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Trade Impacts of Intellectual-Property-Related PTAs

Evidence from Using the World Bank Deep Trade Agreements Database

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Abstract

This paper uses the World Bank database on deep trade agreements to demonstrate the rapid increase in preferential trade agreements with standards of intellectual property protection that are enforceable and elevated beyond the minimums required in the World Trade Organization Trade-Related Aspects of Intellectual Property Rights Agreement. These accords are referred to as intellectual property–related preferential trade agreements. The paper sets out a treatment-control econometric approach, in which treated agreements are defined by various characteristics and the control group is other preferential trade agreements. This approach is used to study whether membership in intellectual property–related preferential trade agreements affects a country's trade with nonmember countries. For this purpose, the paper defines a set of industries that intensively use intellectual property rights (the high-intellectual property group) and a set of industries that do not (the low-intellectual property group). There is evidence that countries in these agreements with the United States, the European Union, or the European Free Trade Association experience significant increases in third-country aggregated exports of biopharmaceuticals at all levels of income, while exports of low-intellectual property goods are relatively diminished, compared with the control preferential trade agreements. This result is reinforced using detailed bilateral sectoral trade and holds also for exports of medical devices from higher-income economies. Because these industries are the target of many elevated standards in intellectual property–related preferential trade agreements, the result suggests that these policies affect trade volumes. Further exploratory analysis suggests that these impacts are associated with higher local sales of affiliates of multinational firms, using US data. These are viewed as preliminary findings that point to the need for further analysis.

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Trade Impacts of Intellectual-Property-Related PTAs:

Evidence from Using the World Bank Deep Trade Agreements Database[1]

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1. Introduction

In 1995, at the foundation of the WTO and its Agreement on Trade-Related Intellectual Property Rights (TRIPS), the international framework for protecting intellectual property rights (IPRs) remained fragmented, with disparate approaches across international treaties and conventions and widely varying national standards. In the ensuing 25 years the system has mushroomed in coverage and complexity, an evolution amounting to the most dramatic globalization of IPRs in history (Maskus, 2012). A primary commercial policy objective of the United States, followed later by the European Union (EU) and members of the European Free Trade Association (EFTA), and yet later by Japan, South Korea and other nations, has been to induce significantly stronger standards in developing and emerging countries for protecting industrial knowledge assets and creative works. The vessel for such upgrades is an increasingly comprehensive treatment of IPRs, meaning patents, copyright and related rights, trademarks, and similar constructs.

While TRIPS was the basis of this campaign, it was quickly eclipsed by demands for even stronger protection in the bilateral and regional preferential trade agreements (PTAs) pursued by these *demandeur* nations. This insistence on so-called "TRIPS-Plus" standards in PTAs is central for their trade negotiating objectives. For example, the United States has concluded agreements with Jordan, Peru, Australia, South Korea, and other countries that embody significantly higher standards of patent protection for pharmaceuticals, stronger regulations governing copyrights in digital goods, and expanded penalties for infringing IPRs. Thus, these trade agreements often provide far-reaching and prescriptive requirements that were not considered by the framers of TRIPS. The recently concluded 11-country Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) added further rules, including for the protection of trade secrets.[2] In 2014, Canada and the EU ratified their bilateral Comprehensive Economic and Trade Agreement, containing an extensive chapter on intellectual property with elevated standards. Thus, PTAs requiring significant TRIPS-Plus standards are the

[2] The decision by the Trump Administration to withdraw from the predecessor agreement, the Trans-Pacific Partnership, permitted the remaining members to moderate or suspend other TRIPS-Plus demands but IPRs protection remains a central principle of CPTPP.

primary channel through which protection has been ratcheted up around the world. We refer to such accords as Intellectual-Property-Related PTAs, or IPAs.

The TRIPS Agreement has been studied empirically in broad terms, with papers asking whether its adoption by members has affected such economic outcomes as trade and foreign direct investment (FDI). The role of PTAs that feature strong IPRs standards has attracted much less attention, however. These agreements, which have steadily proliferated since the mid-1990s, are a potentially significant determinant of trade and investment patterns and innovation activities. As such, they deserve systematic study, which we undertake in this paper. Specifically, we build on an existing working paper (Maskus and Ridley, 2020), which studied the impact of membership in IPAs, where one partner is the US, the EU, or EFTA, on the composition of aggregate and bilateral trade, controlling for compliance with TRIPS standards. Here we delve deeper by using specific aspects of such agreements, as measured by the World Bank's database on the depth of trade agreements (Hofmann, et al, 2017).

The relationship between intellectual property standards and trade is theoretically ambiguous and depends on context. Most important, patents and copyrights are different from import barriers. A cut in import tariffs is a reduction in trade costs, implying generally higher trade. Lower trade barriers expose domestic firms to competition, typically reducing market power and markups. Intellectual property rights, however, create temporary monopolies in the use, including trade, of technologies and goods. These exclusive rights permit their owners to decide where, when, and how they will produce, export, license, and sell protected products and technologies.

A small number of studies have estimated the trade effects of TRIPS, using broad measures. Thus, Ivus (2010) found that a group of developing countries (those that were not British or French colonies) that were obligated by membership in the WTO agreement to adopt stronger patent reforms than a similar group that did not have to reform as much, experienced significantly higher import growth in high-technology products. Delgado et al. (2013) studied a more comprehensive set of developing countries and found that, after implementation of TRIPS patent rules, there was a significant rise in imports of patent-intensive goods. Maskus and Yang (2018) found a significantly positive effect of changes in an index of national patent reforms in the TRIPS era on the growth of R&D-intensive sectoral exports in both emerging and developed

economies. They also discovered evidence that this export expansion was associated with sectoral inflows of patent applications and intra-firm trade within US multinational firms.

Based on this small sample, it seems that stronger IPRs, including those implemented via TRIPS, tend to increase both imports and exports among middle-income emerging economies, especially in high-technology and IPRs-sensitive goods. However, this question has rarely been studied in the context of the further elevation of standards embedded in high-protection PTAs. This is the empirical gap we hope to begin filling with this paper.[3] Specifically, employing the World Bank database, we ask whether legally enforceable PTAs with chapters requiring IPRs standards that exceed TRIPS expectations have some additional impact on the trade of member countries, over and above that of TRIPS. We also ask whether these effects vary by countries in different income groups (development levels) and specific clusters of industries that are highly sensitive to intellectual property protection. We pay particular attention to trade in pharmaceuticals, chemicals, and information and communication technologies, for these are the areas in which TRIPS-Plus chapters embody especially rigorous standards.

Our analysis contributes to the literature on the trade effects of PTAs. Whether such agreements increase or decrease trade, couched in terms of trade creation or trade diversion, has long been a subject of theoretical and empirical research (Romalis, 2007; Baier and Bergstrand, 2007). More recent literature suggests that PTAs generally have positive trade effects, controlling for endogeneity of selection into agreements, but the impacts are strongly heterogeneous (Baier and Bergstrand, 2009; Baier et al., 2019).

Note that such studies consider discriminatory reductions in trade barriers between members to be the policy impact of free trade agreements. Thus, they focus on bilateral or within-agreement trade effects, accounting also for trade diversion from outside. When considering IPRs, however, the logic is different, arising from the inherent spillover effects created by national IPR regimes. Specifically, the TRIPS Agreement requires countries to establish and enforce standards that are applied without discrimination, embodying both national treatment and the most-favored nation principle. Accordingly, when a country strengthens its

[3] A recent paper by Campi and Dueñas (2019) estimated a gravity model of bilateral trade and found evidence of a positive impact five years after signing such agreements. However, this effect seemed to hold for both high-intellectual property goods and low-intellectual property goods, raising some questions about the identification exercise.

IPRs because of PTA provisions, it must extend this treatment to all WTO members. That is, it cannot discriminate between rights-holders from PTA members and others. Indeed, it makes little practical sense for nations to discriminate across the origins of applications for intellectual property protection. Thus, in principle, rights-holders from countries not party to a PTA are affected legally under the same terms as their counterparts from member countries. This fact suggests that the effects of elevated intellectual property norms in PTAs spread beyond the agreements' members *de jure*, though it may not prevent *de facto* discrimination. This insight suggests that the effects of such standards may not display much diversion.

In this paper we study the effects of membership in enforceable IP-related PTAs, negotiated both with strong *demandeur* countries (the United States and EU/EFTA) as well as with other countries (such as Japan, South Korea, and Australia), on exports and imports of goods that intensively use intellectual property, accounting for levels of economic development. We estimate the impacts on member nations' aggregate and bilateral trade in IP-intensive sectors, using a difference-in-differences approach comparing various definitions of treatment agreements. We adopt rigorous econometric specifications to deal with endogenous selection into such agreements. In general, we find that the trade effects are modest. However, there is evidence of a trade-expanding impact on specific IP-intensive sectors, such as pharmaceuticals, chemicals, and information technology products, particularly in higher-income emerging countries. We also find evidence that developing countries that join such agreements see significant reductions in their trade in goods that are not IP-intensive, relative to countries that do not join them. These findings imply that strong IPRs chapters may exert a sorting effect, shifting trade from industries that are less sensitive to IPRs protection to those that are more dependent on it.

The remainder of the paper is organized as follows. Section 2 provides background on the development of PTAs with strong intellectual-property chapters and overviews their scope and coverage, relying on World Bank data. Section 3 discusses the empirical framework and presents estimates of the effects of IP-related PTAs on aggregate and bilateral imports and exports at the sectoral level. Section 4 offers concluding remarks.

2. Background

In recent decades, PTAs have changed considerably in focus and content. Older agreements aimed largely to reduce formal barriers to trade and expand market access between member countries. Beginning in the 1990s they expanded considerably in ambition and coverage. This process began with the North American Free Trade Agreement (NAFTA) and numerous bilateral treaties between the European Free Trade Association and individual countries, such as Estonia, Latvia, and Mexico. This round of trade agreements expanded beyond tariffs to rules covering certain regulatory regimes, including intellectual property rights. A decade later, the EU announced its "new trade policy," shifting its negotiating priorities toward rigorous protection of patents, copyrights, geographical indications and other IPRs in its many new PTAs in Eastern Europe and the Middle East, Latin America, Canada, and Japan.

NAFTA was among the first multi-country and economically large PTAs to set minimum standards for, and move toward partial harmonization of, nearly every aspect of IPRs as they existed then. Regarding patents, NAFTA required minimum patent duration, confidentiality for pharmaceutical clinical trials data, and extensions in patent length to compensate for administrative delays in granting protection, among other elements. These provisions became the foundation for expanding TRIPS-Plus patent standards in later PTAs. It also stipulated a minimum copyright length, the types of works that must be protected, and various neighboring rights. NAFTA required automatic recognition of internationally well-known trademarks, another TRIPS-Plus standard. And the accord called for protection of geographical names through systems effectively the same as those covering trademarks and collective marks. PTAs reached by the EU and EFTA in this era had similar requirements, though differing in particular areas of concern, most prominently in setting up specific systems for geographical indications (GIs).

NAFTA was preceded by the formation of the European Economic Area (EEA) in 1994, linking three members of EFTA to the EU's single-market program. Central to the EEA is the adoption of largely harmonized intellectual property standards throughout the region.

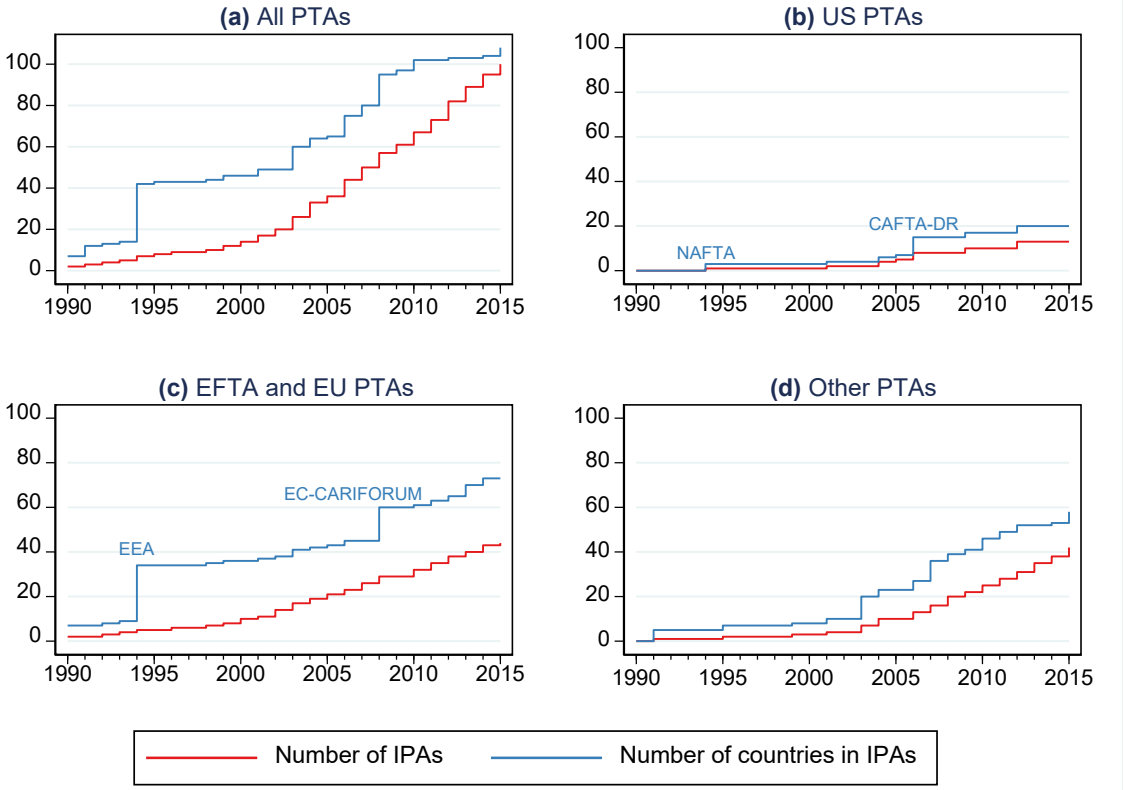
The expanded coverage of PTAs sharply increased after 2000, with the United States and the EU demanding stronger IPR provisions, sometimes extended to new subject matters. To be sure, other newly created PTAs, not involving the United States or the EU, were reached by Mexico, Japan, Australia, South Korea, and Chile, among others. These PTAs also included IPRs

chapters, though typically with less rigorous standards in certain areas. It is also noteworthy that the majority of these IP-related PTAs are legally enforceable, as designated in the World Bank data. Specifically, the database ranks the legal enforceability (LE) of PTAs on a scale of 0, 1, or 2, with 0 essentially indicating no enforcement language exists, 1 indicating weak enforcement language (e.g., "should" or "may"), and 2 identifying those with commitment language (e.g., "shall" or "must"). We use this designation (LE = 2) in selecting our treatment IPAs in the econometric analysis.

Figure 1 illustrates the substantial growth since 1990 in the number of IPAs in the World Bank data that feature strong enforceability. The red lines indicate the number of agreements and the blue line shows the number of countries in one or more of them.[4] As shown in panel (a), the number of IPAs rose from less than 20 in 2000 to 100 in 2015, while the number of countries involve now exceeds 100. Thus, currently around 64 percent of WTO contracting parties are members of at least one IPA, as defined here. Panel (b) shows more modest growth in IP-related PTAs involving the United States as a partner. The establishment of the CAFTA-DR agreement in 2005 markedly raised the number of countries, currently around 20, in such agreements. Panel (c) demonstrates the faster growth in EU-related and EFTA-related IPAs, with discrete jumps in country coverage in 1994 with the EEA and in 2008 with the establishment of the EU-CARIFORUM agreement. Together, the EU and EFTA are party to more than 40 enforceable IPAs. Because of the high degree of IPRs harmonization within them, the EU and EFTA themselves are counted as IP-related trade agreements in our sample. Finally, panel (d) indicates that there are some 40 IPAs, involving around 60 countries, that do not involve the United States, the EU, or EFTA. Thus, there has been considerable proliferation in such agreements, both over time and across countries.

Figure 1: The Number of Legally Enforceable IP-Related Trade Agreements and Number of Countries with Membership in at least One such Agreement by Year, 1990-2015

[4] See also the DESTA database described in Dür et al. (2014), which defines IPAs as agreements with an IPRs chapter, regardless of how comprehensive or rigorous.



Note that these IPAs, while increasing the scope of protection over time, do not treat all elements of IPRs the same, nor do they have the same depth, meaning numbers of specific IPRs provisions. Countries joining PTAs make different decisions about IPRs and other policies based on their own political-economic interests. To illustrate, the United States places great importance on assuring patent and copyright protection for its own nationals' inventions and creative works in foreign markets and negotiates its international agreements accordingly. The EU and EFTA do so as well but particularly prioritize establishing strong systems to register GIs, which protect the rights to use place names in wines, spirits, and other products. Japan and South Korea have focused on extending patent rights, while Australia prefers weaker standards governing copyrights. Developing countries might work to sustain access to international technologies and information, perhaps through more limited patent standards or weaker trade secrets protection. Indeed, it may seem surprising that emerging and developing economies increasingly agree to strong IPRs chapters in PTAs, a point we exploit in our econometric analysis. We simply posit here that different countries, in negotiating PTAs, likely seek to emphasize particular aspects of IPRs.

It would be tedious to characterize textually the many differences in approach we find in the IPAs considered here. Accordingly, we summarize them in Table 1, contrasting agreements involving the United States, the EU or EFTA, and others. The World Bank database identifies 130 detailed IPRs provisions, broken into 16 broad categories. These provisions are simply coded as either 0 (absent in the PTA) or 1 (present). In Panel A we list eight categories that seem relevant for studying potential trade impacts.[5] For example, there are 15 international treaties or conventions covering intellectual property that members of IPAs might be required to gain accession or ratify. The United States is far more likely to negotiate agreements demanding such activity, with the average IPA listing 11.5 conventions, compared to 3.3 for the EU/EFTA IPAs and 2 for the others. Indeed, US-involved IPAs stand out across the board, embedding far more provisions within nearly all categories than do the others. This difference is particularly stark in trademarks, patents, test data protection, copyrights, and enforcement.

In Panel B we turn to a subset of categories and, within those, list the number of provisions that are widely considered to be "TRIPS-Plus" in that they are considerably more prescriptive than what is found in TRIPS (Maskus, 2012). There are 32 such provisions, which we collectively call BTRIPS (for "Beyond TRIPS") to avoid confusing the standard TRIPS-Plus terminology with the World Bank's "WTO-Plus" designation.[6] These 32 provisions were selected because they feature prominently in debates over elevated IPRs norms, but the list is somewhat ad hoc. With this caveat in mind, there are five BTRIPS norms in patents, including such items as patents for new uses of known products, patent-term adjustments, and patent linkage. Similarly, there are five standards in test data protection, including protection for trial data in pharmaceuticals and biologics. The largest group is in enforcement, reflecting the fact that TRIPS essentially committed countries to a best-efforts approach, while some recent IPAs

[5] The other categories focus on procedural questions (such as transparency and cooperation mechanisms), do not strengthen existing IPRs (such as incorporating existing IPRs treaties or recognition of the importance of biodiversity and traditional knowledge), or focus on non-trade issues.
[6] The list of these BTRIPS standards, broken into "core" standards and "broad" provisions, is in Appendix Table A2.

Table 1: Summary of IPRs Provisions in Legally Enforceable IP-Related PTAs

Panel A: all IPR provisions as of 2015	US LE IPAs (13)			EU/EFTA LE IPAs (45)			Other LE IPAs (42)		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Accession/Ratification (n = 15)	11.5	2	14	3.3	0	13	2.0	0	13
National Treatment (n = 2)	2.0	2	2	0.9	0	2	0.6	0	2
Trademarks (n = 15)	9.4	4	15	1.6	0	7	1.5	0	11
Geographical Indications (n = 7)	2.6	0	4	2.0	0	7	0.7	0	3
Patents (n = 14)	4.8	1	13	1.0	0	3	0.7	0	10
Data Protection (n = 5)	2.8	0	5	0.9	0	2	0.1	0	5
Copyrights (n = 14)	10.5	4	14	2.0	0	12	1.9	0	12
Enforcement (n = 23)	17.2	4	20	7.6	0	17	4.8	0	17

Panel B: BTRIPS provisions as of 2015	US LE IPAs (13)			EU/EFTA LE IPAs (45)			Other LE IPAs (42)		
	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Trademarks (n = 4)	2.3	2	4	0.2	0	2	0.4	0	4
Geographical Indications (n = 3)	0.9	0	1	0.8	0	3	0.3	0	2
Patents (n = 5)	1.2	0	4	0.4	0	1	0.2	0	3
Data Protection (n = 5)	2.8	0	5	0.9	0	2	0.1	0	5
Copyrights (n = 6)	5.6	1	6	1.0	0	6	0.8	0	6
Enforcement (n = 10)	7.1	1	9	3.1	0	7	2.0	0	7

require such policies as injunctive relief, destruction of infringing goods, and criminal sanctions for willful infringement.

Again, we find that the United States is far and away the top *demandeur* of these BTRIPS conditions, especially in data protection, copyrights, and enforcement. The EU/EFTA IPAs are considerably less prescriptive, though they are comparatively more focused on GIs and enforcement.[7] The rules on GIs, patents, data protection, and copyrights are, relatively speaking, virtually absent in the IPAs involving countries other than the United States and EU/EFTA, though there are exceptions as seen in the "max" column. The strong impression is gained that, among the comparatively few IPAs featuring the United States as a partner, the adoption of BTRIPS standards is far more common than elsewhere.

3. Empirical Approach and Estimation Results

The proliferation in country coverage and scope of IP-related PTAs discussed above imply that extensive changes in national IPRs policy have been implemented in this period. Our objective in the empirical analysis is to estimate the effects membership in IPAs has had on countries' aggregate and bilateral trade, specified at the detailed sectoral level for goods that are presumably particularly sensitive to IPRs protection.[8]

3.1 Identification Strategy

Regarding aggregate sectoral trade, we adopt a treatment-control econometric framework but focused on PTAs. The designation of treatment countries varies across cases, as discussed below, though in all cases we employ membership in IP-related PTAs that are flagged by the World Bank as legally enforceable (LE = 2). Treatment countries are those with membership in such agreements at any point during the sample, and control countries are all others.

Our definition of clusters of highly IP-intensive industries and less IP-intensive commodities comes from Delgado et al. (2013). They classify the traded commodity codes in the Standard International Trade Classification (SITC), Revision 3, into high-IP or low-IP sectoral classifications based on a similar categorization of the Standard Industrial Classification

[7] These findings are broadly consistent with the rankings in Maskus and Ridley (2020).
[8] The terminology is somewhat confusing. By "aggregate sectoral trade" we mean a country's total trade in specific industries, not its total trade. Maskus and Ridley (2020) offer the latter estimates, using a different designation of treatment IPAs.

(SIC) codes in the Economics and Statistics Association of the US Patent and Trademark Office's 2012 report on intellectual property. Finally, because the impacts of IPAs membership might vary by countries' comparative development levels, we allow for such effects to vary by discrete income groups, as designated by the World Bank.[9] We use unchanging income-group designations for countries based on 1995 definitions, classifying countries as low-income (LI), lower-middle income (LMI), upper-middle income (UMI), or high income (HI). In all cases we estimate trade effects in samples excluding trade with partners (both before and after the entry-into-force of the PTA) in the treatment IPAs. As discussed below, this approach excludes potential endogeneity between existing trade linkages with those partners and decisions to join such PTAs.

Turning to bilateral trade among all country pairs, we adopt a gravity specification in which we identify specific coefficients on imports and exports of IP-sensitive goods, using the disaggregated sectoral breakdowns. This approach permits estimation of the impacts of membership in an IP-related PTA on sectoral trade with bilateral trade partners outside the agreements.

With this background, our identification relies on three types of variation. First, during our sample some countries entered into IP-related trade agreements, as we define them below, while others did not (note that countries rarely exit PTAs once they have joined). We also distinguish among countries at varying income levels, noting that both their membership decisions and their economic responses to such agreements may vary. Second, as already noted, we distinguish between sectors in terms of their apparent relative usage of intellectual property, computing trade impacts in high-IP and low-IP industries compared to the same sectors in control countries. This distinction is important, for if IP chapters matter for trade, in comparison with just the impacts of membership in a PTA generally, the effects should show up in relatively greater impacts in the high-IP set of industries. The third important element for identification is to control for TRIPS adherence. Most countries in our sample became compliant with TRIPS at some point in the period, which may have happened before or after their joining an IP-related PTA. In order clearly to isolate the IPA effect, therefore, our preferred specification defines

[9] For detailed lists of industry and country groupings see Maskus and Ridley (2020).

treatment countries as those which joined an IP-related PTA only after they complied with TRIPS.[10]

An obvious challenge to this identification strategy arises if the causality between trade and IPRs works in two directions. On the one hand, membership in IPAs might increase members' trade. On the other hand, member nations may form such agreements because they already undertake a relatively high level of trade in IPRs-sensitive goods. While this is a potential concern, the threat of an endogenous relationship between such trade and the formation of IPRs-related PTAs is limited by a critical factor in how such agreements arise. The basic objective of PTAs is to liberalize within-agreement trade through cuts in tariffs and other trade barriers. Where strong IPRs chapters are included it is typically at the insistence of a single negotiating party. This is especially the case where IP-related PTAs involve both technologically advanced countries that have a strong comparative advantage in creating IP-intensive goods and developing or emerging countries that produce relatively little intellectual property. This situation characterizes the bulk of the IP-related PTAs in our samples in which one partner is the United States, the EU, or EFTA. Moreover, these developed partners typically bring greater bargaining power to the negotiating table. Thus, it is likely that low-income and middle-income countries that join PTAs with higher-income countries primarily agree to significantly stronger IPRs rules to obtain greater and more secure export access to major foreign markets. Put differently, for such countries IPRs are secondary concessions that they would not ordinarily select as a matter of endogenous policy. While this factor does not ensure that the IPRs effects we estimate are exogenous to countries' trade, it is reasonable to expect that, at least for low-income and middle-income countries, the policy is effectively randomly assigned.

This argument is subject to one significant qualification, however. In PTAs between developing countries and major developed economies, such as the United States or the EU, the former may not, in fact, receive considerable gains in market access in the latter. This is because the developed countries typically already had low MFN tariffs and few quotas on imports of manufactured goods. In this context, developing-country partners may have anticipated potential gains in inward technology flows, through increases in inward FDI and offshoring. Evidence

[10] This restriction implies that we do not include the pre-1995 EU/EEA agreements. However, because the World Bank database classifies each of the post-1995 EU enlargements (in 2004, 2007, and 2013) as separate PTAs, these are included in relevant treatment groups.

suggests that both tariff cuts in PTAs and IPRs reforms, undertaken on a non-discriminatory basis under such agreements, encourage technology transfers to middle-income and emerging economies (Maskus, 2012).

Thus, there may be remaining concerns about endogenous selection. To alleviate the problem, we estimate specifications in which we eliminate from the sample trade with the major partner in each of the treatment agreements, generating estimates of the trade impacts with respect to all other countries, both in the aggregate and bilateral trade. We regard this as the most rigorous specification, in that it extracts the possibility that the intent of the major partner was to increase trade in IP-sensitive goods with treatment countries, including through trade in intermediates, leaving just residual trade effects with third countries.

Our selection of treatment IPAs (and treatment countries as members) is as follows. In case 1 we designate treatment IPAs as those legally enforceable agreements involving the United States, the EU or EFTA as a partner country.[11] This selection is made in part because these are the main *demandeurs* of elevated IPRs standards. However, we also wish to compare results using the World Bank database with the same specification of IPAs using the DESTA database in Maskus and Ridley (2020). In case 2 we consider all PTAs in which IPRs are designated as legally enforceable and in case 3 we use such PTAs where the United States, EU or EFTA are not partners.[12]

In the final two cases we shift from permitting the nature of full agreements to determine the treatment selection to considering, in a basic fashion, whether specific BTRIPS provisions matter for trade sufficiently to serve as meaningful selection devices. We do this in part to explore the explanatory power of the World Bank database in its considerable specificity. However, this focus is of more general interest because of the importance placed on TRIPS-Plus standards by negotiators and the attention they draw in the policy debate. If, for example, American negotiators place heavy emphasis on patent extensions, test-data protection, and anticircumvention of digital copyrights, their inclusion may bear detectable traces in the trade data. In essence, we explore whether IP-related PTAs with specific BTRIPS standards have trade

[11] To clarify, we select PTAs in which the IPRs are designated as LE. These are agreements labeled WTO-X_ipr_le=2 in the World Bank source.

[12] Appendix Table A1 lists IPAs involving the United States, the EU or EFTA, and all those considered legally enforceable by the World Bank. We exclude the North American Free Trade Agreement (NAFTA) because it was implemented prior to our sample period. Lists of other groupings are available on request.

impacts different from what becomes an extensive control group: the trade of countries not in such agreements, including of countries that are in otherwise designated IPAs.

A priori selection of which BTRIPS provisions to use is inevitably somewhat arbitrary because it is far from obvious which may be definitive. We opt for two relatively parsimonious approaches. Thus, in Case 4 we explore the effects of BTRIPS provisions by defining the treatment group as legally enforceable IPAs in which at least three of nine core patents or test data standards are included.[13] The definition of "core" standards is our own, based on the policy debate regarding TRIPS-Plus. We limit the standards to patents and test-data protection because our industry clusters are in manufacturing, rather than digital trade where copyrights might matter. Moreover, because these standards are most relevant for pharmaceuticals and agricultural chemicals, we might anticipate trade effects to be most visible in those sectors. Finally, to investigate the role of a specific standard, we consider only test-data protection for pharmaceuticals, which is seen by the industry as essential.

3.2 Analysis of Aggregate Sectoral Trade

The estimating equation for the analysis of aggregate sectoral trade considers the (logarithm of) the dollar value of country *i*'s trade (denoted TR_{ist}) for year *t* in sector *s*, estimated separately for exports versus imports:

$$\begin{aligned}(1)\qquad \log(TR_{ist}) = {} & \alpha_1 \log(GDP_{it}) + \textstyle\sum_{s \neq Low\text{-}IP} \alpha_{2s} Sector_s \times \log(GDP_{it}) \\ & + \textstyle\sum_g \sum_s \beta_{1gs}\, Group_{ig} \times Sector_s \times IPA_{it} \\ & + \textstyle\sum_g \sum_s \beta_{2gs}\, Group_{ig} \times Sector_s \times TRIPS_{it} \\ & + \lambda_{gst} + \lambda_i t + \varepsilon_{ist}.\end{aligned}$$

Here, the sectors are comprised of the low-IP sector, as well as seven high-IP industry clusters: analytical instruments (AI), biopharmaceuticals (BIO), chemicals (CHEM), information and communication technology (ICT), medical devices (MED), production technology (PT), and a residual category (Other) of trade in commodities that rely intensively on IPRs but belong to none of the specific high-IP clusters. $Sector_s$ is an indicator variable for whether a specific

[13] These relate to the patentability of new uses of existing products, methods, and processes, patent-term adjustments, patent linkage, and test-data protection for agricultural chemicals, pharmaceuticals, new chemical entities in pharmaceuticals, and biologics.

observation of trade represents a particular sector $s \in$ {Low-IP, AI, BIO, CHEM, ICT, MED, PT, Other}, and $Group_{ig}$ is an indicator variable for whether country i is classified in income group $g \in$ {LI, LMI, UMI, HI}. To account for scale effects on total trade, we include (the logarithm of) country i's GDP, plus interactions allowing for differential trade-GDP effects across sectors.[14]

Our policy variable of focus is the IPA_{it} variable, an indicator taking the value of one if country i is member of any in-force PTA of the corresponding treatment definition in year t, and zero otherwise. $TRIPS_{it}$ is defined analogously, with the variable taking a value of one if country i is estimated to be in compliance with the TRIPS agreement in year t and zero otherwise, with compliance dates based on approaches developed in Ginarte and Park (1997), Park (2008), and Hamdan-Livramento (2009). Rather than incorporating a series of main effects and interaction terms to recover treatment effects across the multiple dimensions of heterogeneity (income group, sector, and policy), we exclude the variables for the main effects (e.g., the main effect of a stand-alone IPA_{it} variable) and instead include the full set of interaction terms between income group, sector, and policy treatment.[15] By including the interactions for the exhaustive set of sectors and income groups, the overall impact on trade of the IPA_{it} treatment can be directly recovered from the coefficients β_{1gs}.

Finally, λ_{gst} is an income-group-sector-year fixed effect corresponding to country i's income group, and $\lambda_i t$ is a country-specific linear time trend to account for idiosyncratic country-level dynamic factors. Residual ε_{ist} is a well-behaved error term which we cluster at the country level. We follow Baier and Bergstrand (2007) and take our data at five-year intervals (1995, 2000, … 2015) to account for the notion that trade adjustments to policy changes take several years to manifest (Trefler, 2004).

The estimation results for equation (1) are presented in Tables 2 through 6, corresponding to the various definitions of treatment IPAs (US/EU/EFTA IPAs, all legally enforceable IPAs, all

[14] Data sources are listed in Appendix Table A3.
[15] See Maskus and Ridley (2020) for more detail on, and proof of, the equivalence of this "fully interacted" specification and the more traditional main effect and interaction effect approach to difference-in-differences estimation.

non-US/EU/EFTA IPAs, IPAs with at least three core patents or test data standards, and IPAs with pharmaceutical test data confidentiality provisions).[16]

Consider first the results in Table 2, in which the country-level treatment is defined as membership in a US, EU, or EFTA-negotiated PTA with legally enforceable provisions on IPRs. This specification is closest to the approach taken in Maskus and Ridley (2020). In exports, it is evident that trade in two sectors – low-IP and biopharmaceuticals – evince the strongest and most consistent impacts of IPA membership. The low-IP exports of IPA members to third countries are significantly reduced (relative to countries not in such agreements) for countries in the upper three income classifications, with the impact on low-income countries negative but insignificant. In contrast, for high-income economies exports seem to be stimulated also in AI and MED, perhaps suggesting a tendency of IPAs toward rationalizing exports away from low-IP goods to patent-sensitive goods. There is consistent evidence through all these tables of an increase in relative exports of ICT in low-income countries, which may reflect growth in platform assembly of electronics associated with IPAs.

To illustrate the magnitude of these estimates, the coefficient of –0.833 on the low-IP exports of lower-middle income IPA members suggests that such countries undertake on average 56.5% less of such exports (since $\exp\{-0.833\} - 1 = -0.565$).[17] While these estimates might seem large, it is important to recognize that the impacts reflect trade with third countries outside of the PTA, and it is not inconceivable that small countries party to such agreements could divert such a significant portion of their existing trade in such commodities away from their trade partners outside of the PTA towards a much larger major PTA partner. In contrast, the findings on pharmaceutical exports are strongly positive for each of the four income groups, with low-income countries undergoing a substantial increase in such exports of just under 700% (since $\exp\{-2.062\} - 1 = 6.862$). The significant and positive estimates in this set of results are largely found in biopharmaceutical trade, according well with the idea that PTAs negotiated by the US, the EU, or EFTA generate the strongest export impacts in the sector so extensively emphasized

[16] We omit the estimates of the coefficients on the TRIPS variables from the presentation of the results in the interest of brevity. Results are available upon request.

[17] The β coefficients from equation (1) can be translated to percentage change interpretations according to the relationship percentage change $= (\exp\{\beta\} - 1) \times 100\%$.

in the IPRs provisions of these agreements. There is some evidence of relative export expansions in the ICT cluster as well.

In turning to the results on imports for the US/EU/EFTA IPA case, the results become less systematic. While on the export side, sector-specific policy provisions seemed to drive the key findings, in the case of imports a more general impact is apparent, with positive impacts on the IPRs-sensitive imports of low-income IPA members across five of the seven IPRs-intensive sectors. That low-income countries see their IPRs-intensive imports increase nearly across the board suggests that non-specific IPRs provisions in these PTAs relating to heightened levels of policy commitment and enforcement, and expanded legal recourse for rightsholders encourages imports across a broad range of industries for these countries.[18]

In Table 3 we repeat the regressions where treatment includes all IPAs with legally enforceable IPRs chapters. We again find negative coefficients for low-IP exports, particularly in the high-income economies. For those countries, exports rise in AI, BIO, MED, and PT. Again, there is little systematic evidence that IPA membership differentially affects imports of partners from countries outside the agreement. In Table 4 we consider the set of 42 legally enforceable IPAs that do not include the US, EU, or EFTA as a member. We find no systematic evidence of impacts on either exports or imports of such agreements. In particular, low-IP exports are not affected, nor is BIO trade, in contrast to the cases where those *demandeur* countries are involved. This is perhaps unsurprising, in that these agreements are considerably less demanding regarding intellectual-property standards, as noted in Table 1.

Tables 5 and 6 repeat the regressions for aggregate sectoral trade, where treatment is based on small numbers of key BTRIPS provisions. We reiterate that this is a demanding selection approach because it is unlikely that such micro provisions would exert trade stimulus beyond those already in place from broader IPAs. This expectation is largely born out. There are no indications of such impacts in Table 5, which selects agreements with at least three core provisions.[19] Because those provisions vary across agreements the treatment is far from systematic. It is intriguing, however, that in Table 6, where the treatment agreements are selected

[18] The results in Table 2 are highly consistent with those for the aggregate trade regressions in Maskus and Ridley (2020), suggesting a considerable overlap in the two IPA treatment definitions.
[19] There are 31 such agreements, 10 of which do not involve the US, EU, or EFTA.

solely on the basis of a provision requiring test-data protection for pharmaceuticals,[20] there are positive and significant coefficients on both exports and imports of LI and LMI nations. This offers a preliminary indication that specific standards may affect third-party trade positively in developing economies that adopt them.

These findings regarding aggregate sectoral trade offer initial support for three novel considerations regarding IP-related IPAs. First, where the US, the EU, or EFTA is a partner there may be a sorting effect of membership in such agreements among high-income countries, reducing relative exports of low-IP goods and raising them in specific IP-sensitive sectors. Second, IPAs not involving those partners have little effect on IP-sensitive trade. Finally, it may be that specific IPRs provisions tightly linked to certain industry interests (here, test-data protection and pharmaceuticals) induce more trade between developing-country partners and third countries.

[20] There are 36 such agreements, 7 of which do not involve the US, EU, or EFTA.

Table 2: US/EU/EFTA IPAs (Aggregate Trade; 58 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.508***							
	(0.103)							
Sector × $\log(GDP_i)$		0.087	0.187**	0.252***	0.064	0.144*	0.139**	0.121**
		(0.069)	(0.075)	(0.073)	(0.091)	(0.077)	(0.063)	(0.061)
Sector × LI × IPA_i	–0.062	–0.392	2.062***	0.744	1.529**	0.505	0.259	0.280
	(0.318)	(0.402)	(0.690)	(0.572)	(0.741)	(0.409)	(0.421)	(0.354)
Sector × LMI × IPA_i	–0.833**	–0.127	0.704*	–0.008	0.251	0.266	0.344	0.254
	(0.347)	(0.237)	(0.414)	(0.259)	(0.330)	(0.262)	(0.229)	(0.179)
Sector × UMI × IPA_i	–1.074**	0.134	0.800**	–0.403	0.835*	–0.118	–0.023	–0.004
	(0.489)	(0.301)	(0.393)	(0.302)	(0.462)	(0.356)	(0.311)	(0.219)
Sector × HI × IPA_i	–2.530***	0.432*	1.150***	–0.205	–0.058	0.718***	0.294	–0.831***
	(0.663)	(0.261)	(0.423)	(0.415)	(0.310)	(0.236)	(0.225)	(0.263)
							Observations	7,055
							R^2	0.908
Imports								
$\log(GDP_i)$	0.475***							
	(0.068)							
Sector × $\log(GDP_j)$		0.183***	0.113***	0.214***	0.137***	0.115***	0.146***	0.050***
		(0.022)	(0.032)	(0.020)	(0.023)	(0.021)	(0.022)	(0.016)
Sector × LI × IPA_i	0.552	0.383	0.604**	0.639**	0.992***	0.857**	0.544	0.716**
	(0.385)	(0.340)	(0.288)	(0.315)	(0.288)	(0.388)	(0.349)	(0.289)
Sector × LMI × IPA_j	0.415***	–0.258**	–0.217	–0.129	–0.017	–0.028	–0.309***	–0.067
	(0.140)	(0.103)	(0.172)	(0.109)	(0.141)	(0.120)	(0.096)	(0.094)
Sector × UMI × IPA_i	0.397	–0.092	–0.207	–0.280**	0.315	–0.033	–0.132	0.052
	(0.299)	(0.125)	(0.166)	(0.131)	(0.265)	(0.220)	(0.140)	(0.116)
Sector × HI × IPA_j	0.093	–0.045	–0.117	0.002	0.000	0.321**	–0.384**	–0.273**
	(0.160)	(0.135)	(0.198)	(0.119)	(0.177)	(0.141)	(0.148)	(0.105)
							Observations	7,184
							R^2	0.963

Notes: Robust standard errors clustered by country in parentheses. Includes country trends, income group-sector year FEs, and (not reported) TRIPS controls. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: All IPAs with Legally Enforceable IPRs Provisions (Aggregate Trade; 100 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.479***							
	(0.100)							
Sector × $\log(GDP_i)$		0.102	0.167**	0.231***	0.053	0.139*	0.130**	0.105*
		(0.069)	(0.078)	(0.075)	(0.091)	(0.077)	(0.063)	(0.061)
Sector × LI × IPA_i	–0.111	0.101	1.173*	0.720**	1.432***	1.227***	0.320	0.711*
	(0.429)	(0.300)	(0.597)	(0.351)	(0.476)	(0.426)	(0.342)	(0.376)
Sector × LMI × IPA_i	–0.810**	–0.313	0.466	0.273	0.205	0.128	0.282	0.129
	(0.338)	(0.268)	(0.407)	(0.328)	(0.301)	(0.291)	(0.259)	(0.229)
Sector × UMI × IPA_i	–0.549	–0.588**	0.791*	0.568	–0.426	–0.323	–0.339	–0.227
	(0.528)	(0.259)	(0.418)	(0.407)	(0.414)	(0.352)	(0.303)	(0.247)
Sector × HI × IPA_i	–2.053***	0.618**	1.230**	–0.069	0.359	0.789***	0.509**	–0.284
	(0.621)	(0.271)	(0.505)	(0.504)	(0.425)	(0.283)	(0.235)	(0.254)
							Observations	7,054
							R^2	0.904
Imports								
$\log(GDP_i)$	0.454***							
	(0.059)							
Sector × $\log(GDP_j)$		0.183***	0.116***	0.215***	0.128***	0.113***	0.143***	0.042**
		(0.022)	(0.033)	(0.022)	(0.024)	(0.023)	(0.023)	(0.018)
Sector × LI × IPA_i	0.392*	0.345*	–0.170	0.459**	0.628**	0.474*	0.290	0.383**
	(0.210)	(0.191)	(0.229)	(0.179)	(0.247)	(0.280)	(0.212)	(0.155)
Sector × LMI × IPA_j	0.096	–0.302***	–0.173	–0.207*	0.140	–0.105	–0.314***	–0.086
	(0.201)	(0.097)	(0.161)	(0.111)	(0.170)	(0.112)	(0.095)	(0.092)
Sector × UMI × IPA_i	–0.178	–0.146	0.040	–0.054	0.040	0.074	–0.090	0.025
	(0.260)	(0.124)	(0.146)	(0.139)	(0.193)	(0.176)	(0.120)	(0.099)
Sector × HI × IPA_j	0.107	0.074	–0.224	0.019	0.096	0.404**	–0.245*	–0.158
	(0.167)	(0.129)	(0.258)	(0.167)	(0.236)	(0.168)	(0.142)	(0.108)
							Observations	7,184
							R^2	0.961

Notes: Robust standard errors clustered by country in parentheses. Includes country trends, income group-sector year FEs, and (not reported) TRIPS controls. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Non-US/EU/EFTA IPAs (Aggregate Trade; 42 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.469***							
	(0.108)							
Sector × $\log(GDP_i)$		0.183***	0.239***	0.254***	0.149*	0.216***	0.210***	0.180***
		(0.067)	(0.089)	(0.083)	(0.085)	(0.079)	(0.065)	(0.061)
Sector × LI × IPA_i	–0.060	0.346	0.571	0.681*	1.907***	1.413***	0.425	1.030***
	(0.435)	(0.294)	(0.538)	(0.362)	(0.496)	(0.451)	(0.424)	(0.384)
Sector × LMI × IPA_i	–0.025	–0.441	0.554	0.425	–0.227	–0.138	0.127	–0.123
	(0.334)	(0.301)	(0.408)	(0.395)	(0.324)	(0.255)	(0.297)	(0.206)
Sector × UMI × IPA_i	0.684	–0.762**	–0.170	0.787*	–1.016**	–0.253	–0.383	–0.160
	(0.564)	(0.344)	(0.518)	(0.416)	(0.479)	(0.366)	(0.273)	(0.261)
Sector × HI × IPA_i	1.541**	0.217	–0.848*	–0.038	0.331	–0.146	0.061	0.736**
	(0.725)	(0.275)	(0.457)	(0.377)	(0.424)	(0.212)	(0.254)	(0.369)
							Observations	7,062
							R^2	0.919
Imports								
$\log(GDP_i)$	0.501***							
	(0.055)							
Sector × $\log(GDP_i)$		0.190***	0.128***	0.231***	0.126***	0.121***	0.149***	0.049***
		(0.018)	(0.031)	(0.019)	(0.019)	(0.020)	(0.018)	(0.014)
Sector × LI × IPA_i	0.097	0.125	–0.275	0.211	0.190	0.133	–0.023	0.111
	(0.131)	(0.134)	(0.247)	(0.153)	(0.203)	(0.167)	(0.126)	(0.100)
Sector × LMI × IPA_i	–0.278	–0.183*	0.223	0.063	0.240	0.011	–0.159*	–0.023
	(0.184)	(0.101)	(0.167)	(0.108)	(0.206)	(0.089)	(0.095)	(0.108)
Sector × UMI × IPA_i	–0.367**	0.053	–0.086	0.094	0.066	0.170	0.095	0.099
	(0.160)	(0.112)	(0.195)	(0.123)	(0.140)	(0.106)	(0.132)	(0.089)
Sector × HI × IPA_i	–0.123	0.312**	–0.388**	–0.080	0.157	0.018	0.320*	0.069
	(0.164)	(0.141)	(0.195)	(0.126)	(0.216)	(0.103)	(0.168)	(0.116)
							Observations	7,184
							R^2	0.974

Notes: Robust standard errors clustered by country in parentheses. Includes country trends, income group-sector year FEs, and (not reported) TRIPS controls. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: IPAs with 3 or more Core Patents and Test Data Provisions (Aggregate Trade; 31 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.515***							
	(0.108)							
Sector × $\log(GDP_i)$		0.149**	0.229***	0.264***	0.123	0.205***	0.196***	0.175***
		(0.064)	(0.080)	(0.076)	(0.086)	(0.076)	(0.061)	(0.059)
Sector × LI × IPA_i	–0.688***	0.447**	1.673	1.038***	0.885*	1.263***	0.968	0.979***
	(0.248)	(0.217)	(1.185)	(0.325)	(0.461)	(0.384)	(0.658)	(0.258)
Sector × LMI × IPA_i	–0.633	0.415	0.614	0.317	0.915**	0.421	0.727***	0.167
	(0.385)	(0.259)	(0.429)	(0.322)	(0.372)	(0.336)	(0.259)	(0.165)
Sector × UMI × IPA_i	0.526	0.201	0.373	–0.136	0.599	0.221	0.472	0.248
	(0.642)	(0.468)	(0.586)	(0.299)	(0.500)	(0.371)	(0.299)	(0.264)
Sector × HI × IPA_i	–0.769	0.069	0.614	–0.187	–0.330	0.317	0.033	–0.579**
	(0.563)	(0.217)	(0.380)	(0.306)	(0.342)	(0.204)	(0.210)	(0.244)
							Observations	7,062
							R^2	0.919
Imports								
$\log(GDP_i)$	0.493***							
	(0.054)							
Sector × $\log(GDP_i)$		0.190***	0.129***	0.236***	0.135***	0.124***	0.152***	0.059***
		(0.018)	(0.029)	(0.018)	(0.019)	(0.018)	(0.017)	(0.013)
Sector × LI × IPA_i	0.200	0.005	0.425*	0.136	0.250	0.593**	0.238	0.251
	(0.305)	(0.324)	(0.246)	(0.164)	(0.311)	(0.258)	(0.305)	(0.275)
Sector × LMI × IPA_i	0.115	0.087	0.297*	0.175	0.364***	0.018	–0.035	0.111
	(0.117)	(0.106)	(0.161)	(0.128)	(0.129)	(0.094)	(0.097)	(0.095)
Sector × UMI × IPA_i	0.184	0.059	–0.036	0.082	0.246	–0.195***	0.203	0.135
	(0.143)	(0.138)	(0.180)	(0.099)	(0.196)	(0.067)	(0.130)	(0.106)
Sector × HI × IPA_i	–0.016	–0.122	0.234	–0.065	–0.355*	0.035	–0.191*	–0.163
	(0.158)	(0.108)	(0.179)	(0.134)	(0.209)	(0.103)	(0.114)	(0.105)
Observations							Observations	7,184
R-squared							R^2	0.974

Notes: Robust standard errors clustered by country in parentheses. Includes country trends, income group-sector year FEs, and (not reported) TRIPS controls. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: IPAs with Provision on Test Data Confidentiality for Pharmaceuticals (Aggregate Trade, 36 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.531***							
	(0.108)							
Sector × $\log(GDP_i)$		0.146**	0.219***	0.261***	0.117	0.198***	0.194***	0.170***
		(0.064)	(0.081)	(0.077)	(0.087)	(0.075)	(0.061)	(0.059)
Sector × LI × IPA_i	–0.345	–0.457	1.132*	0.474	2.186***	0.692	–0.013	0.652**
	(0.312)	(0.445)	(0.635)	(0.434)	(0.637)	(0.439)	(0.526)	(0.270)
Sector × LMI × IPA_i	–0.485	–0.100	1.301***	0.376	0.768**	0.504*	0.273	0.450***
	(0.305)	(0.262)	(0.404)	(0.292)	(0.380)	(0.282)	(0.219)	(0.167)
Sector × UMI × IPA_i	0.187	0.450	0.386	–0.302	0.692	0.641	0.366	0.225
	(0.635)	(0.459)	(0.491)	(0.255)	(0.499)	(0.469)	(0.264)	(0.229)
Sector × HI × IPA_i	–0.926	0.096	0.517	–0.043	–0.126	0.289	–0.005	–0.678***
	(0.575)	(0.219)	(0.365)	(0.306)	(0.380)	(0.202)	(0.183)	(0.224)
							Observations	7,062
							R^2	0.920
Imports								
$\log(GDP_i)$	0.491***							
	(0.055)							
Sector × $\log(GDP_i)$		0.190***	0.130***	0.236***	0.132***	0.124***	0.151***	0.058***
		(0.018)	(0.029)	(0.018)	(0.019)	(0.018)	(0.017)	(0.013)
Sector × LI × IPA_i	–0.084	–0.176	0.412**	0.036	0.205	0.250	–0.189	0.075
	(0.194)	(0.212)	(0.191)	(0.174)	(0.172)	(0.246)	(0.248)	(0.170)
Sector × LMI × IPA_i	0.065	–0.192**	0.377***	0.053	0.073	0.007	–0.245**	–0.033
	(0.104)	(0.097)	(0.127)	(0.102)	(0.135)	(0.088)	(0.096)	(0.085)
Sector × UMI × IPA_i	0.088	0.139	–0.125	–0.000	0.285	–0.125	0.200	0.263***
	(0.147)	(0.135)	(0.229)	(0.112)	(0.201)	(0.079)	(0.122)	(0.094)
Sector × HI × IPA_i	–0.104	–0.036	–0.019	–0.049	–0.067	–0.001	–0.127	–0.200**
	(0.148)	(0.099)	(0.194)	(0.125)	(0.197)	(0.094)	(0.109)	(0.089)
							Observations	7,184
							R^2	0.974

Notes: Robust standard errors clustered by country in parentheses. Includes country trends, income group-sector year FEs, and (not reported) TRIPS controls. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.3 Analysis of Bilateral Sectoral Trade

We now refine our estimation approach by considering a gravity equation of bilateral trade, which allows us to simultaneously consider exporter and importer effects using a detailed panel of bilateral trade data. We define our treatment groups analogously to the definition in subsection 3.1, but now differentiate between exporter and importer effects in a unified framework. The estimating equation here is given as

$$
\begin{aligned}
(2) \qquad TR_{ijst} = \exp\{&\alpha_1 \log(GDP_{it}) + \textstyle\sum_{s \neq Low\text{-}IP} \alpha_{2s} Sector_s \times \log(GDP_{it}) \\
&+ \alpha_3 \log(GDP_{jt}) + \textstyle\sum_{s \neq Low\text{-}IP} \alpha_{4s} Sector_s \times \log(GDP_{jt}) \\
&+ \textstyle\sum_g \sum_s \beta_{1gs} Group_{ig} \times Sector_s \times IPA_{it} \\
&+ \textstyle\sum_g \sum_s \beta_{2gs} Group_{jg} \times Sector_s \times IPA_{jt} \\
&+ \textstyle\sum_g \sum_s \beta_{3gs} Group_{ig} \times Sector_s \times TRIPS_{it} \\
&+ \textstyle\sum_g \sum_s \beta_{4gs} Group_{jg} \times Sector_s \times TRIPS_{jt} \\
&+ \lambda_{(i)gst} + \lambda_{(j)gst} + \lambda_j t + \lambda_j t + \lambda_{ij}\} + v_{ist}.
\end{aligned}
$$

TR_{ijst} is the dollar value of (unidirectional) exports from country i to country j in sector s in year t. As before, we account for size effects by including the GDP of the exporter and importer, allowing for these effects to vary between the various sectors. Whereas in the earlier analysis of aggregate trade – estimated separately for exports versus imports – there was only a single *IPA* variable to consider, here we delineate the effect depending on whether a country is the exporter (IPA_{it}) or the importer (IPA_{jt}) in a particular trading relationship. Analogous controls for TRIPS compliance are included again, as in the earlier version.

Our regime of fixed effects remains largely unchanged relative to that in equation (1). We include exporter- and importer-specific income-group-sector-year fixed effects ($\lambda_{(i)gst}$ and $\lambda_{(j)gst}$) and linear time trends ($\lambda_j t$ and $\lambda_j t$), and in addition, we include the dyadic fixed effect λ_{ij} to account for long-run bilateral determinants of trade costs (such as distance, shared border, and common language), accounting for the gravity-based nature of the estimation. These country-pair effects also control for time-invariant exporter- and importer-specific factors, because they are

perfectly collinear with a separate set of exporter-specific and importer-specific fixed effects. Following the gravity literature, we estimate equation (2) using Poisson pseudo-maximum likelihood (PPML) as suggested by Santos Silva and Tenreyro (2006) to account for zero trade flows and heteroskedasticity in the error terms. Because the IPA treatment rules are assigned at the country (exporter and importer) level, we estimate standard errors allowing for two-way clustering at the exporter and importer level. As before, we exclude all trade between treatment PTA members (both before and after the entry into force of the PTA), and take observations of trade at five-year intervals (for 1995, 2000, … , 2015).

The organization of these tables corresponds to those above for aggregate trade in IP-sensitive clusters. There are differences between these groups of results. In Table 7, for example, the positive impact of membership in a US/EU/EFTA agreement on exports of biopharmaceuticals remains intact, throughout all income groups, with even larger coefficients, as do the positive effects in CHEM and MED for the HI group. However, the finding of a negative effect on low-IP trade disappears when considering bilateral exports, though some evidence for it exists in Table 8 covering all IPAs. Again, no systematic impacts on imports are found. Again, IP-related PTAs that do not involve US/EU/EFTA (Table 9) have little effect on third-country trade, except perhaps for growing two-way trade in ICT involving LI countries.

We note, finally, that the earlier finding of a positive coefficient on exports of biopharmaceuticals in LMI and imports in LI, in IPAs with a provision on pharmaceuticals data protection, persists.

Table 7: US/EU/EFTA IPAs (Bilateral Trade, 58 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.352***							
	(0.083)							
Sector × $\log(GDP_i)$		0.485***	0.144*	0.309***	0.267**	0.504***	0.424***	0.330***
		(0.098)	(0.085)	(0.092)	(0.106)	(0.084)	(0.119)	(0.081)
Sector × LI × IPA_i	–0.072	0.316	1.661*	0.016	0.010	1.171*	0.452	0.432
	(0.318)	(0.555)	(0.969)	(0.620)	(0.745)	(0.639)	(0.765)	(0.471)
Sector × LMI × IPA_i	0.041	0.466	1.875***	0.227	–0.665	1.016	0.827*	0.430
	(0.217)	(0.572)	(0.392)	(0.343)	(0.567)	(0.703)	(0.470)	(0.341)
Sector × UMI × IPA_i	–0.178	0.923	1.877***	0.205	–0.110	1.554**	0.362	0.339*
	(0.303)	(0.581)	(0.392)	(0.388)	(0.727)	(0.633)	(0.430)	(0.188)
Sector × HI × IPA_i	0.033	0.479*	2.456***	0.653***	0.106	0.853***	0.108	0.160
	(0.233)	(0.268)	(0.331)	(0.249)	(0.217)	(0.260)	(0.319)	(0.178)
Imports								
$\log(GDP_j)$	0.475***							
	(0.040)							
Sector × $\log(GDP_i)$		0.119***	0.103**	0.016	–0.063	0.113***	0.069**	0.032
		(0.025)	(0.044)	(0.026)	(0.065)	(0.009)	(0.033)	(0.040)
Sector × LI × IPA_j	–0.224	–0.122	1.581***	0.113	–0.611*	0.836***	0.169	0.351
	(0.240)	(0.222)	(0.544)	(0.464)	(0.321)	(0.275)	(0.269)	(0.214)
Sector × LMI × IPA_i	–0.064	–0.513**	–0.122	–0.282	–0.604*	–0.069	–0.587***	–0.318*
	(0.134)	(0.251)	(0.324)	(0.211)	(0.334)	(0.277)	(0.223)	(0.173)
Sector × UMI × IPA_j	–0.032	0.101	0.111	–0.243	0.335	0.005	0.135	0.073
	(0.181)	(0.161)	(0.256)	(0.278)	(0.313)	(0.233)	(0.181)	(0.162)
Sector × HI × IPA_i	–0.121	0.273*	0.805***	0.332*	0.121	0.266	0.295*	0.205
	(0.222)	(0.142)	(0.272)	(0.181)	(0.249)	(0.182)	(0.171)	(0.172)
Observations								923,632
Number of country pairs								24,322
Pseudo R^2								0.945

Notes: Robust standard errors two-way clustered by exporter and importer in parentheses. Includes exporter- and importer-specific time trends, exporter- and importer group-sector year fixed effects, and bilateral pair fixed effects. TRIPS compliance by country included not reported. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: All IPAs with Legally Enforceable IPRs Provisions (Bilateral Trade, 100 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.381***							
	(0.076)							
Sector × $\log(GDP_i)$		0.451***	0.184*	0.306***	0.192**	0.481***	0.380***	0.293***
		(0.092)	(0.106)	(0.099)	(0.097)	(0.094)	(0.127)	(0.079)
Sector × LI × IPA_i	–0.485**	0.597***	–1.762***	–0.634*	3.175***	0.095	0.586*	0.709***
	(0.213)	(0.228)	(0.463)	(0.368)	(0.316)	(0.259)	(0.319)	(0.252)
Sector × LMI × IPA_i	–0.235**	0.707	0.487	0.500	0.102	0.216	0.907**	0.334
	(0.112)	(0.435)	(0.785)	(0.352)	(0.499)	(0.546)	(0.425)	(0.374)
Sector × UMI × IPA_i	0.144	–0.450	1.022**	0.278	–0.841	0.063	–0.803*	–0.192
	(0.150)	(0.387)	(0.403)	(0.322)	(0.594)	(0.507)	(0.421)	(0.148)
Sector × HI × IPA_i	0.262*	0.382**	1.853***	0.575***	–0.249	0.696***	0.066	–0.042
	(0.148)	(0.190)	(0.231)	(0.207)	(0.214)	(0.215)	(0.297)	(0.151)
Imports								
$\log(GDP_j)$	0.527***							
	(0.046)							
Sector × $\log(GDP_i)$		0.125***	0.143*	0.027	–0.080	0.110***	0.069	0.025
		(0.042)	(0.079)	(0.040)	(0.070)	(0.027)	(0.056)	(0.057)
Sector × LI × IPA_j	0.051	0.044	–0.769*	–0.224	1.107***	0.079	0.094	0.146
	(0.189)	(0.117)	(0.429)	(0.194)	(0.288)	(0.188)	(0.156)	(0.198)
Sector × LMI × IPA_j	–0.150*	–0.214**	–0.303	–0.165	–0.010	–0.328**	–0.234**	–0.232**
	(0.083)	(0.088)	(0.375)	(0.164)	(0.184)	(0.158)	(0.103)	(0.096)
Sector × UMI × IPA_j	–0.209	–0.208*	–0.009	0.152	–0.066	–0.159	–0.067	–0.095
	(0.143)	(0.114)	(0.168)	(0.197)	(0.260)	(0.147)	(0.125)	(0.109)
Sector × HI × IPA_i	–0.099	0.242*	0.872***	0.307*	–0.161	0.241**	0.355**	0.233
	(0.218)	(0.139)	(0.278)	(0.164)	(0.237)	(0.112)	(0.157)	(0.163)
Observations								915,312
Number of country pairs								24,098
Pseudo R^2								0.948

Notes: Robust standard errors two-way clustered by exporter and importer in parentheses. Includes exporter- and importer-specific time trends, exporter- and importer group-sector year fixed effects, and bilateral pair fixed effects. TRIPS compliance by country included not reported. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 9: Non-US/EU/EFTA IPAs (Bilateral Trade, 42 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.361***							
	(0.075)							
Sector × $\log(GDP_i)$		0.433***	0.023	0.200**	0.234***	0.375***	0.332***	0.247***
		(0.078)	(0.093)	(0.080)	(0.086)	(0.096)	(0.114)	(0.072)
Sector × LI × IPA_i	–0.465**	0.655***	–1.410**	–0.418	3.091***	0.328	0.685**	0.794***
	(0.190)	(0.241)	(0.553)	(0.424)	(0.297)	(0.329)	(0.330)	(0.287)
Sector × LMI × IPA_i	0.040	–0.649	–0.721	0.167	0.111	–0.750*	–0.755*	–0.512
	(0.154)	(0.431)	(0.516)	(0.299)	(0.490)	(0.454)	(0.431)	(0.318)
Sector × UMI × IPA_i	0.306	–0.898	–1.518***	–0.179	–0.549*	–0.071	–1.115***	–0.536*
	(0.206)	(0.598)	(0.543)	(0.308)	(0.333)	(0.533)	(0.389)	(0.288)
Sector × HI × IPA_i	0.069	–0.110	–0.591	–0.197	0.727**	–0.374	0.001	–0.110
	(0.283)	(0.346)	(0.720)	(0.293)	(0.339)	(0.259)	(0.299)	(0.122)
Imports								
$\log(GDP_i)$	0.569***							
	(0.042)							
Sector × $\log(GDP_i)$		0.127***	0.026	–0.024	–0.053	0.115***	0.050*	0.014
		(0.030)	(0.049)	(0.038)	(0.072)	(0.024)	(0.029)	(0.029)
Sector × LI × IPA_i	0.026	0.104	–0.472	–0.069	1.056***	0.149	0.182	0.196
	(0.173)	(0.115)	(0.409)	(0.238)	(0.245)	(0.187)	(0.130)	(0.167)
Sector × LMI × IPA_i	–0.084	–0.012	0.160	0.323***	0.046	–0.046	0.050	–0.060
	(0.077)	(0.130)	(0.200)	(0.082)	(0.164)	(0.127)	(0.100)	(0.082)
Sector × UMI × IPA_i	–0.053	–0.492**	–0.433	0.141	–0.142	–0.479	–0.272	–0.146**
	(0.135)	(0.198)	(0.398)	(0.215)	(0.228)	(0.369)	(0.189)	(0.068)
Sector × HI × IPA_i	0.224	0.166	–0.155	–0.038	–0.144	0.019	0.160	–0.123
	(0.145)	(0.182)	(0.319)	(0.171)	(0.286)	(0.173)	(0.207)	(0.128)
Observations								1,031,880
Number of country pairs								27,077
Pseudo R^2								0.953

Notes: Robust standard errors two-way clustered by exporter and importer in parentheses. Includes exporter- and importer-specific time trends, exporter- and importer group-sector year fixed effects, and bilateral pair fixed effects. TRIPS compliance by country included not reported. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: IPAs with 3 or more Core Patents and Test Data Provisions (Bilateral Trade, 31 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.303***							
	(0.072)							
Sector × $\log(GDP_i)$		0.478***	0.031	0.239***	0.282***	0.393***	0.378***	0.284***
		(0.087)	(0.115)	(0.082)	(0.093)	(0.093)	(0.105)	(0.071)
Sector × LI × IPA_i	–0.429	0.717	0.709	–0.014	–1.051	0.768	1.355	1.151***
	(0.315)	(0.441)	(1.043)	(0.699)	(0.863)	(0.545)	(0.852)	(0.399)
Sector × LMI × IPA_i	–0.559***	0.845*	0.392	0.493	0.844	0.952**	1.033***	0.716***
	(0.208)	(0.453)	(0.458)	(0.314)	(0.549)	(0.420)	(0.291)	(0.204)
Sector × UMI × IPA_i	–0.295	0.631	0.248	–0.013	0.945*	0.108	0.520	0.141
	(0.316)	(0.423)	(0.520)	(0.250)	(0.503)	(0.509)	(0.358)	(0.278)
Sector × HI × IPA_i	0.135	–0.156	0.271	–0.157	–0.130	0.221	–0.162	–0.072
	(0.194)	(0.231)	(0.304)	(0.193)	(0.309)	(0.141)	(0.218)	(0.102)
Imports								
$\log(GDP_i)$	0.523***							
	(0.048)							
Sector × $\log(GDP_i)$		0.146***	0.014	0.007	0.040	0.114***	0.061***	0.040
		(0.020)	(0.056)	(0.029)	(0.046)	(0.017)	(0.023)	(0.025)
Sector × LI × IPA_i	0.027	0.016	0.770	–0.151	–0.268	0.892***	0.316	0.495***
	(0.111)	(0.294)	(0.477)	(0.399)	(0.361)	(0.211)	(0.345)	(0.155)
Sector × LMI × IPA_i	–0.083	0.253	–0.196	–0.082	0.184	–0.017	–0.081	–0.005
	(0.125)	(0.165)	(0.246)	(0.146)	(0.152)	(0.164)	(0.116)	(0.115)
Sector × UMI × IPA_i	–0.048	0.194	–0.376	–0.355**	0.141	–0.006	–0.001	–0.136
	(0.132)	(0.170)	(0.372)	(0.173)	(0.289)	(0.277)	(0.156)	(0.119)
Sector × HI × IPA_i	0.203**	–0.027	0.282*	–0.028	–0.501**	0.205**	0.077	–0.007
	(0.081)	(0.110)	(0.169)	(0.172)	(0.234)	(0.083)	(0.104)	(0.062)
Observations								1,031,720
Number of country pairs								27,089
Pseudo R^2								0.950

Notes: Robust standard errors two-way clustered by exporter and importer in parentheses. Includes exporter- and importer-specific time trends, exporter- and importer group-sector year fixed effects, and bilateral pair fixed effects. TRIPS compliance by country included not reported. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11: IPAs with Provision on Test Data Confidentiality for Pharmaceuticals (Bilateral Trade, 36 IPAs)

	(1) Low-IP	(2) AI	(3) BIO	(4) CHEM	(5) ICT	(6) MED	(7) PT	(8) Other
Exports								
$\log(GDP_i)$	0.312***							
	(0.075)							
Sector × $\log(GDP_i)$		0.441***	0.042	0.211**	0.241**	0.399***	0.361***	0.271***
		(0.084)	(0.112)	(0.084)	(0.100)	(0.092)	(0.105)	(0.069)
Sector × LI × IPA_i	–0.086	0.182	0.285	–0.484	–0.524	0.507	0.780	0.678
	(0.306)	(0.513)	(1.033)	(0.622)	(0.782)	(0.579)	(0.865)	(0.490)
Sector × LMI × IPA_i	–0.433*	0.764*	0.889**	0.452	0.691	0.830*	0.853***	0.673***
	(0.222)	(0.440)	(0.449)	(0.318)	(0.574)	(0.455)	(0.272)	(0.190)
Sector × UMI × IPA_i	–0.133	0.867**	0.366	–0.305	0.297	1.351***	0.408	0.555***
	(0.201)	(0.438)	(0.451)	(0.333)	(0.626)	(0.475)	(0.302)	(0.192)
Sector × HI × IPA_i	–0.082	0.126	0.231	0.167	0.437	0.295*	–0.058	–0.084
	(0.234)	(0.246)	(0.325)	(0.177)	(0.310)	(0.156)	(0.237)	(0.108)
Imports								
$\log(GDP_i)$	0.543***							
	(0.046)							
Sector × $\log(GDP_i)$		0.112***	0.028	0.001	–0.044	0.093***	0.042*	0.025
		(0.023)	(0.063)	(0.030)	(0.064)	(0.020)	(0.023)	(0.026)
Sector × LI × IPA_i	–0.041	–0.048	1.200**	0.160	–0.533	0.810***	0.152	0.407***
	(0.145)	(0.223)	(0.495)	(0.397)	(0.373)	(0.201)	(0.267)	(0.130)
Sector × LMI × IPA_i	0.069	0.093	–0.055	–0.094	–0.053	0.018	–0.132	–0.045
	(0.127)	(0.130)	(0.250)	(0.131)	(0.181)	(0.141)	(0.104)	(0.092)
Sector × UMI × IPA_i	0.046	–0.549***	–0.662	–0.415**	0.032	–0.841***	–0.423***	–0.061
	(0.166)	(0.169)	(0.422)	(0.210)	(0.276)	(0.321)	(0.158)	(0.088)
Sector × HI × IPA_i	0.123	0.090	0.092	–0.145	0.095	0.188	0.060	–0.099
	(0.089)	(0.126)	(0.210)	(0.155)	(0.177)	(0.153)	(0.104)	(0.060)
Observations								1,025,080
Number of country pairs								26,923
Pseudo R^2								0.951

Notes: Robust standard errors two-way clustered by exporter and importer in parentheses. Includes exporter- and importer-specific time trends, exporter- and importer group-sector year fixed effects, and bilateral pair fixed effects. TRIPS compliance by country included not reported. Observations at 5-year intervals: 1995, 2000, … 2015. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4. Exploratory Analysis of the Mechanisms Underlying the Trade Impacts

Our results to this point indicate that preferential trade agreements containing elevated standards of IPRs protection generate reasonably consistent changes in the trade of IP-intensive goods on the part of member countries with third markets, netting out trade with *demandeur* partners. While the effects overall are modest, there are identifiable impacts on sectoral trade, especially where the major partner is the United States, the EU, or EFTA, and in IPAs in which IPRs standards are legally enforceable as measured by the World Bank database. These agreements tend particularly to expand exports of biopharmaceuticals and medical equipment, both in the aggregate and on a bilateral basis.

Such findings raise the question of what mechanisms may drive the trade expansion. One important channel is the responses of global firms to what they may perceive as improved investment climates associated with IPAs. It may be, for example, that increased third-country exports of high-IP products reflect increases in domestic production capacity, which may be the result of increased inward technology flows. In the absence of data regarding firm-level responses of both affiliates and domestic firms, this is a difficult question to answer. Here we explore this issue on a preliminary basis by bringing in additional data from the U.S. Bureau of Economic Analysis that may capture the role of FDI, via affiliate activities in IPA-member countries. We also employ data on U.S. related-party trade to explore the effects of IPAs on trade in intermediate inputs.

Specifically, we study first the impact of IPAs on the sales of local affiliates of U.S. majority-owned affiliates in broad manufacturing sectors that most closely track our high-IP products. The closest aggregate sectors in the BEA data are chemicals, computers and electronic products, and electrical equipment, appliances, and components. Our approach is to use affiliate sales as the dependent variable in the basic regressions above, with these sectors constituting a set of high-IP sensitive goods.[21] Given our prior results, we consider just three definitions of treatment IPAs: those with the United States as a partner, those with the United States, EU, or

[21] We also considered affiliate employment as the dependent variable, with similar results.

EFTA as a partner, and all those in which the IPRs provisions are considered legally enforceable. The results of this estimation are in Tables 12 through 14, respectively.[22]

All three regressions tell a similar story. For example, in Table 12 we find in column (1) that the direct coefficient of a U.S.-partnered IPA on sales is zero, suggesting no impact on sales of low-IP goods. However, the coefficient on high-IP sectors is significantly positive and economically large. The second column indicates that this impact is spread out over the current year and one-year prior, suggesting a smoother but nevertheless rapid adjustment of local sales to implementation of an IPA. Adding a two-year lag in column (3) reduces the statistical significance of the distributed lag, presumably because of collinearity, but the overall effect on sales remains positive. In Table 13 we find weaker impacts of the group of IPAs involving any of the three *demandeur* partners, though the contemporaneous impact remains significantly positive. This outcome is unsurprising in that the sales of U.S. affiliates may be less affected by EU and EFTA agreements than by those organized by the United States. A notable difference, however, is that the direct coefficient on sales is significantly positive in these cases, while there is little additional effect on high-IP sales. Finally, Table 14 records impacts of legally enforceable IPAs on sales that follow another pattern. The direct coefficients are significant in each case, though the lagged effects continue through two years. Again, however, the computed effects on sales by affiliates of high-IP goods are significantly positive. In sum, there is evidence that IPAs with elevated IPRs expectations are correlated with rapid expansion of sales by U.S.-owned affiliates. Because those sales include exports to third countries, this may suggest that domestic capacity growth underlies our earlier trade results to some degree. We emphasize, however, that this finding needs to be treated with caution, given the broadly aggregated nature of the BEA affiliate-sales data.

[22]Because the BEA data on affiliate sales are reported at highly aggregated levels, we pool all years in the sample to maintain a large sample, rather than consider five-year intervals as performed in the trade regressions.

Table 12. Contemporaneous and Lagged Effects of US-Partnered IPAs on U.S. Majority-Owned Affiliate Sales in Manufacturing

	(1)	(2)	(3)
US IPA_t	–0.043	0.052	0.029
	(0.088)	(0.139)	(0.139)
High-IP × US IPA_t	0.371***	0.124	0.137
	(0.117)	(0.137)	(0.144)
US IPA_{t-1}		–0.120	0.035
		(0.141)	(0.166)
High-IP × US IPA_{t-1}		0.295**	0.102
		(0.146)	(0.183)
US IPA_{t-2}			–0.202
			(0.134)
High-IP × US IPA_{t-2}			0.257
			(0.164)
Total effect time t ($\beta_{IPA} + \beta_{High\text{-}IP,IPA}$)	**0.327*** **	**0.176** **	**0.166** **
F-test of total effect	15.55	5.29	4.52
Total effect t–1		**0.175** **	**0.137**
F-test of total effect		4.11	1.08
Total effect t–2			**0.055**
F-test of total effect			0.16
Observations	5,523	5,283	5,042
R^2	0.906	0.912	0.920
Country-sector FEs	Y	Y	Y
Year FEs	Y	Y	Y

Robust standard errors clustered by country-industry in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13. Contemporaneous and Lagged Effects of US, EU, or EFTA-Partnered IPAS on U.S. Majority-Owned Affiliate Sales in Manufacturing

	(1)	(2)	(3)
US/EU/EFTA IPA_t	0.168**	0.171**	0.161**
	(0.066)	(0.083)	(0.081)
High-IP × US/EU/EFTA IPA_t	0.104	–0.058	–0.081
	(0.091)	(0.160)	(0.167)
US/EU/EFTA IPA_{t-1}		0.001	0.002
		(0.081)	(0.098)
High-IP × US/EU/EFTA IPA_{t-1}		0.170	0.149
		(0.166)	(0.172)
US/EU/EFTA IPA_{t-2}			–0.010
			(0.084)
High-IP × US/EU/EFTA IPA_{t-2}			0.048
			(0.101)
Total effect time t ($\beta_{IPA} + \beta_{High\text{-}IP,IPA}$)	**0.272*** **	**0.113**	**0.081**
F-test of total effect	11.35	0.76	0.34
Total effect t–1		**0.171**	**0.150**
F-test of total effect		1.67	1.13
Total effect t–2			**0.038**
F-test of total effect			0.18
Observations	5,523	5,283	5,042
R^2	0.906	0.912	0.920
Country-sector FEs	Y	Y	Y
Year FEs	Y	Y	Y

Robust standard errors clustered by country-industry in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 14. Contemporaneous and Lagged Effects of Legally Enforceable IPAs on U.S. Majority-Owned Affiliate Sales in Manufacturing

	(1)	(2)	(3)
WTO-X IPR LE = 2 IPA_t	0.268***	0.041	0.079
	(0.064)	(0.085)	(0.079)
High-IP × WTO-X IPR LE = 2 IPA_t	–0.013	0.142	0.103
	(0.069)	(0.095)	(0.093)
WTO-X IPR LE = 2 IPA_{t-1}		0.282***	0.125
		(0.086)	(0.098)
High-IP × WTO-X IPR LE = 2 IPA_{t-1}		–0.164*	–0.022
		(0.096)	(0.121)
WTO-X IPR LE = 2 IPA_{t-2}			0.166**
			(0.078)
High-IP × WTO-X IPR LE = 2 IPA_{t-2}			–0.143
			(0.095)
Total effect time t ($\beta_{IPA} + \beta_{High\text{-}IP,IPA}$)	**0.255*** **	**0.183** **	**0.182** **
F-test of total effect	17.93	5.19	5.60
Total effect t–1		**0.118**	**0.103**
F-test of total effect		2.37	1.17
Total effect t–2			**0.023**
F-test of total effect			0.09
Observations	5,523	5,283	5,042
R^2	0.907	0.913	0.921
Country-sector FEs	Y	Y	Y
Year FEs	Y	Y	Y

Robust standard errors clustered by country-industry in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Our final exercise is to consider the impacts of these groupings of IPAs on U.S. related-party exports to partner countries. Such exports are widely considered in the literature to capture intermediate inputs sent to U.S.-owned affiliates for local assembly or production of final goods. One advantage of these data is that they exist for relatively detailed NAICS industries, which correspond closely to our high-IP sectors used in the trade analysis, permitting us to return to that issue. The results are in Table 15 for the three IPA definitions. They suggest a marked heterogeneity across agreement types. Specifically, U.S.-partnered agreements see notable increases in related-party exports of pharmaceuticals and medical devices, the primary subject matter of many TRIPS-plus demands. In this context, perhaps the increases in third-party exports

noted earlier are associated with greater flows of technological inputs in those sectors. In contrast, related-party trade in these industries is unresponsive to the other forms of IPAs. In those cases, the third-party trade effects seem more associated with locally generated capacity expansion in U.S. affiliates. One notable finding is that related-party exports in ICT are reduced in all three agreement types. This outcome suggests that affiliate production in electronics goods becomes less reliant on imported inputs from headquarters locations in the wake of joining such an agreement.

5. Concluding Remarks

Our intention in this paper was to apply a treatment-control approach, used in other empirical trade contexts, to the World Bank's Database on PTAs and to see if it unearthed systematic evidence that PTAs with enforceable IPRs chapters, and those with more specific provisions, have effects on trade in treated countries versus control countries. We note that the approach may not be the best way to identify such impacts because our treatment definitions may not sufficiently exclude other important impacts on trade arising from the agreements themselves or, indeed, from provisions not directly related to intellectual property protection. Nevertheless, it offers a complementary avenue for thinking about such effects.

Our approach is rigorous in its exclusion of intra-PTA trade and its use of extensive fixed effects. These controls, along with the difficulty of identifying the potential effects of actual IPRs provisions, make it challenging to identify systematic effects. Indeed, while we noted earlier that the aggregate sectoral trade analysis reveals some tentative conclusions, they are only weakly supported in the bilateral analysis. Nonetheless, it does seem that, at least as regards legally enforceable IPAs involving the US, the EU, or EFTA, they have detectable impacts on exports of pharmaceuticals and other goods, depending on the income group. Beyond that, we conclude that, as valuable as the World Bank Database on PTAs clearly is, it is difficult with our approach to use that information to detect trade impacts strictly within the context of intellectual-property provisions. Future refinements in the research may offer a clearer path toward that task.

Table 15. Impacts of IPAs on US Exports to Related Parties by Sector

	(1) US IPA	(2) US/EU/EFTA IPA	(3) WTO-X IPR LE = 2 IPA
Low-IP × IPA	0.302***	0.102	–0.090**
	(0.102)	(0.105)	(0.036)
AI × IPA	0.097*	–0.033	–0.262***
	(0.050)	(0.059)	(0.040)
BIO × IPA	0.508***	–0.002	–0.073
	(0.173)	(0.209)	(0.132)
CHEM × IPA	0.029	–0.098	–0.146***
	(0.064)	(0.063)	(0.035)
ICT × IPA	–0.404***	–0.211***	–0.258***
	(0.127)	(0.077)	(0.073)
MED × IPA	0.301***	0.008	0.118
	(0.077)	(0.111)	(0.164)
PT × IPA	–0.018	0.019	–0.156*
	(0.065)	(0.102)	(0.081)
Other × IPA	–0.047	–0.636***	–0.400***
	(0.129)	(0.137)	(0.103)
Observations	15,294	15,294	15,294
Country-sector FEs	Y	Y	Y
Year FEs	Y	Y	Y

Notes: Dependent variable is US exports to related parties. GDP and TRIPS controls included but not reported. Robust standard errors clustered by country × year in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Appendix A.

Table A1. IPAs in Primary Treatment Groups

	Entry into force		Entry into force
US Agreements		**EU/EFTA Agreements (cont.)**	
US-Jordan	2001	EU-Republic of Moldova	2014
US-Chile	2004	EU-Georgia	2014
US-Singapore	2004	EFTA-Central America	2014
US-Australia	2005	EFTA-Bosnia and Herzegovina	2015
US-Bahrain	2006		
US-Morocco	2006	**Other WTO-X IPR LE = 2 Agreements**	
CAFTA-Dominican Republic	2006	Colombia-Mexico	1995
US-Peru	2009	Chile-Mexico	1999
US-Oman	2009	Ukraine-FYR of Macedonia	2001
US-Panama	2012	China-Macao, China	2003
US-Korea	2012	Australia-Singapore	2003
US-Colombia	2012	Gulf Cooperation Council	2003
		Mexico-Uruguay	2004
EU/EFTA Agreements		Panama-Chinese Taipei	2004
EU-Turkey	1996	Chile-Korea	2004
EU-Tunisia	1998	Korea-Singapore	2006
EFTA-Morocco	1999	Russian Federation-Serbia	2006
EU-Israel	2000	Japan-Malaysia	2006
EU-Morocco	2000	China-Pakistan	2007
EU-FYR of Macedonia	2001	CEFTA	2007
EFTA-FYR of Macedonia	2002	Japan-Thailand	2007
EU-Jordan	2002	Japan-Philippines	2008
EFTA-Jordan	2002	Pakistan-Malaysia	2008
EFTA-Singapore	2003	China-New Zealand	2008
EU-Lebanon	2003	Nicaragua-Chinese Taipei	2008
EU-Chile	2003	Japan-Switzerland	2009
EU Enlargement (25)	2004	Japan-Viet Nam	2009
EU-Egypt	2004	New Zealand-Malaysia	2010
EU-Algeria	2005	ASEAN-Australia-New Zealand	2010
EFTA-Tunisia	2005	ASEAN-Korea	2010
EFTA-Korea	2006	Turkey-Chile	2011
EU-Albania	2006	Peru-Korea	2011
EU Enlargement (27)	2007	China-Costa Rica	2011
EFTA-Lebanon	2007	Panama-Peru	2012
EFTA-Egypt	2007	Japan-Peru	2012
EU-Montenegro	2008	Mexico-Central America	2012
EU-CARIFORUM	2008	New Zealand-Chinese Taipei	2013
EU-Bosnia Herzegovina	2008	Korea-Turkey	2013
EFTA-Serbia	2010	Costa Rica-Peru	2013
EFTA-Albania	2010	Malaysia-Australia	2013
EU-Serbia	2010	Korea-Australia	2014
EFTA-Colombia	2011	Iceland-China	2014
EFTA-Peru	2011	Switzerland-China	2014
EU-Korea	2011	Eurasian Economic Union (EAEU)	2015
EFTA-Ukraine	2012	EAEU-Accession of Kyrgyz Republic	2015
EFTA-Montenegro	2012	EAEU-Accession of Armenia	2015
EFTA-Hong Kong	2012	Canada-Korea	2015
EU-Central America	2013		
EU-Colombia and Peru	2013		
EU Enlargement (28)	2013		

Table A2. List of TRIPS-Plus ("BTRIPS") Provisions in the World Bank Database

Core BTRIPS (18):	
59	Stipulates the scope of protection for a GI
66	Requires patent be made available for new uses of a known product
67	Requires patent be made available for new methods of a known product
68	Requires patent be made available for new processes of a known product
75	Requires patent term adjustment be given for unreasonable delays by granting authority
77	Includes rules governing patent linkage
80	Provides minimum term of protection for undisclosed test or other data for a new agricultural chemical
81	Provides minimum term of protection for undisclosed test or other data for a new pharmaceutical product
83	Provides minimum term of protection for undisclosed test or other data for a pharmaceutical product containing a chemical entity not previously approved by either party
84	Provides minimum term of protection for undisclosed test or other data for a new pharmaceutical product that is or contains a biologic
101	Requires protection against persons seeking to circumvent technological protection measures
102	Requires protection against persons altering rights management information
103	Requires protection against persons who distribute, import, make available product with altered rights management info
112	Stipulates that judicial authorities shall have authority to order injunctive relief
124	Requires parties to provide for criminal procedures & penalties for willful TM counterfeiting on a commercial scale
125	Requires parties to provide for criminal procedures & penalties for willful copyright or related rights piracy on a commercial scale
126	Requires parties to provide for criminal procedures & penalties for unauthorized disclosure/misappropriation of a trade secret
127	Requires parties to make it a criminal offense to unlawfully decode an encrypted program-carrying satellite signal
Other BTRIPS (14):	
25	Requires national exhaustion
39	Provide TMs to include collective and certification marks
40	Requires that TM owner be given exclusive right to prevent 3rd party from using identical or similar signs resulting in likelihood of confusion
43	Prohibits enacting a requirement that a TM must be recognized or registered as a well-known mark elsewhere to be considered "well-known"
57	Requires refusal to register and/or invalidation of a TM that corresponds to a protected GI
82	Provides minimum term of protection for new clinical info for a new indication/formulation/administration method of a previously approved pharmaceutical
95	Requires provision to performers of unfixed performance the right to authorize or prohibit its broadcast

96	Requires provision to performers of unfixed performance the right to authorize or prohibit its fixation
97	Requires provision to performers and producers the exclusive right to authorize or prohibit its broadcast or other public communication by wire or wireless means
116	Requires steps to be taken for provisional measures related to alleged infringement
120	Requires that border authorities shall have ex officio authority to detain suspected counterfeit or pirated goods
121	Stipulates that border authorities shall have authority to order destruction of infringing goods
128	Requires parties to enforce protection of GIs through administrative/legal proceedings, including at customs
130	Requires ISP liability & safe harbor system similar to DMCA

Table A3: Data Sources and Description

Variable	Description	Data Source
Trade flows	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	Membership in various legally enforceable IPAs	Hofmann, et al (2017)
TRIPS	Estimates of TRIPS compliance dates by country	Ginarte and Park (1997), Park (2008), and Hamdan- Livramento (2009)
IP Clusters	IP-intensive commodities by SITC Rev. 3 code	Delgado, et al (2013) based on U.S. Department of Commerce (2012)
Affiliate Sales	Sales of U.S. majority-owned affiliates, major manufacturing sectors, 1995-2015	U.S. Bureau of Economic Analysis database
Related Party Trade	Exports from U.S. parents to related parties abroad, 1995-2015	U.S. Bureau of the Census