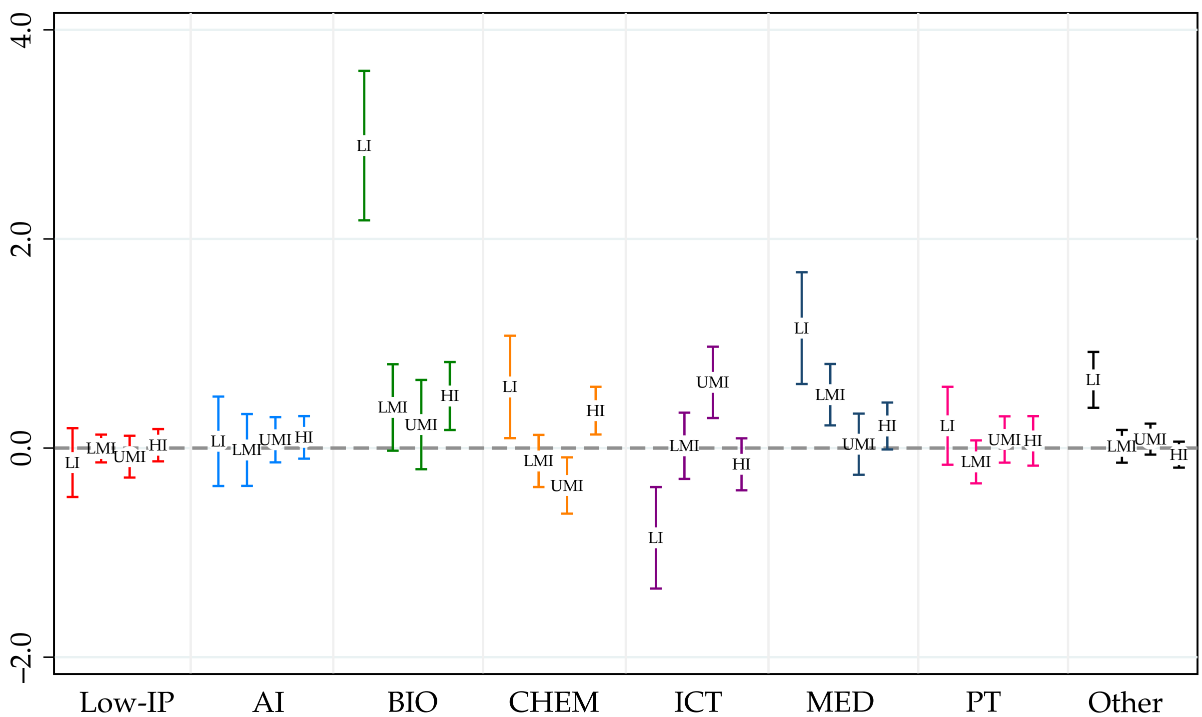
Notes: The dependent variable is unidirectional bilateral trade flows, excluding bilateral linkages with current and future IPR-related PTA partners. Each of the columns report coefficients from a single regression, delineated by sector. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Figure 4: Intensive Margin Effects of IPR-related PTA Accession, by Income Group and Sector

4A: Exporter Effects



4B: Importer Effects



Notes: For each subsector, the label in the center of the confidence band indicates the location of the point estimate of the coefficient on *IPA* for countries in the indicated income group. The confidence bands correspond to the 95% confidence intervals on the estimates of each coefficient.

the pharmaceutical imports of LI countries, which on average increase by a dramatic 1,704.7%. When viewed in conjunction with the results in the next section on the extensive margin of trade, this will be powerful evidence in favor of a strong market expansion effect dominating any market power effects in pharmaceuticals. Beyond pharmaceutical trade, other notable effects come through on the import side: LI PTA members also witness their imports of chemicals, medical devices, and other high-IP commodities increase in the wake of the implementation of rigorous IPRs standards, while ICT imports are seen to decline. For LMI countries, medical device imports increase substantially, while for UMI countries chemicals imports decline and ICT imports increase, in contrast with the effect on the ICT imports of LI countries. Finally, HI countries undergo significant increases in their imports of pharmaceuticals and chemicals, which again accords with the logic on the effects of pharmaceutical- and chemical-sector specific provisions, as even advanced economies are required by their PTA obligations to implement strong protections for these sectors that were not in place before.

To recap, the systematic third-country results on exports and scattered results on imports are preserved when considering more disaggregated high-IP subsectors. The positive export effects on high-IP trade remain consistent with broad comparative advantage effects, but in examining specific sectors, it can be seen that some sectors' exports are affected more noticeably than others; most notably, in order of magnitude, pharmaceuticals, medical devices, analytical instruments, and production technology. And while many of the effects seem to be imparted through the export channel, there are considerable impacts to be seen in some industries. The most pronounced effect arise in the imports of LI PTA members of pharmaceuticals, but these countries also import more chemicals, medical devices, and other high-IP commodities. HI PTA members also import more in these industries, suggesting that consumers in economies at different levels of development receive expanded access to these types of commodities.

4.4 The Extensive Margin of IP-intensive Trade

The effects that have been considered thus far have been intensive margin effects on the value of third-country bilateral trade flows. From the discussion in Section 3, it is conceivable that stronger IPRs reveal their effects both with respect to the value of trade as well as the extensive margin of trade, which I will take to be the number of varieties exported or imported within each of the specific low-IP and high-IP sectors. Stronger IPRs in a PTA member country might facilitate domestic production of IPR-intensive goods that would not otherwise be produced and exported, and could potentially expand the extensive margin of exports. Similar logic could motivate an expansion in the number of imported varieties: stronger IPRs in a destination market reduce the expected costs of entering that market that might arise from deterring imitation or making sure that IPRs are effectively enforced. On the other hand, if stronger IPRs expand the set of varieties that are produced domestically, this could crowd out imports of these varieties, and thus the overall effect on the extensive margin of imports is not immediately apparent. IPRs, then can thus be expected to influence the extensive margin of third-country trade in ways similar to the ones posited earlier, but for subtly different reasons.

Equation (4) presents the specification to be estimated, which is a slight modification of the one in equation (3):

$$\begin{aligned} X_{ijst} = \exp\Big\{ & \beta_1 \log\left(GDP_{it}\right) + \sum_s \beta_{2s}\, Sector_s \times \log\left(GDP_{it}\right) \\ & + \beta_3 \log\left(GDP_{jt}\right) + \sum_s \beta_{4s}\, Sector_s \times \log\left(GDP_{jt}\right) \\ & + \sum_g \beta_{5g}\, Group_i^g \times Low\text{-}IP_s \times IPA_{it} + \sum_g \sum_s \beta_{6gs}\, Group_i^g \times Sector_s \times IPA_{it} \\ & + \sum_g \beta_{7g}\, Group_i^g \times Low\text{-}IP_s \times TRIPS_{it} + \sum_g \sum_s \beta_{8gs}\, Group_i^g \times Sector_s \times TRIPS_{it} \\ & + \sum_g \beta_{9g}\, Group_j^g \times Low\text{-}IP_s \times IPA_{jt} + \sum_g \sum_s \beta_{10gs}\, Group_j^g \times Sector_s \times IPA_{jt} \\ & + \sum_g \beta_{11g}\, Group_j^g \times Low\text{-}IP_s \times TRIPS_{jt} + \sum_g \sum_s \beta_{12gs}\, Group_j^g \times Sector_s \times TRIPS_{jt} \\ & + \alpha_i\, t + \alpha_j\, t + \alpha_{g_i st} + \alpha_{g_j st} + \alpha_{ij} \Big\} + \nu_{ijst}. \end{aligned} \tag{4}$$

Interpretation of the coefficients will be the same, as will the construction of the dataset in its omission of trade between current and future IPR-related PTA partners. The only difference from the earlier equation is the dependent variable X_{ijst}, which is defined as the count of unique 6-digit HS commodities within a particular sector s that are exported from country i to country j in year t.[25]

[25]The low-IP and high-IP sectors and subsectors are comprised of SITC codes that encompass levels of aggregation ranging from 2-digit to 5-digit industries. Even at the most disaggregated 5-digit level of SITC classifications, the

This is an imperfect measure of the extensive margin (consider, for instance, the most disaggregated definition of the extensive margin of trade in specific chemicals or pharmaceuticals, where varieties can be delineated at the molecular level), yet it still captures the role of IPRs in influencing the binary decision of whether a particular variety is traded between two countries. On one hand, if the notion of IPRs acting as a determinant of comparative advantage is to be believed, then a country with stronger IPRs will export more varieties of IPR-intensive commodities to a larger number of markets than an otherwise similar country with weaker IPRs. Further, in making the decision on whether and how to serve a particular foreign market, owners of knowledge assets and producers of IPR-intensive commodities must weigh the potential revenues to be gained in the new market against the costs of serving the market, both of which will be determined in part by the destination's IPR regime—by the enforcement efforts of the government, by the rules on coverage and duration of protection, and by the costs that might otherwise be incurred to deter imitation or appropriation.

Table 6A presents the results for the exporter coefficients and Table 6B the analogous results for the importer coefficients for the relation between IPR-related PTA accession and the extensive margin of bilateral trade with third countries. The results are also depicted graphically in Figure 5. On the export side, some of the results mirror the analysis of the intensive margin effects, while some results contrast noticeably. While the earlier results on the high-IP exports of LI countries were generally insignificant, the results here show a significant positive effect on the number of low-IP varieties exported to third countries, and significantly negative effects on the number of varieties within the analytical instruments, medical device, and production technology high-IP subsectors. For LMI partners, however, this effect is largely reversed: on average, the number of low-IP varieties exported declines, while the number of varieties exported in a number of high-IP subsectors expands considerably. And, for UMI and HI countries, the effects are more scattered: in some subsectors, the number of exported varieties expands, while in others it contracts.

How do these results on the extensive margin of exports fit with the narrative that arose from the results on the intensive margin? Immediately obvious is that, as before, the direction and significance of the effects depends on the development level of the PTA member and industrial

SITC industries can be disaggregated even further into corresponding 6-digit HS commodity codes. The number of 6-digit HS2012 commodities within each sector based on the 2012 revision of the HS classification is: low-IP (2106), AI (41), BIO (69), CHEM (178), ICT (76), MED (40), PT (267), and other (1606).

Table 6A: The Extensive Margin of Trade in Low-IP and High-IP Subsectors (excluding trade with current or future IPR-related PTA partner)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exporter effects								
log(GDP)	–0.092***							
	(0.010)							
Sector × log(GDP)		0.016***	0.030***	0.164***	–0.062***	0.037***	0.063***	0.048***
		(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)
Sector × LI × IPA	0.121***	–0.372***	0.118	0.297**	–0.091	–0.426***	–0.292***	0.026
	(0.047)	(0.069)	(0.097)	(0.141)	(0.059)	(0.103)	(0.071)	(0.058)
Sector × LMI × IPA	–0.138***	0.273***	0.373***	0.115***	0.158***	0.301***	0.218***	0.041
	(0.025)	(0.035)	(0.042)	(0.040)	(0.035)	(0.035)	(0.032)	(0.026)
Sector × UMI × IPA	–0.285***	0.136***	0.053	–0.198***	0.233***	–0.056	0.007	–0.045**
	(0.027)	(0.037)	(0.040)	(0.034)	(0.044)	(0.037)	(0.028)	(0.022)
Sector × HI × IPA	–0.049***	0.010	0.309***	0.266***	–0.173***	–0.017	0.089***	–0.036***
	(0.014)	(0.021)	(0.020)	(0.017)	(0.019)	(0.018)	(0.014)	(0.010)
Sector × LI × TRIPS	–0.232***	0.206***	0.138***	0.137***	0.146***	0.245***	0.168***	0.082***
	(0.015)	(0.033)	(0.030)	(0.031)	(0.027)	(0.026)	(0.031)	(0.015)
Sector × LMI × TRIPS	0.096***	–0.207***	0.150***	0.102***	0.179***	0.015	–0.114***	0.054***
	(0.017)	(0.031)	(0.041)	(0.038)	(0.028)	(0.028)	(0.022)	(0.015)
Sector × UMI × TRIPS	–0.060***	0.035	0.170***	–0.014	–0.100***	–0.083**	0.170***	–0.049**
	(0.023)	(0.043)	(0.048)	(0.031)	(0.038)	(0.038)	(0.031)	(0.020)
Sector × HI × TRIPS	0.124***	0.306***	0.377***	–0.061**	0.153***	0.360***	0.274***	0.120***
	(0.018)	(0.023)	(0.030)	(0.027)	(0.025)	(0.028)	(0.019)	(0.014)

⋮

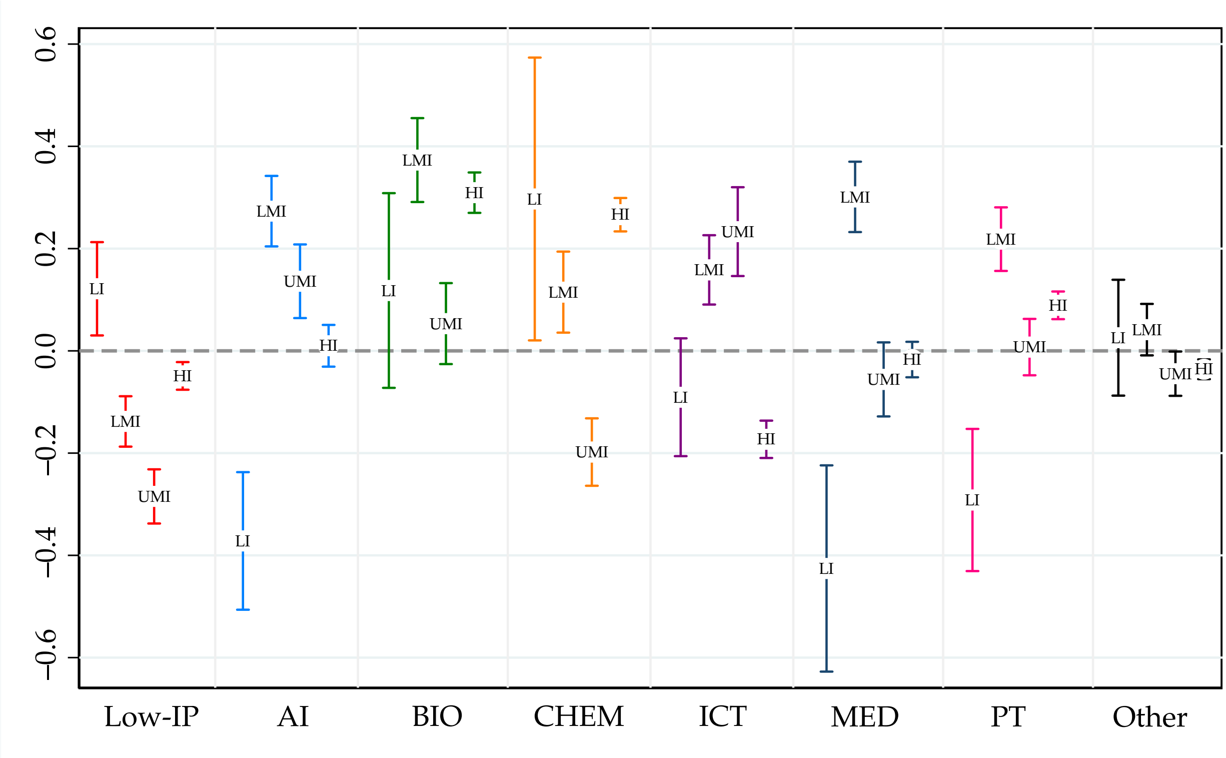
Table 6B: The Extensive Margin of Trade in Low-IP and High-IP Subsectors (excluding trade with current or future IPR-related PTA partner, cont.)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Importer effects								
log(GDP)	0.287***							
	(0.009)							
Sector × log(GDP)		0.008	–0.045***	0.085***	–0.044***	–0.035***	0.011***	–0.022***
		(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.003)
Sector × LI × IPA	–0.173***	0.052	0.405***	0.186**	–0.140**	0.221***	0.065	–0.005
	(0.038)	(0.064)	(0.072)	(0.080)	(0.066)	(0.061)	(0.041)	(0.032)
Sector × LMI × IPA	0.025	0.061***	0.034	–0.012	0.107***	0.117***	–0.001	0.020*
	(0.017)	(0.023)	(0.028)	(0.024)	(0.024)	(0.022)	(0.016)	(0.012)
Sector × UMI × IPA	–0.047**	–0.077**	–0.232***	–0.279***	–0.002	–0.078***	–0.135***	–0.130***
	(0.021)	(0.034)	(0.039)	(0.033)	(0.030)	(0.029)	(0.024)	(0.016)
Sector × HI × IPA	–0.061***	0.105***	–0.048*	–0.020	0.093***	0.078***	–0.007	–0.046***
	(0.013)	(0.025)	(0.026)	(0.022)	(0.022)	(0.020)	(0.016)	(0.010)
Sector × LI × TRIPS	0.039**	–0.159***	–0.057*	0.023	–0.123***	–0.157***	–0.131***	–0.051***
	(0.018)	(0.025)	(0.030)	(0.026)	(0.025)	(0.023)	(0.018)	(0.013)
Sector × LMI × TRIPS	0.030*	0.094***	0.272***	0.220***	0.153***	0.117***	0.054***	0.087***
	(0.016)	(0.024)	(0.026)	(0.022)	(0.023)	(0.021)	(0.016)	(0.011)
Sector × UMI × TRIPS	–0.085***	0.010	0.010	0.061**	0.066**	–0.068**	–0.093***	–0.061***
	(0.021)	(0.031)	(0.032)	(0.025)	(0.027)	(0.029)	(0.021)	(0.012)
Sector × HI × TRIPS	0.120***	0.149***	0.120***	0.022	0.184***	0.208***	0.142***	0.156***
	(0.017)	(0.030)	(0.036)	(0.033)	(0.027)	(0.028)	(0.023)	(0.015)
Observations								4,221,104
No. of country pairs								27,892
Country trends								✓
Group-sector-year FEs								✓
Pair FEs								✓

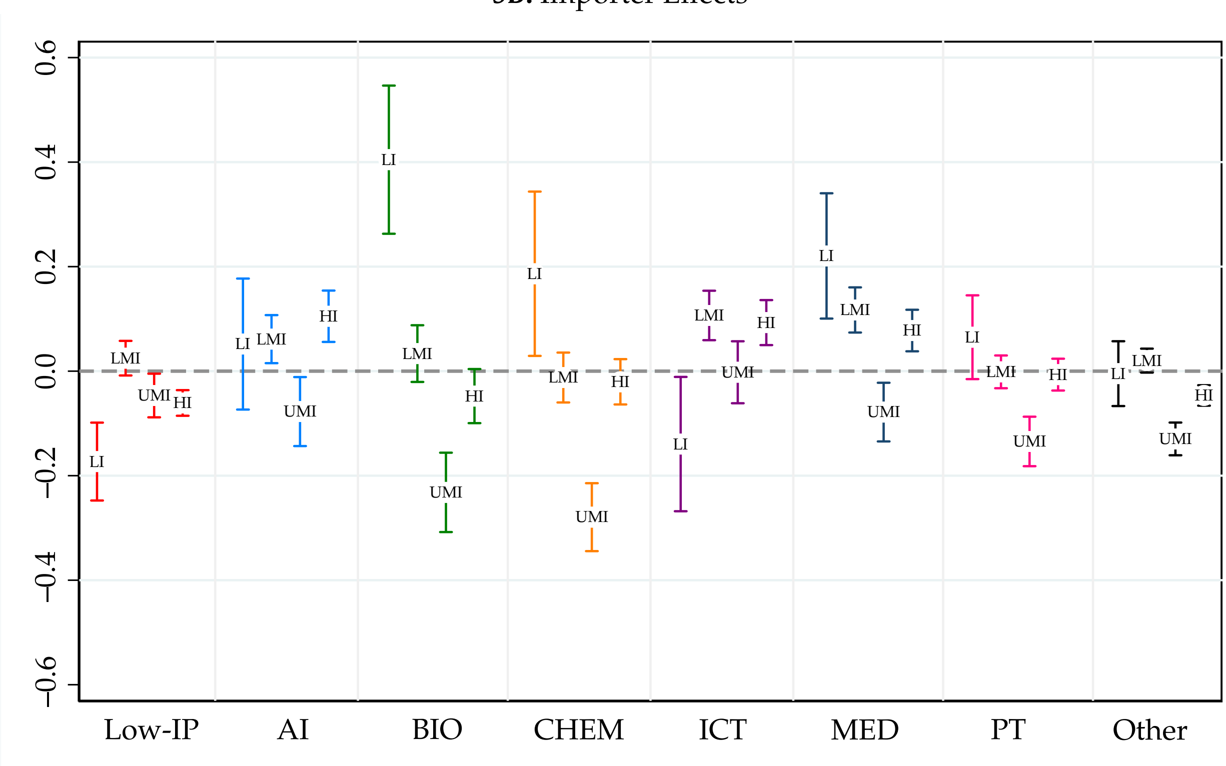
Notes: The dependent variable is the count of 6-digit HS commodities within each sector, excluding bilateral linkages with current and future IPR-related PTA partners. Each of the columns reports coefficients from a single regression, delineated by sector. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Figure 5: Extensive Margin Effects of IPR-related PTA Accession, by Income Group and Sector

5A: Exporter Effects



5B: Importer Effects



Notes: For each subsector, the label in the center of the confidence band indicates the location of the point estimate of the coefficient on *IPA* for countries in the indicated income group. The confidence bands correspond to the 95% confidence intervals on the estimates of each coefficient.

composition. Again, there seem to be threshold effects that impede the least-developed PTA partners from realizing substantial effects on their exports. On the other hand, for LMI countries positive effects abound in nearly all of the high-IP subsector, with impacts ranging from a 12.2% increase in the number of exported varieties within chemicals, to a sizable 45.2% increase in the number for pharmaceuticals. One channel that could explain this is the notion that stronger IPRs alter the incentives to produce and export particular varieties that would otherwise not be traded by LMI countries: stronger IPRs provide sufficient benefits to, in a Melitz (2003) sense, alter the export margins of industries. Why, then, are the export results less consistent for UMI and HI countries? Recall that member countries in these income groups exhibited substantial gains in the intensive margin of their exports to partners outside of the PTA. That the extensive margin effects only materialize in a small subset of sectors (or are estimated as being negative) suggests that the change in exports occurs within already-traded varieties: stronger IPRs bolster an already existing comparative advantage in these sectors, but do not push these countries to export new varieties.

Similarly, the estimates on the extensive margin import effects match the original intensive margin results in some ways, but in other ways diverge. For LI countries, there are significant increases in the number of varieties imported in pharmaceuticals (49.9%), chemicals (20.4%), and medical devices (24.7%). Recall that it was in these categories that the intensive margin of imports of LI countries expanded most sharply, suggesting that not only do these PTA partners import more of these commodities in value terms, but they also import a wider variety of these commodities in response to IPRs-upgrading. Another noteworthy result can be seen in the imports of UMI countries: in every category but ICT. This paints a drastically different picture from the intensive margin results, where hardly any significant effects were evident. The immediate driver of this effect is not clear, but it seems plausible to suggest that a strengthening in the IPRs regimes of these countries bolsters domestic production in these sectors, which results in fewer commodities in these industries needing to be imported from abroad. Finally, effects for LMI and HI countries are generally positive, but not systematic.

The way in which these results fit with each other—strong positive effects for some income groups, strong negative effects for others, or nonexistent effects—is not immediately apparent. While it may seem convenient to point to the ambiguity of the theory while emphasizing potential channels, no single narrative carries the day in the results depicted here. Comparative advantage effects consistent with a strengthening of institutional quality seem to be a reasonable fit for many of the positive export results, while on the other hand, there seem to be cases where either market power or market expansion effects drive the changes. Or, it could be that unobserved shifts in FDI—MNEs deciding to serve a market through domestic production rather than exports—drive of some of the results. While this is admittedly a shortcoming of this reduced-form analysis, it remains apparent that third-country trade along the extensive margin is materially impacted by IPR-related PTA accession in ways that sometimes mimic, but in other ways differ, from the effects on the intensive margin.

4.5 The Origins and Destinations of Third-Country Trade

IPR-related PTA accession is associated with changes in the composition of countries' trade with partners outside of the PTA along both the intensive and extensive margin. As a final extension on the previous analyses, this section explores which types of bilateral linkages these changes occur in: for instance, when high-income countries in IPR-related PTAs export more IPR-intensive commodities, such as analytical instruments or production technology, what types of countries are they exporting these commodities to? Or, when low-income countries import more high-IP goods such as pharmaceuticals and medical devices, where are they importing these goods from? I now consider the source or destination of the third-country trade undertaken by countries in IPR-related PTAs. In particular, to avoid adding even more complicated subsector-level results to an already cumbersome analysis, I return to the original analysis of low-IP and high-IP trade.

Equation (2) is modified by interacting the IPA policy effects with the income group of the partner in a given bilateral linkage. To illustrate, instead of having a series of interactions along the lines of $\sum_g \beta_{5g}\, Group_i^g \times Low\text{-}IP_s \times IPA_{it}$, where β_{5g} yielded the impact of IPA on the low-IP exports of an IPR-related PTA member country i belonging to income group g, now such a term will have an additional layer of complexity according to the export destination's income group. The new analogous term becomes $\sum_g \sum_{g'} \beta_{5g}\, Group_i^g \times Group_j^{g'} \times Low\text{-}IP_s \times IPA_{it}$, where g' indexes which of the four income groups to which partner j belongs. Alternatively for the IPA_j effects, a term is added to the interaction indicating the group to which the export partner i of IPR-related PTA member j belongs: $\sum_g \sum_{g'} Group_j^g \times Group_i^{g'} \times Low\text{-}IP_s \times IPA_{jt}$. I transform each of the IPA interactions in such a way, for both exporters and importers and for the low-IP and high-IP sectors:[26]

$$
\begin{aligned}
T_{ijst} = \exp\Big\{ & \beta_1 \log\left(GDP_{it}\right) + \beta_{2s}\, High\text{-}IP_s \times \log\left(GDP_{it}\right) \qquad (5) \\
& + \beta_3 \log\left(GDP_{jt}\right) + \beta_{4s}\, High\text{-}IP_s \times \log\left(GDP_{jt}\right) \\
& + \sum_g \sum_{g'} \beta_{5gg'}\, Group_i^g \times Group_j^{g'} \times Low\text{-}IP_s \times IPA_{it} + \sum_g \sum_{g'} \beta_{6gg'}\, Group_i^g \times Group_j^{g'} \times High\text{-}IP_s \times IPA_{it} \\
& + \sum_g \beta_{7g}\, Group_i^g \times Low\text{-}IP_s \times TRIPS_{it} + \sum_g \beta_{8gg'}\, Group_i^g \times High\text{-}IP_s \times TRIPS_{it} \\
& + \sum_g \sum_{g'} \beta_{9gg'}\, Group_j^g \times Group_j^{g'} \times Low\text{-}IP_s \times IPA_{jt} + \sum_g \sum_{g'} \beta_{10gg'}\, Group_j^g \times Group_j^{g'} \times High\text{-}IP_s \times IPA_{jt} \\
& + \sum_g \beta_{11g}\, Group_j^g \times Low\text{-}IP_s \times TRIPS_{jt} + \sum_g \beta_{12gs}\, Group_j^g \times High\text{-}IP_s \times TRIPS_{jt} \\
& + \alpha_i\, t + \alpha_j\, t + \alpha_{g_i st} + \alpha_{g_j st} + \alpha_{ij} \Big\} + \nu_{ijst}.
\end{aligned}
$$

I first conduct this analysis for high-IP versus low-IP trade. In addition to reporting the numerical results of the regression (shown Table 7), which necessitates the presentation of four times as many coefficients for IPA as in the original analysis, I also present the estimation results graphically in Figure 6. Subfigures 6A and 6B depict the results for the low-IP and high-IP exports of IPR-related PTA members, respectively, while Subfigures 6C and 6D show the corresponding results for the imports of IPR-related PTA members.

It was shown earlier that low-IP exports declined for IPR-related PTA members in LMI, UMI, and HI income groups, while the high-IP exports of these countries increased. In both sectors, the exports of LI countries were seemingly unaffected in any significant way. When examining the direction of exports in Subfigure 6A, the types of bilateral linkages in which these impacts materialize becomes apparent. UMI exporters—the countries with the strongest estimated negative impacts of IPR-related PTA accession on low-IP exports—see their exports of such commodities to LMI, UMI, and HI partners decline substantially. For LMI countries, these negative effects are limited to their low-IP exports to countries in the middle of the income distribution, with the strongest negative effect occurring on their exports to LMI countries. And finally, HI countries witness a modest decline in their low-IP exports to UMI countries.

In high-IP exports, the pattern is slightly different. On average, both LMI and HMI countries see their exports of high-IP commodities expand significantly to countries at middle and high

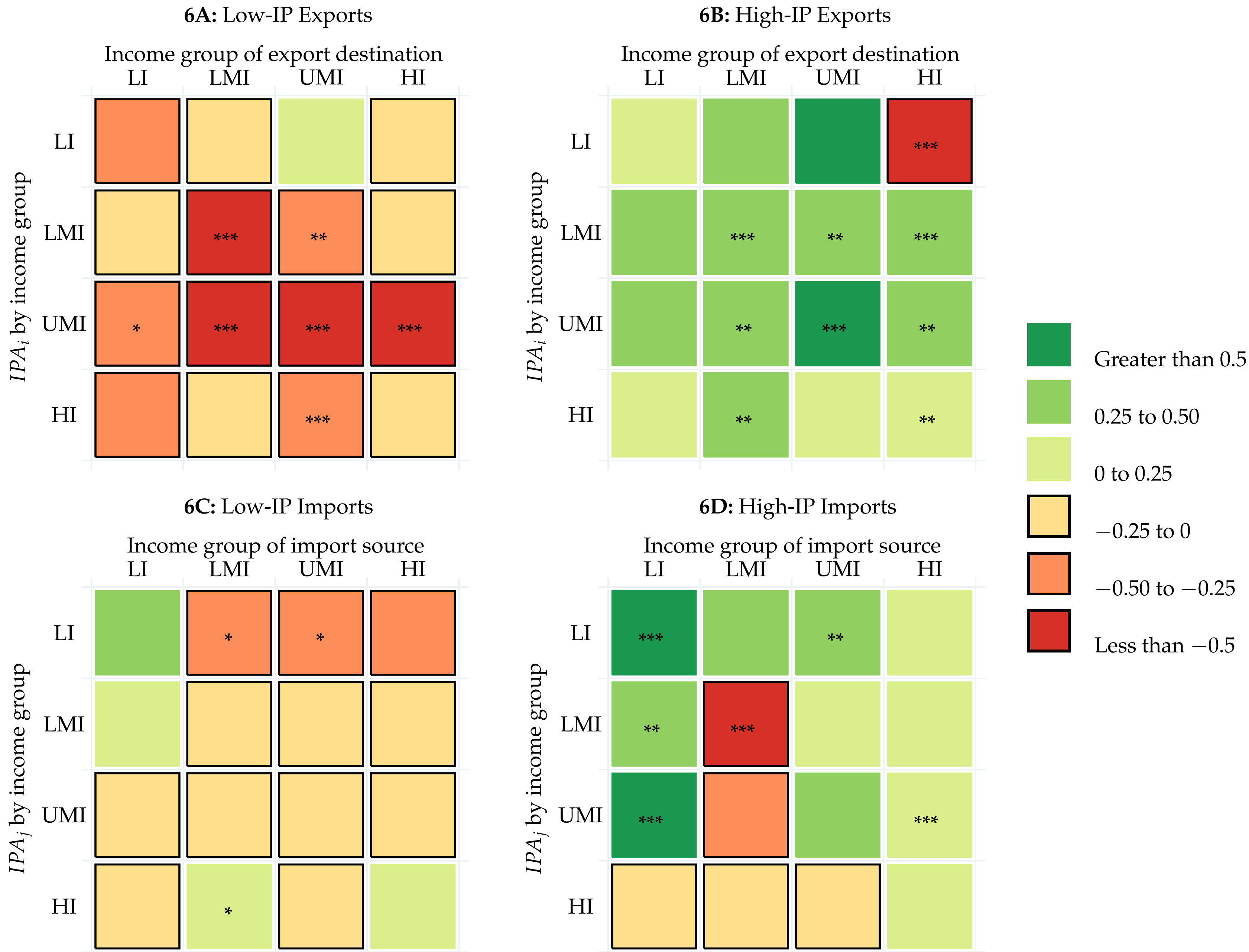
[26]For brevity, reporting of the TRIPS coefficients is suppressed for this analysis.

Table 7: Effects of IPR-related PTA Accession by Income Group of Trade Partner

	Exporter effects				Importer effects			
	Income group of export destination ($Group_j^{g'}$)				**Income group of import source ($Group_i^{g'}$)**			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LI	LMI	UMI	HI	LI	LMI	UMI	HI
LI × Low-IP × IPA	−0.446	−0.193	0.213	−0.197	0.335	−0.440*	−0.453*	−0.374
	(0.412)	(0.181)	(0.442)	(0.126)	(0.220)	(0.259)	(0.251)	(0.279)
LMI × Low-IP × IPA	−0.028	−0.620***	−0.291**	−0.095	0.196	−0.045	−0.019	−0.181
	(0.257)	(0.141)	(0.147)	(0.110)	(0.126)	(0.092)	(0.137)	(0.141)
UMI × Low-IP × IPA	−0.307*	−1.090***	−0.874***	−0.786***	−0.120	−0.094	−0.011	−0.086
	(0.163)	(0.139)	(0.276)	(0.184)	(0.182)	(0.121)	(0.222)	(0.146)
HI × Low-IP × IPA	−0.318	−0.173	−0.429***	−0.152	−0.037	0.186*	−0.030	0.004
	(0.273)	(0.146)	(0.117)	(0.138)	(0.141)	(0.107)	(0.123)	(0.126)
LI × High-IP × IPA	0.243	0.343	0.530	−1.647***	0.548***	0.392	0.442**	0.063
	(0.273)	(0.222)	(0.363)	(0.334)	(0.151)	(0.283)	(0.224)	(0.144)
LMI × High-IP× IPA	0.288	0.420***	0.442**	0.355***	0.298**	−0.593***	0.082	0.094
	(0.287)	(0.147)	(0.202)	(0.134)	(0.117)	(0.217)	(0.130)	(0.091)
UMI × High-IP × IPA	0.433	0.435**	0.657***	0.419**	0.561***	−0.294	0.327	0.248***
	(0.389)	(0.189)	(0.224)	(0.184)	(0.194)	(0.295)	(0.324)	(0.087)
HI × High-IP × IPA	0.140	0.266**	0.121	0.194**	−0.096	−0.207	−0.034	0.019
	(0.121)	(0.117)	(0.088)	(0.083)	(0.103)	(0.166)	(0.203)	(0.076)
Observations								1,055,276
No. of country pairs								27,892
Country trends								✓
Group-sector-year FEs								✓
Pair FEs								✓

Notes: The dependent variable is bilateral trade flows excluding trade with future/current IPR-related PTA partners. Each of the columns reports coefficients from a single regression, delineated by income group of the trading partner. Controls for GDP and TRIPS are included in the estimation, but their coefficient estimates are omitted from the reporting. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Figure 6: Effects of IPR-related PTA Accession by Income Group of Trade Partner



Notes: Estimation method is PPML using the full sample of bilateral trade data, including zeroes. Outlined cells indicate a negative coefficient estimate. The p-value on the estimate of each interaction coefficient is indicated in the relevant cell of each figure. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

levels of income; for HI countries, this effect is limited to LMI and HI destinations. And strikingly, despite the average effect on the high-IP exports of LI countries originally being found to be insignificant, when disaggregating the effects by the income group of the destination country, substantial decreases are observed in LI countries' high-IP exports to HI countries. What spurs these changes in the destination of exports? As before, I am unable to deduce the exact underlying mechanism given the nature of the analysis, but the prior intuition informs the understanding of the results to some extent. As before, the patterns of trade are consistent with a shift in comparative advantage: countries with stronger IPRs tend to export more in value terms of IPRs-intensive goods. This is not the case, however, for every permutation of relative levels of development. For instance, note that LMI countries export fewer low-IP goods to other middle-income economies; however, their low-IP exports to HI partners are unimpacted. This could perhaps reflect LMI countries retaining a role as suppliers of IPR-unintensive commodities to advanced economies as part of a global supply chain, even as they specialize relatively more in IPR-intensive activities. UMI countries, on the other hand, do see their low-IP exports decline to their most-developed trading partners, suggesting a more significant restructuring of these PTA members' patterns of trade. Also of note is the significant decline in the exports of LI countries to advanced trading partners. This seemingly anomalous result could arise for several reasons: perhaps because of IPRs restricting the supply of parallel imports from these countries.

With regard to import effects, the insignificant estimates that were found in the first low-IP versus high-IP analysis generally carry over to the origin-and-destination analysis. For low-IP imports, I find few significant effects, none of which are significant at the 95% level. High-IP imports, however, show more promise, though the particular nature of the results might elicit surprise. On average, LI, LMI, and UMI PTA members see their imports in IPR-intensive sectors rise, with the strongest effects coming from their imports from LI sources. This result might contrast with expectations about what the effect should be, given that more advanced economies tend to be the producers and exporters of advanced manufactures and other knowledge-intensive products. And while the least-developed PTA members do see their high-IP imports from UMI countries increase, it is only UMI countries that import more IPR-intensive goods from HI partners.

Ultimately, the mechanisms underlying this exercise might come across as even more opaque than the previous mechanisms. That this further refinement reveals effects that were previously hidden, however, suggests that a consideration of who exports to whom—and who imports from whom—is an element of the analysis worth considering. One potentially revealing aspect of this analysis relates to the link between IPRs and technology transfer. Because IPRs determine the extent to which foreign IP-owners' assets are protected, they also determine the extent to which proprietary knowledge and processes from advanced trading partners can diffuse through an economy. And while technology transfer arising from imports from advanced partners has generally been found to be less significant than that arising from FDI, a substantial increase in high-IP imports from HI partners would give evidence for the existence of such a channel.[27] Such an increase fails to materialize for countries on the lowest half of the income distribution, but it is evinced for UMI PTA members. These countries import more IPR-intensive commodities from HI sources, and the expansion in access to a greater number of IPR-intensive manufactures, and the knowledge that these commodities embody, imply that the IPR effects here facilitate such a channel—but only for importers at a sufficiently high level of development. And, while, the caveat must again be offered that this analysis only uncovers effects on trade, the effects that it does reveal could have implications beyond this single outcome.

5 Conclusion

IPRs have become a point of emphasis in PTAs, especially so for those agreements negotiated by the US and Europe, whose need for an avenue through which to implement their policy goals in a forum besides the WTO drives the inclusion of substantive chapters on IPRs in trade agreements. In mandating IPR standards that go beyond what PTA member countries would effect on their own (and which go beyond the basic minimum requirements of TRIPS), PTAs serve an increasingly important role as a mechanism through which developed economies "export" their policies to trading partners. And going forward, the stalled "mega PTAs" such as the TPP and TTIP promise to usher in a new era of regulatory harmonization between many of the world's largest economies, particularly with regard to IPRs—what impacts these massive agreements will have on trade, investment, innovation, and any number of other outcomes are sure to be substantial, and the profound breadth of their regulatory coverage suggests the agreements will have

[27] For instance, Delgado et al. (2013) interpreted their finding of an expansion in developing countries' imports of high-tech goods from advanced partners as evidence of an import-based channel for technology transfer.

nuanced effects.

Given that the IPRs provisions adopted by PTA members are generally applied equally to fellow PTA and non-PTA members' knowledge assets alike, they present a way through which PTAs could directly impact trade with non-PTA members. This paper takes a first step in exploring the effects of these agreements, focusing on the IPR-related PTAs negotiated by the US, the EU, or EFTA possessing substantive provisions relating to IPRs and investigating the ensuing impact on PTA members' third-country trade—trade with third countries outside of the PTA. These agreements tend to contain language on IPRs by default, and thus member countries are required to comply with the IPR provisions required by the US or Europe—this creates an effectively exogenous policy change that, based on the growing body of evidence in the literature, should impact economic relations with extra-PTA partners. And, while there are many outcomes that might be considered in appraising the full effects of these agreements' IPR provisions, trade agreements are foremost about trade, which is the outcome considered in this work. The relationship between IPRs and trade is theoretically ambiguous, and offers no consistent message on what the effects of IPRs-upgrading on trade should be. The three channels posited in this paper—comparative advantage, market power versus market expansion effects, and the activities of MNEs—go some way towards informing an expectation of what the overall effects might be, but the ultimate impacts can only be revealed empirically.

Based on results from a gravity approach, membership in IPR-related PTAs is associated with third-country export effects that are generally consistent with a strengthening of comparative advantages in IPRs-intensive industries for IPR-related PTA members. Countries in the middle and high end of the income distribution reap most of these benefits, with the intensive margin of their exports of IPR-intensive industries expanding considerably. The value of exports in IPR-unintensive industries, on the other hand, declines on average for these countries. The estimates for imports are more nuanced, where significant effects only become apparent upon disaggregating IPR-intensive industries into a set of IPR-intensive subsectors. Results on this dimension of trade are more scattered, but several pronounced effects are evident: notably, sizable increases in the imports of pharmaceuticals, chemicals, and medical devices by low-income PTA members from extra-PTA sources, as well as increases in the pharmaceutical and chemical imports of high-income countries. That the results break down along lines of PTA members' development levels and sectoral definitions should come as no surprise. First, as these results relate to notions of comparative advantage, countries at higher levels of development are likely to be better equipped to realize the impacts of stronger IPRs: these countries have different endowment structures relative to less-developed countries, and the upgrading of IPRs per se for lower income countries might not have noticeable effects if other crucial institutions necessary for trade to take place are lacking. Second, given the exact wording of the agreements and the policies that they mandate—namely, TRIPS-Plus provisions relevant to pharmaceuticals, chemicals, and other specific sectors, along with requirements to accede to international treaties on specific areas of IPRs—certain sectors are more likely to be observably impacted than others. The fact that third-country pharmaceutical and chemical trade generally undergoes the largest impacts aligns with this aspect of the agreements. And, importantly, these effects are evident even upon controlling for TRIPS compliance, suggesting that IPRs-upgrading beyond the minimum requirements of TRIPS imparts its own array of effects distinct from existing policies.

It is important to highlight the limitations of this work, and to shed light on potentially rewarding directions for future research to take. As mentioned before, trade is but a single outcome of relevance: there is no reason to think that investment, innovation, or other outcomes are less important, or are less impacted by IPRs, than are exports and imports. Future work will hopefully shed light on these other outcomes, ideally in a framework that considers them jointly with trade. Further, while the direction of the empirical results in this paper could be explained by an assortment of mechanisms hypothetically linking IPRs to trade, pinning down the particular mechanism is infeasible in this paper's reduced-form analysis. Hopefully, the effects revealed by this work motivate thoughtful explorations of the structural linkages between IPRs and trade, whether in the context of IPR-related PTAs or in other settings.

As PTAs evolve and continue to grow in importance as a venue for policy-setting, their role in affecting important economic outcomes merits more and more consideration. IPRs are but one area of focus in newer PTAs: rules on investment, government procurement, environmental and labor standards, along with many other policy environments suggest far-reaching impacts on variables beyond those directly impacted by the traditional market access concessions of trade agreements. Future work in this area would consider the impacts of these other policies, and a nuanced consideration would consider them jointly—for instance, IPRs and investment rules might interact with each other to affect trade, innovation, or the way in which multinationals conduct FDI. Other outcomes beyond trade in goods likewise merit consideration. This work is but a first step in the direction of exploring this increasingly important aspect of globalization, and the results suggest that ignoring the non-trade policy aspects of PTAs would be to ignore the full array of mechanisms through which PTAs impart their impacts.

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Appendix

Data Sources

The data sources are described in Table A1. To construct the measures of bilateral trade flows by sector (high-IP vs. low-IP, and then broken down into more detailed sectors within the high-IP classification), I start with commodity-level bilateral trade data from CEPII (see Gaulier and Zignago 2010) classified by 6-digit Harmonized System codes. Because the high-IP vs. low-IP industry classifications from Delgado et al. (2013) and US Department of Commerce (2012) are delineated by SITC industries, I map (in a one-to-one fashion) the HS6 trade data to a corresponding SITC code based on a concordance from the EU RAMON database (Eurostat, 2017). From here the value of bilateral trade flows is aggregated according to the high-IP versus low-IP industry classifications.

Table A1: Data Sources and Description

Variable	Description	Data Source
Intensive (T_{ijst}) and extensive (X_{ijst}) margins of trade	Bilateral trade flows in current USD by 6-digit HS code, 1995–2014	Gaulier and Zignago (2010)
GDP	GDP in current USD by country and year	World Bank (2016)
Income groups	Countries' income group classifications	World Bank (2016)
IPA	Entry-into-force years of preferential trade agreements	Dür et al. (2014)
TRIPS	Estimates of TRIPS compliance dates by country	Ginarte and Park (1997), Park (2008), and Hamdan-Livramento (2009)
Low-IP and high-IP industries	IP-intensive commodities by SITC Rev. 3 code	Delgado et al. (2013) based on US Department of Commerce (2012)

Table A2: Countries' Income Group Classifications

High income (HI, 38 countries)			
Andorra	Denmark	Italy	Singapore
Aruba	Finland	Japan	Spain
Australia	France	Kuwait	South Korea
Austria	French Polynesia	Macao	Sweden
Bahamas	Germany	Netherlands	Switzerland
Belgium	Greenland	New Caledonia	United Arab Emirates
Bermuda	Hong Kong	New Zealand	United Kingdom
Brunei	Iceland	Norway	United States
Canada	Ireland	Portugal	
Cyprus	Israel	Qatar	
Upper-middle income (UMI, 25 countries)			
Antigua and Barbuda	Czech Republic	Mauritius	St. Kitts and Nevis
Argentina	Gabon	Mexico	St. Lucia
Bahrain	Greece	Oman	Trinidad and Tobago
Barbados	Hungary	Saudi Arabia	Uruguay
Brazil	Libya	Seychelles	
Chile	Malaysia	Slovenia	
Croatia	Malta	South Africa	
Lower-middle income (LMI, 61 countries)			
Algeria	Fed. States of Micronesia	Marshall Islands	Solomon Islands
Belarus	Fiji	Moldova	St. Vincent and Grenadines
Belize	Grenada	Montenegro	Suriname
Bolivia	Guatemala	Morocco	Syria
Bulgaria	Indonesia	Palestine	Thailand
Cabo Verde	Iran	Panama	Tonga
Colombia	Iraq	Papua New Guinea	Tunisia
Costa Rica	Jamaica	Paraguay	Turkey
Cuba	Jordan	Peru	Turkmenistan
Djibouti	Kazakhstan	Philippines	Ukraine
Dominica	Kiribati	Poland	Uzbekistan
Dominican Republic	Latvia	Romania	Vanuatu
Ecuador	Lebanon	Russia	Venezuela
Egypt	Lithuania	Samoa	
El Salvador	Macedonia	Serbia	
Estonia	Maldives	Slovakia	
Low income (LI, 63 countries)			
Afghanistan	Comoros	Kenya	São Tomé and Príncipe
Albania	Congo	Kyrgyzstan	Senegal
Angola	Côte d'Ivoire	Laos	Sierra Leone
Armenia	Dem. Rep. of the Congo	Liberia	Somalia
Azerbaijan	Equitorial Guinea	Madagascar	Sri Lanka
Bangladesh	Eritrea	Malawi	Sudan
Benin	Ethiopia	Mali	Tajikistan
Bhutan	Gambia	Mauritania	Tanzania
Bosnia and Herzogovina	Georgia	Mongolia	Timor-Leste
Burkina Faso	Ghana	Mozambique	Togo
Burundi	Guinea	Nepal	Uganda
Cambodia	Guinea-Bissau	Nicaragua	Vietnam
Cameroon	Guyana	Niger	Yemen
Central African Republic	Haiti	Nigeria	Zambia
Chad	Honduras	Pakistan	Zimbabwe
China	India	Rwanda	

Notes: Groups reflect the country development level classification from the World Bank (2016) as given for the year 1995.

Table A3: Sectoral definitions and associated SITC Rev. 3 codes and code descriptions

High-IP industries by mode of IPR-intensiveness	
Patent-intensive	
Crude fertilizers: 277, 278	Metalworking machinery: 73
Organic and inorganic chemicals: 51, 52	General machinery: 74139, 7421–3, 7427, 743–9
Dyeing materials: 53	Office machines: 75
Medicinal and pharmaceutical products: 54	Telecommunications: 76
Essential oils and perfume materials: 55	Electrical machinery: 77
Chemical materials and products: 59	Professional apparatus: 87
Rubber manufactures: 6214, 625, 6291–2	Photographic apparatus: 881–2, 884, 8853–4
Power-generating machinery: 71	Miscellaneous manufacturing: 8931, 893332, 8939, 8941–3, 8947, 8952, 89591, 897–9, 8991–6
Industrial machinery: 721–3, 7243, 7248, 725–8	
Trademark-intensive	
Dairy products and beverages: 022–4, 111, 1123	Manufactures of metal: 66494, 69561–2, 69564, 6966, 6973
Crude rubber: 231–2	
Pulp and waste paper: 251	Road vehicles: 784, 78531, 78536
Plastics: 57, 5813–7, 582–3	Furniture: 82
Paper and related articles: 64	Footwear: 85
Copyright-intensive	
Cinematographic film: 883	Printed matter & recorded media: 892, 8986–7
High-IP subsectors	
Analytical Instruments (AI)	***Medical Devices (MED)***
Laboratory instruments: 87325, 8742–3	Diagnostic substances: 54192–3, 59867–9
Optical instruments: 8714, 8744	Medical equipment and supplies: 59895, 6291, 774 872, 8841
Process instruments: 8745–6, 8749	
Biopharmaceuticals (BIO)	***Production Technology (PT)***
Medicinal and pharmaceutical products: 5411–6, 54199, 542	Materials and tools: 2772, 2782, 69561–2, 69564
	Process and metalworking machinery: 711, 7248, 726, 7284–5, 73
Chemicals (CHEM)	
Chemically-based ingredients: 5513, 5922, 5972, 59899	General industrial machinery: 7413, 7417–9, 7427, 7431, 74359, 74361–2, 74367–9, 7438–9, 7441, 7444–7, 74481, 7449 7452–3, 74562–3, 74565–8, 74591, 74595–7, 746–7, 7482–3, 7486, 7492–9
Dyeing and package chemicals: 531–2, 55421, 5977	
Organic chemicals: 5124, 5137, 5139, 5145–6, 5148, 5156	
Information and Communications Technology (ICT)	
Communications equipment: 7641, 76425, 7643, 76481, 7649, 77882–4	
Computers and peripherals: 752, 75997	
Office machines: 7511–2, 7519, 75991–5	
Electrical and electronic components: 5985, 7722–3, 7731, 7763–8, 77882–4	
Low-IP sectors	
Animal and vegetable oils, fats, and waxes: 41–3	Manufactures of leather, cork and wood, minerals, or metal: 61, 63, 6511–4, 652, 654–9, 661–2, 6633, 6639 6641–5, 6648–9, 67, 6821–6, 68271, 683, 6841, 68421–6, 685–9, 6911–2, 69243–4, 6932–5, 694, 6975, 699
Food and live animals: 01, 03, 041–5, 05, 061, 071–2, 074–5, 08	
Inedible crude materials (except fuels): 21, 22, 244, 261–5, 289–9, 273, 28, 292–7, 29292–3, 29297–9	Miscellaneous: Prefabricated buildings (811–2), travel goods (83), and apparel and accessories (84)
Lubricants, mineral fuels, and related materials: 32–4	

Notes: From Delgado et al. (2013), based on US Department of Commerce (2012).

Table A4: Bilateral Trade in Low-IP and High-IP Sectors (excluding trade with current or future IPR-related PTA partner)

	Exporter effects		**Importer effects**	
	No TRIPS Controls (1)	With TRIPS Controls (2)	No TRIPS Controls (3)	With TRIPS Controls (4)
log(GDP)	0.108***	0.129***	0.512***	0.533***
	(0.036)	(0.036)	(0.033)	(0.032)
High-IP × log(GDP)	0.371***	0.373***	0.024	0.023
	(0.030)	(0.033)	(0.032)	(0.034)
LI × Low-IP × IPA	–0.130	−0.131	–0.365***	−0.264*
	(0.106)	(0.107)	(0.126)	(0.154)
LMI × Low-IP × IPA	–0.399***	−0.265***	0.089	−0.003
	(0.087)	(0.097)	(0.077)	(0.066)
UMI × Low-IP × IPA	–0.725***	−0.748***	0.008	−0.062
	(0.131)	(0.143)	(0.111)	(0.099)
HI × Low-IP × IPA	–0.228**	−0.222**	0.061	0.029
	(0.098)	(0.100)	(0.079)	(0.079)
LI × High-IP × IPA	0.006	−0.064	0.287**	0.298**
	(0.205)	(0.215)	(0.128)	(0.134)
LMI × High-IP× IPA	0.914***	0.388***	–0.059	0.019
	(0.128)	(0.111)	(0.095)	(0.078)
UMI × High-IP × IPA	0.582***	0.471***	0.233**	0.258***
	(0.170)	(0.155)	(0.091)	(0.082)
HI × High-IP × IPA	0.152**	0.173***	–0.070	−0.031
	(0.068)	(0.067)	(0.067)	(0.068)
LI × Low-IP × TRIPS		−0.298***		0.230**
		(0.077)		(0.107)
LMI × Low-IP × TRIPS		−0.561***		0.146**
		(0.084)		(0.058)
UMI × Low-IP × TRIPS		−0.488***		−0.173**
		(0.077)		(0.078)
HI × Low-IP × TRIPS		0.451***		0.068
		(0.102)		(0.096)
LI × High-IP × TRIPS		0.595***		0.354***
		(0.115)		(0.097)
LMI × High-IP × TRIPS		1.428***		−0.079
		(0.154)		(0.049)
UMI × High-IP × TRIPS		1.130***		0.137**
		(0.163)		(0.055)
HI × High-IP × TRIPS		0.150**		0.012
		(0.074)		(0.059)
Observations	1,055,276	1,055,276	1,055,276	1,055,276
No. of country pairs	27,892	27,892	27,892	27,892
Country trends	✓	✓	✓	✓
Group-sector-year FEs	✓	✓	✓	✓
Pair FEs	✓	✓	✓	✓

Notes: The dependent variable is bilateral trade flows excluding trade with future/current IPR-related PTA partners. Columns (1) and (3), and columns (2) and (4), present exporter and importer coefficients from the same regressions—one version without controls for TRIPS compliance, the other with such controls. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A5: High-IP and Low-IP Trade, Alternative Samples

	Exporter effects			Importer effects		
	(1)	(2)	(3)	(4)	(5)	(6)
	All trade	No partner trade	No US/ EU/EFTA trade	All trade	No partner trade	No US/ EU/EFTA trade
log(GDP)	0.127***	0.129***	0.100**	0.552***	0.533***	0.527***
	(0.034)	(0.036)	(0.047)	(0.033)	(0.032)	(0.047)
High-IP × log(GDP)	0.302***	0.373***	0.392***	0.014	0.023	−0.090**
	(0.027)	(0.033)	(0.047)	(0.031)	(0.034)	(0.044)
Low-IP × LI × IPA	−0.169*	−0.131	−0.290*	0.277	−0.264*	0.019
	(0.090)	(0.107)	(0.151)	(0.305)	(0.154)	(0.209)
Low-IP × LMI × IPA	−0.453***	−0.265***	−0.002	0.037	−0.003	0.191*
	(0.084)	(0.097)	(0.145)	(0.057)	(0.066)	(0.106)
Low-IP × UMI × IPA	−0.973***	−0.748***	−0.440**	0.002	−0.062	−0.058
	(0.112)	(0.143)	(0.182)	(0.078)	(0.099)	(0.151)
Low-IP × HI × IPA	−0.242***	−0.222**	0.129	−0.005	0.029	−0.015
	(0.083)	(0.100)	(0.203)	(0.069)	(0.079)	(0.110)
High-IP × LI × IPA	−0.609***	−0.064	0.211	−0.031	0.298**	0.103
	(0.174)	(0.215)	(0.243)	(0.183)	(0.134)	(0.146)
High-IP × LMI × IPA	0.398***	0.388***	0.163	−0.012	0.019	0.009
	(0.094)	(0.111)	(0.162)	(0.043)	(0.078)	(0.088)
High-IP × UMI × IPA	0.387***	0.471***	0.336*	−0.040	0.258***	0.530***
	(0.146)	(0.155)	(0.183)	(0.113)	(0.082)	(0.143)
High-IP × HI × IPA	0.159***	0.173***	0.062	−0.004	−0.031	−0.012
	(0.057)	(0.067)	(0.184)	(0.053)	(0.068)	(0.128)
Low-IP × LI × TRIPS	−0.394***	−0.298***	−0.246***	0.188*	0.230**	−0.002
	(0.080)	(0.077)	(0.090)	(0.108)	(0.107)	(0.122)
Low-IP × LMI × TRIPS	−0.549***	−0.561***	−0.524***	0.132***	0.146**	0.087
	(0.072)	(0.084)	(0.100)	(0.051)	(0.058)	(0.077)
Low-IP × UMI × TRIPS	−0.482***	−0.488***	−0.414***	−0.060	−0.173**	−0.239***
	(0.061)	(0.077)	(0.088)	(0.069)	(0.078)	(0.089)
Low-IP × HI × TRIPS	0.468***	0.451***	0.567***	0.109	0.068	0.208*
	(0.102)	(0.102)	(0.125)	(0.088)	(0.096)	(0.111)
High-IP × LI × TRIPS	0.720***	0.595***	0.495***	0.380***	0.354***	0.604***
	(0.108)	(0.115)	(0.137)	(0.098)	(0.097)	(0.113)
High-IP × LMI × TRIPS	1.301***	1.428***	1.130***	−0.098**	−0.079	0.056
	(0.132)	(0.154)	(0.182)	(0.044)	(0.049)	(0.086)
High-IP × UMI × TRIPS	0.844***	1.130***	1.060***	0.041	0.137**	0.277***
	(0.164)	(0.163)	(0.203)	(0.044)	(0.055)	(0.081)
High-IP × HI × TRIPS	0.052	0.150**	0.129	−0.007	0.012	−0.067
	(0.085)	(0.074)	(0.108)	(0.057)	(0.059)	(0.114)
Observations	1,120,596	1,055,276	720,040	1,120,596	1,055,276	720,040
No. of country pairs	29,525	27,892	19,114	29,525	27,892	19,114
Country trends	✓	✓	✓	✓	✓	✓
Group-sector-year FEs	✓	✓	✓	✓	✓	✓
Pair FEs	✓	✓	✓	✓	✓	✓

Notes: Robust standard errors clustered by bilateral pair are reported in parentheses. Samples used: *All trade*, columns (1) and (4): full dataset, including PTA linkages; *No partner trade*, columns (2) and (5): excluding bilateral linkages with current or future IPR-related PTA partners (baseline results); *No US/EU/EFTA trade*, columns (3) and (6): excluding all bilateral linkages with US, EU, and EFTA countries regardless of partner status. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A6A: Bilateral Trade in Low-IP and High-IP Subsectors (All bilateral trade flows, including with current and future IPR-related PTA partner)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exporter effects								
log(GDP)	0.123***							
	(0.033)							
Sector × log(GDP)		0.549***	0.190***	0.313***	0.206***	0.479***	0.454***	0.321***
		(0.048)	(0.060)	(0.037)	(0.039)	(0.063)	(0.033)	(0.025)
Sector × LI × IPA	−0.108	−1.039**	−1.446**	−1.192**	−0.749***	−0.500	−1.649***	−0.540*
	(0.101)	(0.495)	(0.654)	(0.527)	(0.250)	(0.770)	(0.361)	(0.289)
Sector × LMI × IPA	−0.430***	0.879***	1.115***	0.023	−0.298	0.812***	0.995***	0.582***
	(0.085)	(0.194)	(0.256)	(0.157)	(0.191)	(0.230)	(0.129)	(0.083)
Sector × UMI × IPA	−0.939***	1.287***	1.043**	−0.353	0.117	1.425***	0.549**	0.511***
	(0.118)	(0.240)	(0.423)	(0.300)	(0.261)	(0.194)	(0.224)	(0.096)
Sector × HI × IPA	−0.235***	0.322***	0.896***	0.415***	−0.428***	0.132	0.481***	0.207***
	(0.083)	(0.121)	(0.175)	(0.088)	(0.109)	(0.159)	(0.098)	(0.052)
Sector × LI × TRIPS	−0.416***	0.463***	0.019	0.016	1.736***	−0.129	0.325**	0.337***
	(0.082)	(0.170)	(0.260)	(0.181)	(0.149)	(0.236)	(0.151)	(0.112)
Sector × LMI × TRIPS	−0.549***	0.830***	1.157***	0.715***	2.323***	1.906***	1.200***	1.030***
	(0.071)	(0.262)	(0.239)	(0.209)	(0.157)	(0.205)	(0.178)	(0.131)
Sector × UMI × TRIPS	−0.482***	0.694**	1.222***	1.154***	1.036***	0.736**	1.528***	0.679***
	(0.063)	(0.276)	(0.206)	(0.147)	(0.216)	(0.296)	(0.183)	(0.142)
Sector × HI × TRIPS	0.446***	0.118	0.577***	0.179	−0.381**	0.713***	0.342***	0.251***
	(0.103)	(0.187)	(0.204)	(0.131)	(0.176)	(0.246)	(0.120)	(0.060)
				⋮				

Table A6B: Bilateral Trade in Low-IP and High-IP Subsectors (All bilateral trade flows, including with current and future IPR-related PTA partner, cont.)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Importer effects								
log(GDP)	0.546***							
	(0.033)							
Sector × log(GDP)		0.108***	0.035	0.043	−0.052	0.118**	0.055*	0.029
		(0.038)	(0.046)	(0.030)	(0.051)	(0.048)	(0.033)	(0.026)
Sector × LI × IPA	0.371	−0.791**	1.984***	0.097	−0.891***	0.259	−0.527	0.299
	(0.302)	(0.360)	(0.437)	(0.311)	(0.204)	(0.418)	(0.341)	(0.201)
Sector × LMI × IPA	0.043	−0.194*	0.046	−0.236***	0.007	0.020	−0.215***	0.032
	(0.058)	(0.109)	(0.170)	(0.077)	(0.113)	(0.117)	(0.070)	(0.043)
Sector × UMI × IPA	−0.003	−0.471**	−0.131	−0.431***	0.208	−0.498**	−0.430**	−0.030
	(0.079)	(0.217)	(0.253)	(0.098)	(0.210)	(0.253)	(0.190)	(0.078)
Sector × HI × IPA	−0.004	−0.068	0.100	0.326***	−0.165	0.067	−0.039	0.046
	(0.068)	(0.114)	(0.160)	(0.099)	(0.120)	(0.166)	(0.093)	(0.051)
Sector × LI × TRIPS	0.162	0.191	−0.924***	0.290**	1.395***	−0.322*	0.228	0.086
	(0.108)	(0.157)	(0.263)	(0.133)	(0.179)	(0.196)	(0.149)	(0.086)
Sector × LMI × TRIPS	0.134***	−0.130	−0.442***	0.246***	0.381***	−0.509***	−0.344***	−0.139***
	(0.051)	(0.105)	(0.130)	(0.063)	(0.119)	(0.098)	(0.072)	(0.044)
Sector × UMI × TRIPS	−0.063	0.136*	−0.104	0.074	0.227**	0.079	−0.064	−0.020
	(0.068)	(0.079)	(0.142)	(0.097)	(0.115)	(0.153)	(0.081)	(0.037)
Sector × HI × TRIPS	0.088	−0.200	0.282**	−0.308***	0.077	0.299*	−0.350***	0.005
	(0.086)	(0.149)	(0.134)	(0.100)	(0.158)	(0.179)	(0.113)	(0.064)
Observations								4,481,584
No. of country pairs								29,520
Country trends								✓
Group-sector-year FEs								✓
Pair FEs								✓

Notes: The dependent variable is unidirectional bilateral trade flows, including bilateral linkages with current and future IPA partners. Each of the columns report coefficients from a single regression, delineated by sector. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A7A: Bilateral Trade in Low-IP and High-IP Subsectors (Excluding all US, EU, and EFTA trade)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exporter effects								
log(GDP)	0.115**							
	(0.046)							
Sector × log(GDP)		0.597***	0.133***	0.412***	0.315***	0.590***	0.679***	0.402***
		(0.071)	(0.040)	(0.062)	(0.057)	(0.070)	(0.062)	(0.044)
Sector × LI × IPA	−0.245	0.083	−1.438***	−0.285	−0.181	1.037	0.318	0.471*
	(0.156)	(0.488)	(0.395)	(0.485)	(0.530)	(0.776)	(0.394)	(0.281)
Sector × LMI × IPA	0.004	−0.838***	1.590***	−0.047	−0.104	1.274***	−0.379	0.170
	(0.146)	(0.313)	(0.260)	(0.196)	(0.346)	(0.345)	(0.239)	(0.162)
Sector × UMI × IPA	−0.416**	1.274***	1.339***	0.200	0.087	1.513***	0.136	0.411**
	(0.182)	(0.341)	(0.244)	(0.222)	(0.328)	(0.372)	(0.204)	(0.160)
Sector × HI × IPA	0.112	−0.116	0.761***	0.275	0.538**	−0.237	−0.178	−0.193
	(0.202)	(0.229)	(0.278)	(0.252)	(0.235)	(0.238)	(0.219)	(0.165)
Sector × LI × TRIPS	−0.260***	0.210	0.187	−0.094	1.600***	−0.531**	−0.419**	0.173
	(0.091)	(0.253)	(0.162)	(0.255)	(0.167)	(0.241)	(0.198)	(0.151)
Sector × LMI × TRIPS	−0.527***	0.292	0.972***	0.645**	2.663***	1.833***	0.930***	0.824***
	(0.099)	(0.277)	(0.191)	(0.259)	(0.244)	(0.307)	(0.230)	(0.171)
Sector × UMI × TRIPS	−0.412***	1.628***	0.921***	1.282***	1.873***	1.455***	1.476***	0.627***
	(0.089)	(0.246)	(0.159)	(0.215)	(0.267)	(0.277)	(0.195)	(0.173)
Sector × HI × TRIPS	0.552***	0.289	0.737***	−0.039	−0.339**	0.336	0.268*	0.222*
	(0.126)	(0.197)	(0.240)	(0.138)	(0.168)	(0.251)	(0.149)	(0.118)
				⋮				

Table A7B: Bilateral Trade in Low-IP and High-IP Subsectors (Excluding all US, EU, and EFTA trade, cont.)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Importer effects								
log(GDP)	0.525***							
	(0.047)							
Sector × log(GDP)		0.001	−0.231***	0.008	−0.108	0.052	−0.035	−0.086**
		(0.047)	(0.046)	(0.041)	(0.066)	(0.052)	(0.039)	(0.039)
Sector × LI × IPA	0.098	−0.256	0.807**	0.658**	−0.927***	0.520*	0.218	0.397***
	(0.216)	(0.265)	(0.350)	(0.318)	(0.281)	(0.305)	(0.223)	(0.151)
Sector × LMI × IPA	0.190*	−0.589***	0.155	0.401*	−0.369	0.364**	−0.190*	0.109
	(0.105)	(0.196)	(0.233)	(0.214)	(0.234)	(0.175)	(0.108)	(0.081)
Sector × UMI × IPA	−0.096	0.223	0.196	−0.191	0.944***	−0.046	0.128	0.303***
	(0.160)	(0.200)	(0.271)	(0.222)	(0.237)	(0.164)	(0.129)	(0.111)
Sector × HI × IPA	−0.018	0.045	0.038	0.285	0.056	0.065	0.426***	−0.136
	(0.110)	(0.146)	(0.297)	(0.180)	(0.253)	(0.151)	(0.151)	(0.111)
Sector × LI × TRIPS	−0.024	0.231	−0.233	0.174	1.552***	−0.190	0.160	0.318***
	(0.121)	(0.167)	(0.255)	(0.185)	(0.191)	(0.190)	(0.144)	(0.098)
Sector × LMI × TRIPS	0.083	0.032	−0.037	0.535***	0.574***	−0.458**	−0.192*	−0.044
	(0.077)	(0.188)	(0.230)	(0.110)	(0.208)	(0.196)	(0.107)	(0.085)
Sector × UMI × TRIPS	−0.241***	0.405***	−0.138	0.414***	0.908***	0.105	0.142	0.000
	(0.089)	(0.137)	(0.221)	(0.151)	(0.153)	(0.133)	(0.098)	(0.076)
Sector × HI × TRIPS	0.207*	−0.199	0.177	−0.254	−0.150	0.250	−0.182	−0.025
	(0.111)	(0.244)	(0.345)	(0.219)	(0.200)	(0.178)	(0.216)	(0.121)
Observations								2,879,360
No. of country pairs								19,109
Country trends								✓
Group-sector-year FEs								✓
Pair FEs								✓

Notes: The dependent variable is unidirectional bilateral trade flows, excluding all bilateral linkages with the US, the EU, or EFTA, regardless of whether a country in a particular linkage forms a PTA with one of these partners. Each of the columns report coefficients from a single regression, delineated by sector. Robust standard errors clustered by bilateral pair are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.