Peeling Away the Layers: Impacts of Durable Tariff Elimination

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Abstract

We demonstrate that simple but durable tariff elimination affects trade patterns through several layers, and magnitudes of effects are sizable. We focus on the WTO's Information Technology Agreement (ITA) because it provides a unique opportunity to study complete, durable, and nondiscriminatory tariff elimination in a global value chain setting. Tariff reductions have non-linear impacts. Complete tariff elimination results in a large premium in terms of trade gains, especially for intermediate goods. A second nonlinearity results from commitment to durable tariff elimination, with ITA members' imports and exports rising more than under equivalent unilateral reforms. ITA commitment effects spurned development of a downstream IT export sector in a subgroup of countries which acceded to ITA as by-product of a larger policy objective and was previously devoid of a large IT sector. Within this subgroup, countries with low remoteness, higher education levels, and better institutions and business environments experienced the largest export expansions.

JEL Classification: F13, F14, F15, L63

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1. Introduction

This paper demonstrates that simple but durable tariff elimination can impact trade patterns from several dimensions – and many of these effects can be sizable in a global value chain (GVC) setting. The Information Technology Agreement (ITA) provides a unique opportunity to study tariff impacts for three reasons. First, it completely eliminated tariffs on a broad range of, but not all, information and communications technology (ICT) products. This provides us with a natural control sector of non-covered ICT products for identification.

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Second, it is a WTO agreement, reducing also members' WTO bound tariff rates on covered products to zero. Thereby liberalization under the ITA is (i) hard to reverse and (ii) enforceable through the WTO dispute settlement system. Third, it is a "critical mass agreement" meaning that members represent more than 90 percent of world trade in products covered by the agreement ("ITA goods") and tariff eliminations apply on an MFN basis also to members. This all but eliminates concerns over trade diversion.

Our work adds to large literatures on trade agreements and international production sharing (e.g. Antràs and Staiger, 2012). It also relates to literature taking renewed interest in the impacts of tariff reductions. Caliendo et al. (2015) document, using a heterogeneous firm model, that Uruguay round tariff reductions can explain some 90 percent of subsequent trade gains. Like their contribution, ours also incorporates GVCs, by distinguishing between intermediate and final goods trade. The sizable magnitudes of many of our estimates support the hypotheses of (i) Yi (2003) that effects of trade policy changes on trade should be especially high in GVC sectors and (ii) Ornelas and Turner (2008) who emphasize that tariff liberalization boosts trade more than would be expected in standard models, because tariffs aggravate the hold-up problem of underinvestment when contract enforcement is imperfect. In addition, we agree with Bagwell et al. (2015) that the WTO is not passé. Our strong results derived in the ITA context suggest that much can be achieved there, even outside of large multilateral trade rounds.

Our estimation framework breaks down the impact of tariffs on trade into four separate effects or "layers". First, we allow for a non-linear response of imports to tariff reductions. Tariff reductions (Layer 1) are found to exert a positive but moderate impact on imports. Each percentage point decrease in tariffs raises import value by 0.3 to 0.4 percent. An additional larger impact is realized if the tariff is lowered all the way to zero (Layer 2), because this reduces costly administrative burdens and time delays in crossing the border. The detrimental impacts of customs clearance times and other red tape on imports have been found to be substantial by an expanding "time in trade" literature (e.g., Djankov et al., 2010; Hummels and Schaur, 2013; Martincus et al., 2015). Indeed, we confirm that eliminating tariffs completely has a much larger impact, boosting imports of ITA goods by 10-13 percent on average and by more for intermediate goods (as should be expected in presence of GVCs).

Tariff reductions therefore have non-linear effects. Tariff elimination results in a premium in trade gains. Perceived durability of such tariff elimination yields yet further gains.[3] These non-linearities remain under-appreciated, despite an emergence of a small recent literature on trade policy certainty (Osnago et al., 2015; Groppo and Piermartini, 2014). We show that the perceived durability of liberalization under ITA fosters "commitment" effects on both imports (Layer 3) and exports (Layer 4). The former increase ITA final goods imports by 9-10 percent relative to other ICT and machinery products in a subgroup of mostly advanced countries (Table 1). We name this subgroup "active signatories", because they joined the ITA out of their own initiative and most were founding members.

With regards to the commitment effect on exports, existing literature underscores that lower import tariffs stimulate development of domestic export industries through investment,

[3]Portugal-Perez et al. (2010) points out that magnitude of such effects may also increase over time as higher trade creates incentives to harmonize standards.

including FDI (Antras and Helpman, 2008; Blyde et al., 2015; Gawande et al., 2011; Handley and Limão, 2013, 2015; Osnago et al., 2016). Given lack of FDI data specific to the ITA sector, we maintain our focus on trade flows and therefore test this *indirectly*. We estimate whether, after accession, trade in intermediate or final ITA goods outperformed that in control sectors. To this end, we define a second "passive signatory" subgroup consisting of countries which joined the ITA after inception. For this diverse subgroup of countries, joining the ITA was mostly a means to achieve a larger policy goal: accession to the WTO, EU or a free trade agreement with the U.S. (This also conveniently allays endogeneity concerns.) We show that ITA accession resulted for these passive signatories in 30 percent higher final ITA goods exports. This large effect comes in addition to increases already implied by lower tariffs in destination countries.[4] Its high magnitude highlights that ITA helped turn passive signatories into downstream IT exporters and jives with the intuition of Blyde et al. (2015). Unlike us, they quantify effects through investment *directly* by exploiting FDI data. They study preferential trade agreements and find that deeper agreements yield stronger effects. The ITA – being a WTO critical mass agreement – is as durable and deep as it can get while remaining within the tariff realm. The high commitment effects on exports are thus intuitive.[5]

Within the passive signatory group, we further find large country-specific heterogeneity. Those countries with high education, favorable business environments, strong institutions, or a favorable location to end markets reaped the most export benefits from the ITA. We also find that China stands out clearly from this subgroup. When it is included, the average export commitment effect jumps from 30 percent to around 50 percent. Unlike other passive signatories, China also realizes such a commitment effect for intermediate exports. This demonstrates that the country post ITA accession achieved a diversified export structure in the sector, including upstream products.

Given the unique opportunity provided by the ITA to study complete and durable tariff elimination, the scarcity of previous literature exploiting this agreement is surprising. WTO (2012) provides a comprehensive analysis of the formation, membership and coverage overview of the ITA, on which we build to identify the active and passive signatory groups. Mann and Liu (2009), with Bora and Liu (2010) further developing their work, provide the only econometric analyses of trade impacts of the ITA. Instead of our detailed product-level data, these studies use a dummy-variable approach on aggregate ITA trade and only focus on one aggregate impact on the import side. With short time coverage implying that many important passive signatories are not covered, they find that ITA signatories imported on average 14 percent more ITA goods after accession than non-members of the WTO.[6]

[4]It also helps resolve a dispute in earlier literature. Joseph and Parayil (2006) hypothesized that countries joining ITA after its inception would reap lower benefits given that they could not bring their own interests to bear in the negotiations. In contrast, Anderson and Mohs (2010), benefiting from more extended time coverage, argue – in line with our results – that the ITA underpinned the rapid increases observed in developing countries' exports.

[5]Some of ITA estimates' magnitude may derive from knowledge-intensive industries relying more on knowledge transfer in embodied form, i.e. through trade in intermediates, as compared to direct communication (Keller and Yeaple, 2013). Therefore such knowledge-intensive sectors would tend to form more extensive value chain networks.

[6]These studies use data through 2003, while this paper covers the period 1996-2012.

The remainder of the paper is structured as follows. Section 2 provides a brief overview of the ITA and initial graphical analyses of the ITA's trade impact in active and passive signatories. Section 3 describes our dataset and Section 4 the estimation strategy. Section 5 presents results and Section 6 confirms their robustness. Section 7 explores how export commitment effects vary alongside country characteristics. Section 8 concludes.

2. The ITA and a first glance at its impact

The ITA is a plurilateral critical mass agreement under the WTO. Negotiations among 34 countries were finalized in 1996. Nine more countries signed up by a March 1997 deadline, which made the agreement surpass "critical mass" threshold of representing 90 percent of global trade in covered products. The agreement came into force on July 1, 1997. Membership increased to 74 countries by 2012, the end of our sample period, and 82 by 2016. Our analysis focuses exclusively on the original ITA, although our broad conclusions may also of interest in light of the ITA's 2016 expansion to another 201 products (among a more limited set of 53 member countries).

The ITA eliminates tariffs for certain ICT-related products; it does not include any further provisions, e.g., on non-tariff measures. The original ITA itemizes 190 covered products in a rigid positive listing. These 190 products correspond to 154 HS1996 subheadings, i.e. 6-digit product codes, but many subheadings are only covered partially (see WTO (2012)). This makes the ITA's product coverage complex, adding challenges to the construction of our dataset (Section 3). The positive listing of the ITA implies that new ICT products generally are not covered.[7]

The ITA requires members to apply agreed tariff concessions to all WTO members, whether ITA signatories or not, by adjusting their MFN applied and bound tariffs. Therefore, trade diversion is not much of a concern in our analysis. Founding members were to implement zero tariffs by 2000, but some developing countries had longer implementation periods (up to 2005 at the latest). Implementation periods for countries joining later (after 1997) have been determined in negotiations and therefore varied, but in most cases did not surpass three years.

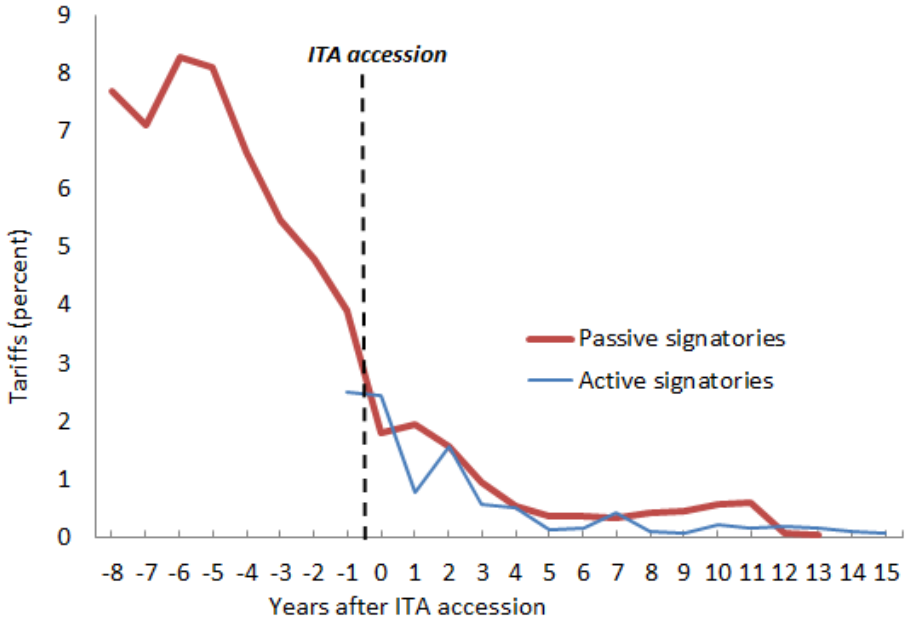
The context in which latecomers joined the agreement was generally different from that of founding members. Many late signatories joined the ITA mainly as a by–product of the pursuit of a larger integration or trade agreement.[8]

We identify three motivations behind the accessions of such countries, which we refer to as "passive signatories". First, for most countries acceding to the WTO after 1997, joining the ITA was made part of their WTO accession protocol. Second, all recent members of the European Union (EU) had to adopt the trade policy of the EU upon accession or in the preparatory process and hence joined the ITA, unless they had already acceded earlier. Third, the U.S. was one of the initiators of the ITA and has actively persuaded potential

[7] Trade coverage of these 190 products therefore eroded over time, motivating the expansion of the ITA, but the positive list strategy was maintained. Resulting complex product coverage therefore remains a point of criticism and has caused a dispute in the WTO (Dreyer and Hindley, 2008).

[8] Whether ITA accession was indeed such a by-product case was assessed by the authors based on Table 2.1 in WTO (2012) and interviews with WTO delegations and secretariat staff.

Figure 1: Average applied import tariffs on ITA goods by type of accession (percent)



preferential trade agreement partners to join the ITA.

All ITA members that are not passive signatories are assigned to the "active signatories" group. It includes all founding members as well as late signatories whose accession was not mainly motivated by one of these three broader policy objectives.

Table 1 below presents the lists of active and passive signatories as well as accession years for all non-founding members. Passive signatories entered the agreement in various years. Thirteen economies were classified as passive signatories due to WTO accession and another fifteen because their ITA accession was related to EU accession or negotiations of an FTA with the U.S.

Tariffs on ITA products were generally already low before accession for member countries. This is particularly true for active signatories, whose ITA product tariffs averaged 2.5 percent in the year before accession. Passive signatories had somewhat higher tariffs in the year before accession, averaging 3.9 percent.[9] However, they had been reducing their tariffs considerably on these goods already before accession (Figure 1).

Passive signatories' importance in world ITA goods trade has grown immensely over our sample period. These gains have come at the expense of active signatories, which are predominantly developed countries. Although China stands out, Figure 2 illustrates that other passive signatories have recorded remarkable increases in their world market shares as well, albeit from a low base. Over the sample period, China has become a dominant player in IT products and this raises concerns that a large part of our results could be driven by China. We therefore run all our regressions twice: once on the whole sample and on a sample

[9]These average tariff figures include preferential tariffs. Average MFN applied tariffs are somewhat higher, 3.8 and 6.3 percent for initial and late signatories, respectively.

Table 1: ITA members categorized by motivation driving their ITA accession

"Active" ITA signatories, including all founding members[1]		
Australia	Hong Kong, China	New Zealand
Austria	Iceland	Norway
Belgium	India	Philippines
Canada	Indonesia	Poland
Chinese Taipei[2]	Ireland	Portugal
Costa Rica	Israel	Romania
Czech Republic	Italy	Singapore
Denmark	Japan	Slovak Republic
Egypt (2003)	Korea, Republic of	Spain
El Salvador	Kuwait (2010)	Sweden
Estonia[2]	Liechtenstein	Switzerland
European Union	Luxembourg	Thailand
Finland	Macao, China	Turkey
France	Malaysia	United Arab Emirates (2007)
Germany	Mauritius (1999)	United Kingdom
Greece	Netherlands	United States of America

"Passive" ITA signatories, whose ITA accession was likely significantly motivated by...		
WTO accession	EU accession	US FTA
Albania (1999)[3]	Bulgaria (2002)	Bahrain, Kingdom of (2003)
China (2003)	Cyprus (2000)	Colombia (2012)
Croatia (1999)[3]	Hungary (2004)	Dominican Republic (2006)
Georgia (1999)[3]	Malta (2004)	Guatemala (2005)
Jordan (1999)[3]	Slovenia (2000)	Honduras (2005)
Kyrgyz Republic (1999)		Morocco (2003)
Latvia (1999)		Nicaragua (2005)
Lithuania (1999)[3]		Panama (1998)
Moldova, Republic of (2001)		Peru (2008)
Oman (2000)		
Saudi Arabia, Kingdom of (2005)		
Ukraine (2008)		
Viet Nam (2006)[3]		

Sources: Authors' compilation based on WTO (2012) and information obtained through interviews of various WTO Secretariat staff.

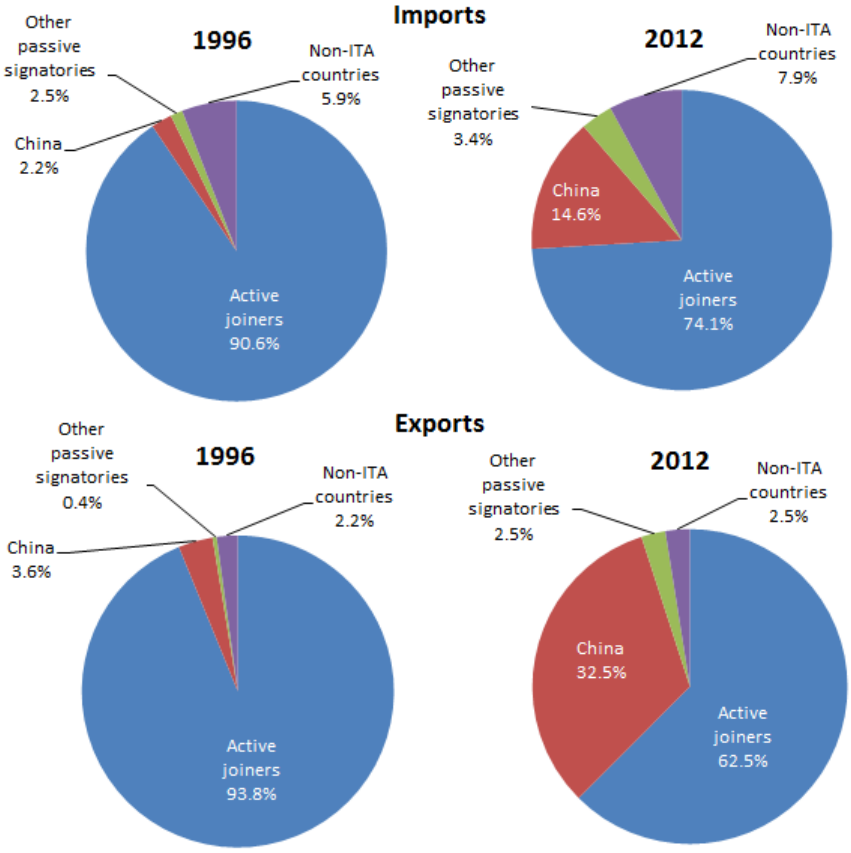
[1] ITA founding members joined in 1997. Accession year for all non-founding members is given in parentheses.

[2] Among ITA founding members, Chinese Taipei and Estonia were the only ones which only joined the WTO subsequently (in 2002 and 1999, respectively). They had ITA membership as a requirement in their WTO accession protocols, we classify them as active signatories because they were founding members and acceeded before their WTO accession.

[3] These countries already joined the ITA during their WTO accession process in the calendar year before WTO accession (only Lithuania acceeded the WTO two calendar years later, in 2001).

excluding China's exports.

Figure 2: World market shares in ITA products by type of accession, 1996 and 2012

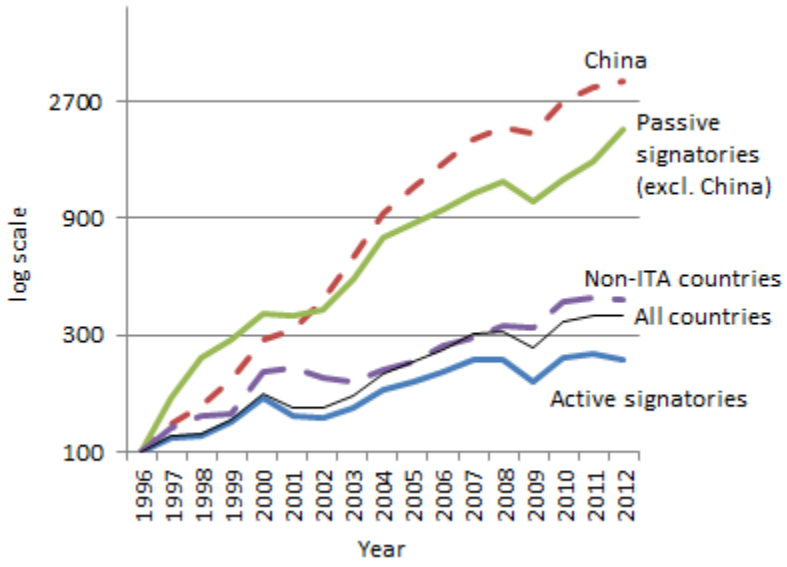


Both for China and other passive signatories, increases in market shares are more impressive for exports than imports. This illustrates that, geographically speaking, import demand for ITA goods has been relatively stable over time, while the origin of products changed significantly in the last two decades, arguably driven in part by location and sourcing decisions of multinational enterprises as described in the GVC literature.

Figure 3 further explores export trends among these country groups over time. Both exports of active signatories and non-members show only moderate growth. Passive signatories instead have a much steeper slope. When the lower initial start value is taken into account, the expansion of their exports almost matches that of China. However, Figure 3 does not provide a good notion of whether ITA accession may have driven growth in passive signatories, because many passive signatories were not yet ITA members in the beginning of the period covered in the figure.

To obtain a notion of whether ITA accession may have boosted exports of passive signatories, we therefore look at how their exports have evolved before and after ITA accession. To eliminate influences of global fluctuations in ITA trade, we now look at market shares, which we rescale to 100 in the entry year to allow for simple averaging across countries. To retain a sufficient number of countries in the sample, we focus only on the 7 years before the ITA

Figure 3: Nominal export value of ITA products
(index, 1996=100)



entry year and 5 years after. Figure 4 presents the results. Twelve passive signatories can be observed during such a 12-year time window ("Constant Country Sample"). To check the robustness of the ITA exports pattern over time across larger set of passive signatories, we also look at all passive signatories ("Changing Country Sample") during this 12-year period. For both samples, the figure indeed suggests that export market shares of passive signatories start to increase substantially around the time of ITA accession. The figure includes China, but it is insensitive to its exclusion.

Shares of ITA products in countries' export baskets have also expanded in response to accession (Figure 5). We note that from the mid-1990s until the dot-com bust in 2001, these shares were expanding across all groups. For active signatories, this expansion coincided with the years just after their ITA accession in 1997. But given that IT exports expanded globally, it may be hard to attribute this to the ITA. Passive signatories acceded to the ITA in different years, but most did so in 1999 or the early 2000s (Table 1). We calculate a mean accession year for this group of late 2002. Figure 5 suggests that passive signatories experienced growth of their ITA sector after accession. During the mid-2000s, the share of ITA products in their export baskets surged – and stabilized subsequently at a higher level – while those of other countries were stagnant. Thus their increasing global ITA export market share of Figure 4 went hand in hand with an increased importance of the sector within passive signatories' economies.

This suggests that expansion of ITA exports coincided with development of an ITA export sector in passive signatories. Notably, ITA export sectors were small in passive signatories before accession: ITA product exports amounted to only 0.4 percent of passive signatories' GDP on average (median 0.1 percent), while in active signatories they were 2.8 percent of

Figure 4: Market share in global ITA product exports of "passive signatories" (index, accession year=100)

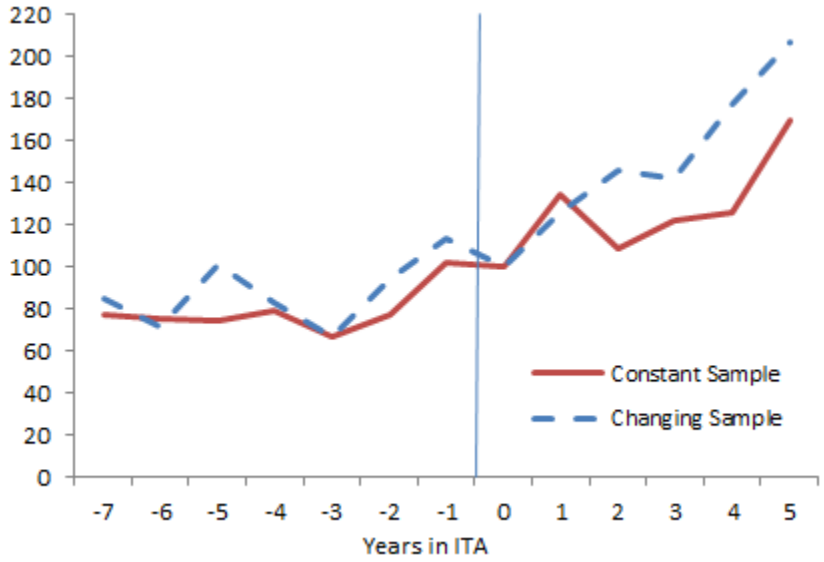
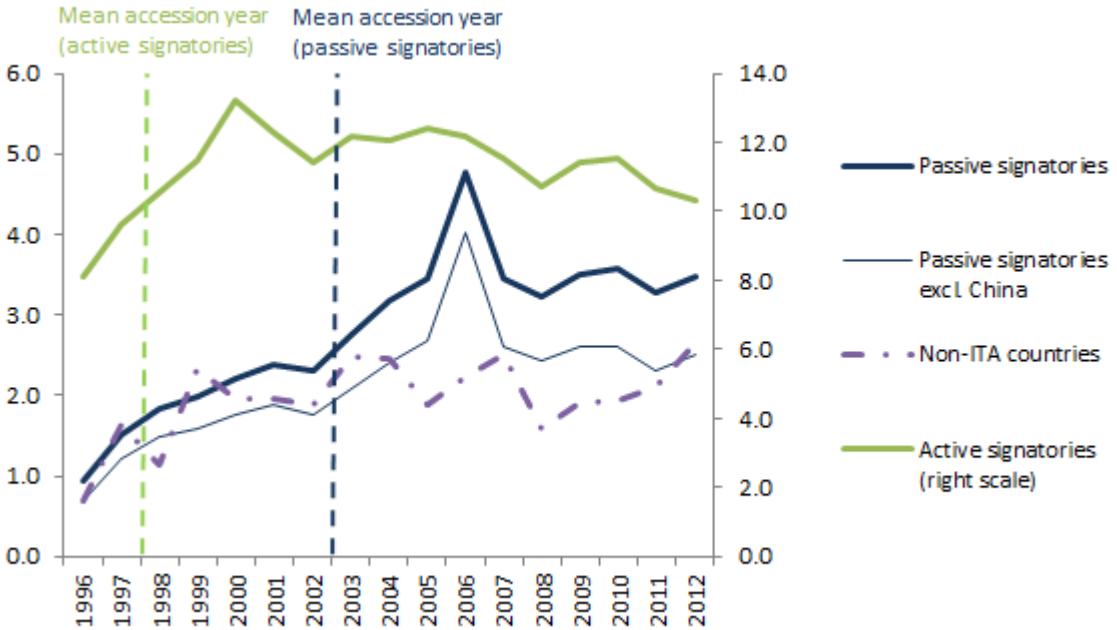


Figure 5: Average ITA product share in total exports by type of ITA accession, 1996-2012 (percent)



GDP (median 1.0 percent).[10]

3. Data

Our dataset covers 1996-2012 and matches product-level trade data to tariffs, ITA and WTO membership indicators, and common gravity variables. Construction of the dataset involves conversions across tariff vintages and translation of the ITA agreement into coverage of tariff lines.[11]

Data on tariffs at the 6-digit level are obtained from UN TRAINS and converted to the HS1996 vintage. WTO and ITA membership data was taken from the WTO website. We collect those gravity variables that vary across time within any country or country-pair from standard sources and include a remoteness measure.[12]

The ITA's list of covered products remained unchanged between its entry into force 1997 and the end of our sample period in 2012. It lists 154 products, which we translate into a coverage of 106 product lines at the 6-digit HS1996 level.[13] Gross imports data on these product lines is obtained from UN Comtrade.[14] While use of value-added trade data would be desirable, its granularity is insufficient for identifying an ITA sector and matching detailed tariffs.

To nevertheless add a value chain dimension to our analysis, we classify product lines into those containing mostly intermediate and mostly final goods as in Yeats (2001) and Orefice and Rocha (2014). Sturgeon and Memedovic (2010) provide the needed classification at the HS 6-digit level; it covers 47 of our 106 ITA product lines. While this leads to a loss observations in intermediate (final) goods regressions, 680 (825) thousand of a total of 2.5 million ITA observations remain.[15]

In many of our regressions, we employ control sectors to assess how ITA trade has performed relative to that of comparable goods. We use two control sectors: other information and communications technology (ICT) goods that are not covered by the ITA, and machinery goods.

For ICT goods, OECD (2003, 2011) provide definitions covering 193 product lines at the 6-digit HS1996 classification. Of these 193 lines, 77 overlap with our 106-line ITA definition. Thus non-ITA ICT goods comprise 116 lines.[16]

[10] See also Figures 6 and 7 in the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015).

[11] For further details, we refer the reader to the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015).

[12] Non-time-variant variables such as distance are controlled for by country-pair-product fixed effects in all our specifications. Remoteness was computed for importers and exporters analogue to measures commonly used in the literature. To obtain a single remoteness measure for any bilateral pair in the interest of parsimony, importer and exporter remoteness are then multiplied before taking the natural logarithm.

[13] The 154 products cover 95 of these lines fully and 106 lines almost fully.

[14] Where import data are not available, export data reported by trading partners are filled in.

[15] When the ICT (machinery) control sector is added 102 of 202 (165 of 995) 6-digit product lines are covered by the classification.

[16] This implies that 29 ITA lines are not considered ICT goods by the OECD. These 29 lines cover manifold products, mainly printing machinery, electric typewriters and optical photo-copiers; laser discs and magnetic tapes; electric and power capacitators; equipment for measuring liquid or gas; and parts/accessories of aforementioned products.

Finally, we also construct a broad machinery control sector. We select HS sections 84, 85, 87, and 90. These comprise electrical and non-electrical machinery, road vehicles and optical/photographic/precision instruments. They were chosen because they make a good larger comparator group, as they are also highly traded and often integrated in GVCs. This broad machinery sector comprises all ITA and ICT tariff lines.[17] Its inclusion brings our dataset to a total of 21.8 million usable observations.

4. Empirical Strategy

Our estimation strategy is based on the structural gravity model developed by Anderson and Van Wincoop (2003). We only expand their two dimensional setup (exporter and importer) to include time and product dimensions. Using product-level data has the advantage of minimizing aggregation bias, because it allows us to account for variations in trade costs and elasticities across products (Clausing, 2001; Anderson and Yotov, 2010b,a).

Our four-dimensional gravity equation is:

$$x_{ijkt} = \frac{y_{jkt}x_{ikt}}{y_{kt}}(\frac{T_{ijkt}}{\Pi_{jkt}P_{ikt}})^{1-\sigma_k} \tag{1}$$

where the t subscript denotes years. The variable x_{ijkt} denotes imports of country i from country j of good k; y_{jkt} is total production of good k by country j; x_{ikt} is total expenditure on good k in country i; y_{kt} is global production of good k; σ_k is the elasticity of substitution parameter for good k; and T_{ijkt} stands for bilateral trade costs. Multilateral resistance, or general equilibrium effects, are represented by Π_{jkt}, the average outward trade barriers faced by country j, and P_{ikt}, the average inward trade barriers of country i. If such average trade costs faced by a country are high, it will be expected to trade more with any bilateral partner at a given bilateral trade cost (than a country facing low average trade costs). Notably, multilateral resistance varies over time.

The gravity relation is conveniently linear in logarithmic form, which allows estimation by OLS. The relationship is presented then as:

$$lnx_{ijkt} = lny_{jkt} + lnx_{ikt} - lny_{kt} + (1-\sigma_k)lnT_{ijkt} - (1-\sigma_k)ln\Pi_{jkt} - (1-\sigma_k)lnP_{ikt}. \tag{2}$$

This transformation eliminates zero trade flows and can lead to bias whenever the non-positive trade flows are not random. This was first highlighted by Helpman et al. (2008) and also emphasized in Head and Mayer (2014) seminal guide to gravity estimation. We therefore also estimate directly the multiplicative version (equation 1) in the robustness section.

As data on total production and expenditure on specific products are not available and multilateral resistance terms are hard to measure, our model relies on fixed effects analog to Olivero and Yotov (2012):

$$lnx_{ijkt} = \alpha_{ikt} + \alpha_{jkt} + \alpha_{kt} + (1-\sigma_k)lnT_{ijkt} \tag{3}$$

where $\alpha_{ikt} = lnx_{ikt} - (1-\sigma_k)lnP_{ikt}$, $\alpha_{jkt} = lny_{jkt} - (1-\sigma_k)ln\Pi_{jkt}$ and $\alpha_{kt} = lny_{kt}$.

[17] To be exact, two ITA tariff lines (HS 381800: Chemical element/compound wafers doped for electronics; HS 950410: Video games used with the TV receiver) are not covered by the four HS sections, but we retain them in the dataset throughout.

Next we set out the trade cost equation. It posits that there may be four channels – or layers – through which the ITA can affect bilateral trade costs T_{ijkt}:

$$T_{ijkt} = (1 + t_{ijkt})exp(\gamma_1 t0_{ijkt} + \gamma_2 imita_{ijt} + \gamma_3 exita_{jt} + \gamma_4 I_{ijt} + \alpha_{ijk}) \quad (4)$$

The first layer is the tariff reduction effect, captured by directly introducing the applied bilateral tariff (t_{ijkt}).

The second layer is the tariff elimination effect. It allows for a binary cost of maintaining a positive tariff ($t0_{ijkt}$), as eliminating the tariff completely might decrease red tape in customs clearance. The intuition here is that reducing tariffs from 2 to 0 percent, i.e. eliminating the so-called "nuisance tariffs", could have a bigger impact than reducing them from 4 to 2 percent. A growing "time in trade" literature highlights that reducing bureaucratic hurdles in customs and curbing associated clearing times has substantial impacts on trade (e.g. Freund and Pierola, 2015). Whether this tariff elimination effect is economically significant is an empirical question, because there may also be reasons to believe that reductions in customs clearance costs may not be large. First, even with a zero tariff, customs procedures might not be much simplified as VAT still has to be assessed at customs in many countries.[18] Second, despite zero tariffs, some administrative burdens could be retained as customs officials may require proof that an import is covered by the agreement (Wiese et al., 2014). Our empirical findings suggest that tariff elimination effects have are economically and statistically significant (Section 4).

The third layer is the commitment effect on imports, $imita_{ijt}$. The associated ITA importer dummy only takes a value of one only when the exporter is a WTO member; this is because the concessions of ITA are only guaranteed to WTO members. Its coefficient quantifies possible additional effects on imports through higher trade policy certainty. A growing literature suggests that trade policy certainty can boost trade, including through investment and entry/location decisions of firms (Handley and Limão, 2013, 2015).

The fourth and final layer is the commitment effect on exports, $exita_{jt}$, an export-side analogue to the third layer. The exporter ITA membership dummy $exita_{jt}$ equals one when the exporter is an ITA member independent of trading partner. This is because a country's higher export potential, e.g. due to more FDI-driven technology transfer, would be expected to affect all its trading relationships. The notion here is that location and sourcing decisions of firms increasingly depend on import availability in light of global production sharing. Anecdotal evidence suggests for instance that, in short-listing potential production locations, multinational enterprises may only consider such locations that are part of certain international agreements or have certain institutional features ensuring low risks disruption of business operations, including importing and exporting.

The I_{ijt} matrix includes the few common gravity regressors that vary simultaneously across the importer, exporter, and time dimensions. There are dummies for joint currency union membership and for a common preferential or regional trade agreement (RTA). In addition to this overall RTA dummy, another two specific RTA-related variables are included. First, we note that many ITA passive signatories were EU accession countries. With ITA and EU accession often occurring around the same time, it is possible that the ITA passive

[18] E.g. see Office of the Revenue Commissioners (2013) for EU customs procedures.

exporter effect come to erroneously capture EU trade creation if exceeds that of other RTAs. To forestall this possibility we include a dummy capturing exports to the EU of countries to that joined the EU after 1997.[19] Second, we add a similar dummy capturing exports to the U.S. of countries that joined an RTA with the U.S. after 1997. Furthermore, the I_{ijt} matrix also contains two variables capturing the impact of the ITA and WTO on non-members.[20]

Finally, equation (4) includes a fixed effect term α_{ijk} which accounts for all country-pair-product specific trade determinants – whether observable or unobservable. Given large heterogeneity in bilateral trade relationships, such a fixed effect term has been strongly advocated by various authors (e.g. (e.g. Baldwin and Taglioni, 2007).

Plugging in the trade cost equation (4) into the gravity equation (3) yields our estimation equation:

$$\begin{aligned} lnx_{ijkt} &= \alpha_{it} + \alpha_{jt} + \alpha_{kt} + \alpha_{ijk} + (1-\sigma_k) ln(1+t_{ijkt}) \\ &+ \beta_1 t0_{ijkt} + \beta_2 imita_{ijt} + \beta_3 exita_{jt} + \beta_4 I_{ijt} + \epsilon_{ijkt} \end{aligned} \tag{5}$$

where $\beta_l = \gamma_l(1-\sigma_k)$ for $l = 1, ..., 4$.

We drop the product dimension of the multilateral resistance proxies α_{it} and α_{jt} in equation (5). This allows us to identify our ITA commitment effects of interest, whose identification relies on variation between ITA and non-ITA products. However, it also implies that we cannot control for asymmetric changes of multilateral resistance across products. We deem the risk of such changes to be low, given the relative homogeneity of the products we consider. Moreover, the remaining 4-dimensional set of fixed effects remains rather rich, accounting for importer-exporter-product and product-time effects in addition to the *it* and *jt* multilateral resistance terms.[21]

Equation (5) can only be estimated on a dataset including a control sector in addition to ITA products. As discussed, we consider two control sectors: ICT products not covered by the ITA, and machinery. The estimates of the ITA commitment effects resulting from this equation illustrate how ITA trade flows performed *relative* to those of the control sector after ITA accession.

We also employ the following simplified equation in some estimations, which drops completely the α_{it} and α_{jt} terms:

$$\begin{aligned} lnx_{ijkt} &= \alpha_{kt} + \alpha_{ijk} + (1-\sigma_k) ln(1+t_{ijkt}) \\ &+ \beta_1 t0_{ijkt} + \beta_2 imita_{ijt} + \beta_3 exita_{jt} + \beta_4 \tilde{I}_{ijt} + \epsilon_{ijkt} \end{aligned} \tag{6}$$

This equation can provide different insights by focusing on time variation within country pairs. It can thus address the policy-relevant question how joining ITA has affected a coun-

[19] While some of the EU impact should be picked up by the RTA dummy, some authors have pointed out, that trade creation may vary substantially across specific agreements and may be particularly strong for the EU (Eicher et al., 2012).

[20] They capture the idea that non-ITA WTO members may deviate their exports to ITA members in light of their lower import tariffs. Likewise non-WTO members may deviate trade to WTO members, given that multilateral tariff reductions are in practice often also applied to nonmembers ("One in WTO" dummy).

[21] On a side note: all four sets of fixed effects are high dimensional, rendering estimation of equation (5) computationally challenging. We rely on the Stata command *reghdfe* for equations with high dimensional fixed effects and cluster standard errors by country-pair-product combinations. The working paper version provides further discussion of computational issues.

try's trade compared to its trade before accession and gives a better notion of absolute gains in imports or exports.

There is, however, the theoretical drawback that controlling for multilateral resistance becomes imperfect. Only *average* multilateral resistance during 1996-2012 can now be controlled for via (country-pair-product) fixed effects. With respect to the time-varying element of multilateral resistance, we take comfort from tariff and ITA coefficients in our application being hardly affected by neglecting it.[22] Nonetheless, we make efforts to proxy for its time-varying element. We do this by expanding I_{ijt} to include (i) (logs of) importer and exporter GDPs, which can also capture some further variation attributable to multilateral resistance, given that the latter is correlated with country size (Anderson and Yotov, 2010b), and (ii) a distance-based remoteness dummy. It weighs distances by GDPs of destination countries and therefore also varies over time. Such remoteness measures were often used in the early gravity literature.

A final variable included in the expanded $\tilde{I}_{ijt}$ matrix accounts for the fact that WTO accessions in recent times required more onerous reforms (Tang and Wei, 2009) – and these could stimulate ITA goods exports. This dummy variable takes the value of one during years of WTO membership for exporters that joined the WTO after 1997.

Finally, it is important to consider endogeneity in our estimation equations. There is ample empirical evidence that sectors characterized by higher levels of import penetration receive greater protection (e.g. Trefler, 1993; Lee and Swagel, 1997), which is in line with the predictions of political economy models of trade protection.[23] It is likely that high import penetration would cause import flows (our dependent variable) to also be high. We thus need to suspect that high imports would cause higher tariff levels or reduce the likelihood of zero tariffs as well as that of joining the ITA. In absence of appropriate instrumental variables, the standard in the literature – which we also follow here – has become to rely on country-pair(-product) fixed effects (Baier and Bergstrand, 2007). This mitigates the issue as long as import penetration does not dramatically change over the sample period. If import penetration does change, but relatively homogeneously across sectors within a country (say due to changes in macroeconomic conditions such as exchange rates), then our importer-time fixed effects constitute a second line of defense. Any remaining endogeneity would bias our estimates toward zero. Thus, to the extent that some endogeneity remained despite the extensive fixed effect controls, our estimates would need to be interpreted as lower bounds. Finally, it would be even less likely that those estimates relating to passive signatories carry bias, because their accession to ITA came about largely exogenously in the pursuit of a larger policy objective, as discussed above.

[22] See Table A5 the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015).

[23] While the seminal model of Grossman and Helpman (1994) predicts that higher import penetration would actually lead to lower levels of protection, Maggi and Rodrıguez-Clare (2000) show that this prediction is reversed when the assumptions are relaxed that (i) trade taxes are the government's only policy instrument and that (ii) government has access to non-distortionary taxation.

5. Results

Table 2 summarizes our results.[24] Its rows distinguish between the four different layers of impact, alongside which we will structure our discussion. For the export commitment effect (Layer 4), we also report estimates from analogue regressions excluding China's exports from the sample (gray shading). Impacts at the other layers are not sensitive to inclusion or exclusion of China.[25] Table 2's columns cover two dimensions. First, they compare the effects in the "all goods sample" with those in intermediate and final goods. As not all product lines can be classified into intermediate and final goods, sample selection effects imply that the "all goods" estimates do not necessarily lie between the former two. Second, it contrasts the results of our simplified equation (6) focusing on time variation in the ITA only sample (Regressions 1, 4, 7) with those of equation (5). The latter exploit between-product variation within each importer and exporter in a given year and identify how ITA goods performed relative to other ICT goods (Regressions 2, 5, 8) and machinery (Regressions 3, 6, 9) after ITA accession.

5.1. Layer 1: Tariff reduction effect

The tariff reduction effect is the first of three layers of impact that the ITA may have on imports. It measures effects of tariff reductions whether or not they were related to ITA accession. The results suggest that a one percent reduction of tariffs on ITA products would cause a 0.3 to 0.4 percent increase in imports. In the regressions including control sectors, we allow these import demand elasticities to differ for other ICT and machinery products and obtain higher elasticities for these sectors in absolute terms (-0.6 to -0.7).

These tariff elasticities are lower than most import demand elasticities reported in the literature, which are derived based on aggregate trade flows. For instance, Kee et al. (2008) and Tokarick (2014) estimate such elasticities for many different countries and come up with averages in the range of -1.1 to -1.2, although an earlier study by Senhadji (1998) is relatively close to our value, at -0.32.

Our values are lower mainly due to allowing for non-linear impacts of tariff liberalization by including the separate tariff elimination dummy in the second layer. If this second layer were to be dropped, our ITA import demand elasticity would settle in the -0.7 to -0.8 range. Moreover, adding lagged tariffs in our robustness analysis increases the tariff reduction effect considerably, suggesting that tariff reductions take some time to produce effects (Section 6).

[24] All these results are derived from HS 6-digit product-level data. In the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015), we investigate how aggregating ITA trade flows, as in Mann and Liu (2009) and Bora and Liu (2010), affects results. We find that some effects, especially export commitment effects are estimated considerably higher in aggregate data. This suggests that product-specific unobservable determinants are indeed important and product-level data should be used where possible to avoid bias.

[25] Full results from all regressions on a sample excluding China's exports are reported in the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015, Appendix Table A3). We also explored whether results change further when also excluding Chinese imports, which is not the case. This underscores that, while China is not very distinct in its import pattern from other countries, it has become an exceptional case of export success in ITA products since its accession to the agreement.

Table 2: The layers of ITA trade effects

	Type of goods	All			Intermediate			Final		
	Fixed effects[2]	ijk & kt	ijk, kt, it & jt		ijk & kt	ijk, kt, it & jt		ijk & kt	ijk, kt, it & jt	
	Sample	ITA	ITA & ICT	Machinery	ITA	ITA & ICT	Machinery	ITA	ITA & ICT	Machinery
	Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Layer 1: Tariff reduction effect	ln(1+tariff) for ITA goods	-0.347***	-0.389***	-0.293***	-0.117	-0.592**	-0.327*	-0.677***	-0.194	-0.118
		(-4.26)	(-4.54)	(-3.89)	(-0.72)	(-3.01)	(-2.00)	(-4.56)	(-1.24)	(-0.78)
	ln(1+tariff) for other goods		-0.677***	-0.614***		-0.928***	-0.562***		-0.577***	-0.528***
			(-9.52)	(-22.10)		(-4.13)	(-6.24)		(-4.93)	(-6.10)
Layer 2: Tariff elimination effect	Zero tariff for ITA goods	0.101***	0.123***	0.099***	0.130***	0.190***	0.139***	0.071***	0.090***	0.092***
		(20.45)	(21.33)	(20.11)	(13.99)	(15.72)	(13.92)	(8.53)	(9.34)	(9.89)
	Zero tariff for other goods		0.030***	0.008**		0.051**	0.014		0.021*	0.034***
			(4.81)	(3.23)		(3.05)	(1.66)		(2.07)	(3.89)
Layer 3: Commitment effect on Imports	Active ITA Importer[1]	0.336***	0.155***	0.159***	0.405***	0.284***	0.192***	0.339***	0.078**	0.097***
		(11.63)	(9.18)	(11.47)	(7.34)	(7.02)	(6.54)	(6.69)	(2.77)	(3.64)
	Passive ITA Importer[1]	0.349***	0.113***	0.122***	0.478***	0.368***	0.218***	0.347***	0.023	0.061*
		(14.32)	(6.49)	(8.70)	(10.40)	(8.74)	(7.27)	(8.23)	(0.82)	(2.28)
	Non-ITA WTO Importer[1]	0.325***	0.102***	0.094***	0.446***	0.361***	0.194***	0.265***	-0.020	0.013
		(12.70)	(6.57)	(7.48)	(9.14)	(9.64)	(7.27)	(5.93)	(-0.78)	(0.52)
	Active ITA Im. - non-ITA WTO Im.[3]	0.010	0.053***	0.065***	-0.041	-0.077*	-0.002	0.074**	0.097***	0.084***
		(0.63)	(3.50)	(5.12)	(-1.36)	(-2.22)	(-0.08)	(2.57)	(4.06)	(3.66)
	Passive ITA Im. - non-ITA WTO Im.[3]	0.023	0.011	0.029*	0.032	0.007	0.024	0.082**	0.043	0.048*
		(1.49)	(0.68)	(2.28)	(1.08)	(0.18)	(0.90)	(3.08)	(1.70)	(2.02)
Layer 4: Commitment effect on Exports	Active ITA Exporter	-0.074***	0.167***	0.086***	-0.025	0.091	-0.014	-0.109**	0.028	0.018
		(-3.57)	(8.18)	(5.11)	(-0.64)	(1.61)	(-0.35)	(-3.21)	(0.90)	(0.61)
	Passive ITA Exporter	0.429***	0.177***	0.143***	0.393***	0.195***	0.051	0.507***	0.381***	0.419***
		(25.74)	(9.09)	(9.55)	(13.20)	(3.87)	(1.58)	(17.52)	(11.48)	(13.45)
	Passive ITA Exporters other than China[4]	0.018	0.125***	0.111***	0.060	0.085	0.071	0.081*	0.309***	0.253***
		(0.83)	(4.63)	(5.58)	(1.61)	(1.13)	(1.64)	(2.20)	(6.95)	(6.20)
	Observations	2477294	5632921	21813553	680728	1165824	2530265	825203	1970737	2397118
	R^2	0.8050	0.7978	0.7984	0.8238	0.8161	0.8268	0.7839	0.7936	0.8003
	Adjusted R^2	0.8049	0.7974	0.7982	0.8237	0.8150	0.8262	0.7838	0.7928	0.7997

Notes: Based on robust standard errors clustered by country-pair-product combinations. All regressions include a "One in WTO" dummy, separate dummies for exports of late joiners of the WTO, EU and US FTA covered under these agreements, and standard gravity variables; their coefficients are reported in Henn and Gnutzmann-Mkrtchyan (2015, Tables 2 , A1, A2). The number of observations is higher in it/jt specifications, because these fixed effects lead to GDPs and remoteness – which contain some missing values – to be dropped.

[1] ITA importer variables only take the value of one if exporter is a WTO member and if the product in question is an ITA product.

[2] Sets of fixed effects: kt = product-time; ijk = country-pair-product; it = importer-time; jt = exporter-time.

[3] The difference of these two variables expresses how much more active/passive ITA signatories import compared to non-ITA WTO members. In other words, this would be the amount that a country, which is already a WTO member, could expect to import more from other WTO members by joining the ITA.

[4] This coefficient is obtained from an exact analog regression that excludes China's exports from the sample. The Passive ITA exporter coefficient is the only one to substantially vary as a result of such a sample modification. The full regression results from this restricted sample are reported in Henn and Gnutzmann-Mkrtchyan (2015, Appendix Tables A3).

Finally, we find that tariff reduction effects are higher for intermediate goods than for final goods. This is both true in the ITA and control sectors. It is intuitive in light of global value chains, as firms would cluster more production steps in one country if tariffs are higher, thereby reducing intermediate goods flows (Yi, 2003). While this result emerges from the control sector regressions, we cannot confirm it in the ITA only sample in our simplified specification (Regressions 4 and 7). This likely results from the much smaller samples for which the intermediate/final good distinction is available; and this becomes accentuated when further limiting the sample to only ITA goods.

5.2. Layer 2: Tariff elimination effect

Estimates of the tariff elimination effect are found to be large. This suggests that reducing tariffs to zero has a large impact on imports of ITA products, above and beyond those of tariff reductions. An additional impact of eliminating tariffs seems intuitive, because zero MFN tariffs (i) could considerably reduce border formalities and (ii) eliminate firms' costs in studying eligibility for tariff preferences under preferential trade agreements (PTAs), meeting associated rules of origin, and providing relevant documentation thereof.

Our estimates suggest that tariff elimination – whether implemented because of ITA accession or unilaterally – will boost ITA imports by about 10-13 percent on average.[26] Thus, making the final effort to reduce small tariffs, say from 1 to 0 percent, will achieve a much higher impact than reducing a high tariff by several percentage points without reaching zero.

Tariff elimination is especially important for ITA goods imports, more so than for other ICT goods or the broader machinery sector for which we find tariff elimination to lift trade by 3 and 1 percent, respectively. These differences likely come against the background of the ITA sector's especially high integration into value chains, so that burdensome border formalities imply high costs. The estimates for intermediate and final goods support this conclusion; For intermediates, the impact of tariff elimination is higher – in the 14-20 percent range for ITA goods – likely because these goods are particularly important in value chains. Tariff elimination for final ITA goods is expected to increase such imports by 7-10 percent.

To our knowledge, zero tariff dummies to capture tariff elimination effects have thus far not been included in the gravity literature. In fact, much of the literature does not even include tariffs as an explanatory variable, partly for data availability reasons. Nonetheless, our strong tariff elimination effects are intuitive in light of the findings of two related literatures. First, the time in trade literature finds that border formalities have substantial effects on trade flows (e.g. Djankov et al., 2010). Second, the extensive empirical literature on trade impacts of preferential trade agreements (PTAs) generally finds these to be large. It seems likely that a considerable part of these benefits accrues from reducing tariffs to zero.[27]

[26]Regression coefficients on dummy variables, such as the zero tariff dummy and our ITA membership variables, express impacts in log units. These are very similar to percentage changes for values close to zero. The exact percentage change implied by any coefficient b can be calculated as $\exp(b)$-1. The 10-13 percent range mentioned here is obtained from the highest and lowest coefficients on "Zero tariff for ITA goods" in Regressions 1-3: exp(0.099)-1=10.4%; exp(0.123)-1=13.1%.

[27]Our estimates also provide new information specifically on commitment impacts of PTAs. PTA studies typically compound all PTA effects, including tariff reduction and elimination, into a single dummy. Because

Strong policy implications arise from our confirmation of the existence of tariff elimination impacts. It implies that, from a trade perspective, tariffs that are already low should be eliminated – losing related tariff revenues would not have large fiscal implications while trade gains can be substantial. To the extent that sectoral tariff elimination agreements at the WTO provide a credibility mechanism that allows governments to achieve such tariff elimination, they should be worthwhile pursuing. In particular, we would expect the recently implemented ITA expansion to also have substantial impacts. Tariff elimination in other sectors, such as machinery or chemicals – which have been proposed by some WTO members in the past – would likely also have trade expansion benefits beyond those of tariff reduction.

Interpreted in reverse, our results suggest that reintroducing even moderate tariffs on products currently benefiting from zero tariffs could disproportionately hurt trade. Therefore, any studies exploring "trade war" scenarios would do well in paying attention to these non-linearities in tariff impacts.

Non-linearity of tariff impacts can help resolve some puzzles raised in previous literature. First, Feenstra (2008) examines, specifically for IT products, a question related to ours. He focuses on the tariff to import price pass-through and finds that tariff reductions for ITA goods have a highly magnified effect – of up to a factor of 22 (!) – on their import prices. He suggests that the huge magnitude of this effect may result because ITA members' tariffs were already in the low single digits before accession, and thereby absolute price changes would nonetheless be moderate. Our results meanwhile indicate that these high estimates may rather be a result of non-linearity in the impact of tariff reductions. Elimination seems to have a distinctive additional impact in lowering trade costs, which could be passed on in the form of lower prices.

Second, Yi (2003)'s model of value chain trade underscores that tariff reductions will have an especially high trade impact once fragmentation of production kicks in. To provide intuition for his model, Yi argues that tariff reductions in the 1980s and '90s were much more potent than those in 1960s and '70s. Our results suggest that the higher potency of tariff reduction in the 1980s and '90s could have partly been driven by higher incidence of tariffs elimination during this period.

5.3. Layer 3: Commitment effect for imports

This layer quantifies whether the ITA had a further impact on imports beyond those of tariff reduction and elimination. This additional impact emerges from the binding commitments established by the agreement, making the resulting tariff elimination more costly to reverse than if it were achieved through unilateral actions. This may spur additional integration, for instance because higher trade policy certainty makes investments by exporters in distribution networks in ITA destinations less risky. As a result, exporters may have an incentive to redirect their exports toward ITA members.

Correct interpretation of results requires evaluating simultaneously the three coefficients

we explicitly consider tariffs and a zero tariff dummy in the same regression, our PTA coefficient will only quantify PTA benefits going beyond tariff reduction and elimination – chiefly those related to trade policy certainty, harmonization and reduction of non-tariff barriers. We find in the working paper version that for ITA goods, these on average lead to a 5 percent trade increase (Henn and Gnutzmann-Mkrtchyan, 2015, Appendix Table A2).

on the Active and Passive ITA importer and the non-ITA WTO importer variables. The non-ITA WTO Importer dummy captures how ITA members' exports evolved to WTO importers that did not join ITA. Added together, these three variables form a "Both in WTO" dummy variable commonly used in studies on the trade impact of joint WTO membership (Rose, 2004, and subsequent literature). Thus, when the three variables show broadly equal coefficient values – as in Regression 1 – it signals WTO trade creation. Regression 1 therefore does not hold strong conclusions about the ITA. Rather it implies that joining the WTO leads to a 40 percent increase in ITA goods imports, with higher impacts found for intermediate goods.[28] Other regressions involving control sectors confirm that WTO membership is very important for facilitating countries' integration also in ITA goods trade. WTO membership has a 10 percent stronger effect in the ITA sector than in the broader ICT or machinery sectors (as implied by the coefficients on Non-ITA WTO Importers in Regressions 2 and 3.)

ITA-specific commitment effects, however, do have a role to play in explaining higher final goods imports of active signatories. The commitment effect of ITA (above and beyond the effect of WTO membership) is implicit in the difference between active/passive ITA importer and non-ITA WTO importer effects, which is reported in the gray shaded lines.[29] We find that commitment effects of the ITA have increased final goods imports by active signatories by 8 percent (Regression 7). ITA accession increased final ITA imports in these countries by 9-10 percent relative to other ICT and machinery imports (Regressions 8, 9). Meanwhile ITA commitment effects on intermediate goods imports are muted and could even be slightly negative for active signatories.

Overall these results underscore that, in the wake of the ITA, production in active signatories was oriented away from downstream stages, which rely on intermediate imports. In return, active signatories' final goods imports increased.

5.4. Layer 4: Commitment effects for exports

The ITA commitment effect on export activity is most pronounced for passive signatories. When focusing on time variation in our simplest regression (#1), their ITA exports increased by over 50 percent compared to the period before ITA accession. A considerable part of this impact is driven by the out-performance of China. China has become more than a mere downstream assembly hub for ITA products since its ITA accession. Our estimates suggest that it has, in addition to final goods, also taken to exporting substantially more ITA intermediate products, including relative to ICT intermediates.

Nonetheless, passive signatories other than China have also noticeably profited from ITA accession. This is shown by our more disaggregate estimates. When focusing on time variation, they register gains in final goods exports of some 8 percent as a result of ITA accession (Regression 7). When evaluated relative to control sectors, final goods exports in these countries even performed 30 percent better (Regressions 8, 9). Meanwhile, passive signatories did not record significant export gains in intermediate goods. This again suggests that ITA membership facilitated adoption of downstream positions in ITA value chains for these passive

[28] Country pairs including just one WTO member register a much lower increase of only 7 percent. This increase is in comparison to country pairs consisting of two WTO nonmembers. This coefficient is omitted from Table 2 here, but reported in the working paper version.

[29] These linear combinations of coefficients are obtained post estimation.

signatories, focused on producing final goods, including through the assembly of intermediate goods. The literature on value chains indeed suggests that for initial entrants, it is most common to join in downstream activities, because capabilities needed to perform those tasks can be acquired most easily (see WTO (2014) for an overview).

In active signatories, ITA commitment effects also underpinned export competitiveness. Although active signatories suffered large declines in export market shares (Figure 2), these likely would have been worse in absence of the ITA: Estimates suggest that ITA exports outperformed ICT and machinery exports by 18 and 9 percent, respectively (Regressions 2 and 3) on account of commitment effects. Unfortunately, related results on intermediate and final results are more difficult to interpret, as statistical significance is diminished in these smaller subsamples, likely in light of sample selection. However, they hint at ITA underpinning active signatories exports relatively more in intermediate than final goods. This would seem intuitive, because more advanced countries generally tend to specialize in high-value added intermediates in manufacturing GVCs.

Finally, with regards to non-ITA related controls, we find that some of them are indeed important, particularly those capturing EU-related trade creation.[30]

6. Robustness

In this section, we present two robustness checks. We first explore dynamic impacts of tariff reductions by gradually adding lagged tariff levels (Table 3). As Figure 1 illustrated, ITA signatories had already reduced their tariffs rapidly in the run up to accession. If these tariff reductions only had an impact on trade with a lag, e.g., as firms adjust their export patterns, their impact could be falsely attributed to layers 2-4.

For the first lag, we find that it is very significant with its coefficient of the same order of magnitude as the contemporaneous tariff in the ITA only sample (Regression 10). The total tariff reduction elasticity therefore rises to the order of -0.7 to -0.9, when it is approximated by summing tariff reduction coefficients across lags. This larger impact is confirmed also if two lags are added (Regression 11) or if we include the ICT control sector and, alongside it, importer-time and exporter-time fixed effects (Regressions 12, 13).[31] With regards to the tariff elimination effect (Layer 2), we do find that it is somewhat reduced as a result of this modification, but remains highly significant. Also, its magnitude still exceeds that of a 6 percentage point tariff reduction in all specifications. Results on both types of ITA commitment effects remain unchanged.

The second robustness check explores zero trade flows. All estimations up to this point contained only positive trade flows, ignoring country-pair-product-time combinations with no trade. Eliminating zero trade flows by taking logs of the gravity equation had crucial advantages in deriving our main results discussed above. Foremost, it allowed us to introduce

[30]The dummy capturing within-EU exports of late EU signatories shows EU membership increased these markedly. It carries highly statistically significant coefficients of 0.48 in Regression 1 and 0.06-0.08 in Regressions 2 and 3. See the working paper version for coefficients on all non-ITA controls (Henn and Gnutzmann-Mkrtchyan, 2015).

[31]We added up to three lags in unreported results without further changes. Coefficients from the second lag onwards become statistically insignificant or positive.

Table 3: Robustness I: Lagged Tariff Reduction Effects

Sample	ITA			ITA & ICT		
Fixed Effects[2]	ijk & kt			ijk, kt, it & jt		
Regression No.	1	10	11	2	12	13
ln(1+tariff), ITA goods	-0.347***	-0.374***	-0.578***	-0.389***	-0.038	-0.037
	(-4.26)	(-3.52)	(-4.80)	(-4.54)	(-0.34)	(-0.29)
ln(1+tariff), ITA goods, t-1		-0.367***	-0.613***		-0.675***	-0.842***
		(-4.10)	(-6.01)		(-7.20)	(-7.68)
ln(1+tariff), ITA goods, t-2			0.303**			-0.047
			(3.17)			(-0.47)
ln(1+tariff), ITA,	-0.347***	-0.741***	-0.888***	-0.389***	-0.713***	-0.926***
Sum of t to t-2	(-4.26)	(-7.14)	(-7.03)	(-4.54)	(-6.36)	(-6.75)
ln(1+tariff), ICT goods				-0.677***	-0.242**	-0.261*
				(-9.52)	(-2.66)	(-2.53)
ln(1+tariff), ICT goods, t-1					-0.597***	-0.249**
					(-7.67)	(-2.83)
ln(1+tariff), ICT goods, t-2						-0.582***
						(-6.93)
ln(1+tariff), ICT goods,				-0.677***	-0.839***	-1.091***
Sum of t to t-2				(-9.52)	(-8.99)	(-9.56)
Zero tariff, ITA goods	0.101***	0.071***	0.052***	0.123***	0.100***	0.082***
	(20.45)	(12.73)	(8.76)	(21.33)	(14.99)	(11.35)
Zero tariff, ICT goods				0.030***	0.027***	0.020**
				(4.81)	(3.91)	(2.71)
Active ITA Importer[1]	0.336***	0.383***	0.425***	0.155***	0.174***	0.184***
	(11.63)	(12.33)	(12.70)	(9.18)	(9.04)	(8.76)
Passive ITA Importer[1]	0.349***	0.396***	0.447***	0.113***	0.124***	0.141***
	(14.32)	(14.84)	(14.95)	(6.49)	(6.21)	(6.22)
Non-ITA WTO Importer[1]	0.325***	0.359***	0.415***	0.102***	0.137***	0.169***
	(12.70)	(12.88)	(13.64)	(6.57)	(7.71)	(8.70)
ITA Commitment effect on Imports:[3]						
Active ITA Im.	0.010	0.024	0.010	0.053***	0.037*	0.015
- non-ITA WTO Im.	(0.63)	(1.52)	(0.61)	(3.50)	(2.21)	(0.83)
Passive ITA Im.	0.023	0.036*	0.032	0.011	-0.012	-0.028
- non-ITA WTO Im.	(1.49)	(2.18)	(1.72)	(0.68)	(-0.69)	(-1.40)
Active ITA Exporter	-0.074***	-0.104***	-0.147***	0.167***	0.152***	0.150***
	(-3.57)	(-4.67)	(-6.43)	(8.18)	(6.42)	(5.95)
Passive ITA Exporter	0.429***	0.463***	0.501***	0.177***	0.208***	0.250***
	(25.74)	(22.96)	(21.65)	(9.09)	(8.74)	(9.14)
Passive ITA Exporters	0.018	0.033	0.064	0.125***	0.172***	0.226***
other than China[4]	(0.75)	(1.19)	(1.95)	(4.63)	(4.70)	(5.13)
Observations	2477294	1894584	1600294	5632921	4181602	3514499
R^2	0.8050	0.8100	0.8162	0.7978	0.8017	0.8077
Adjusted R^2	0.8049	0.8099	0.8160	0.7974	0.8013	0.8072

Notes: All regressions are on the all goods sample and represent analogs to Regression 1 or 2. Notes of Table 2 apply, including for [1] through [4].

up to four sets of high-dimensional fixed effects in estimations containing more than 20 million observations and thereby forestall omitted variable bias. While zeros are hard to incorporate in our setup because of computational constraints posed by the various high-dimensional fixed effects, we recognize that their exclusion can induce selection bias (Helpman et al., 2008).

The most straightforward way to introduce zeros, and we will pursue it in this robustness check, is to avoid taking logs altogether, thereby preserving the zero trade flows. The gravity equation is then estimated in multiplicative form, as in equation (1), using Poisson estimation as proposed by Silva and Tenreyro (2006).

Three simplifying modifications are necessary to implement Poisson estimation in our application: (i) limit the number and dimensionality of fixed effects, (ii) reduce our product dimension by aggregating to 7 broad categories of ITA products, and (iii) reduce our country coverage. The latter two are needed to ensure convergence of the Poisson algorithm. We briefly discuss these three modifications in turn.

First, the number and dimensionality of our fixed effects needs to be limited. The Poisson estimation only allows one set of fixed effects to be absorbed, requiring dummy variables for other sets of fixed effects to be created and held in memory. This implies that we cannot replicate any of baseline regressions of Table 2 directly in a Poisson setup. However, we are able replicate a close analogue to Regression 1 by reducing its product-time fixed effect to a time fixed effect.[32] Regression 14 in Table 4 provides least squares results; they are very similar to those of Regression 1. This provides evidence that *time-specific* shocks across ITA goods are relatively homogeneous, so that losing the product dimension on the time fixed effects does not change coefficients much.[33] We thus feel comfortable in simplifying the fixed effects structure in this way to enable us to incorporate zero trade flows.

Second, ITA products can be classified in 7 broad product categories, as outlined in WTO (2012). We resort to these to reduce the dimensionality of our dataset. The categories are the following (with corresponding number of our 6-digit HS1996 product lines included in parentheses): Computers (14), Instruments and apparatus (17), Parts and accessories (32), Semiconductor manufacturing equipment (10), Semiconductors (15), Data-storage media and software (9) and Telecommunications equipment (9). Computers, semiconductors, and parts and accessories are the most traded product categories, making up around 80 percent of ITA product trade flows.

Third, we reduce the country coverage of the dataset to 112 (from 235 in the baseline dataset). In doing so, we exclude all countries that do not account for at least 0.25 percent of world trade in at least one of the 7 categories in 2011. The resulting smaller dataset still covers more than 97 percent of world trade in 2011.

The results of this robustness check underline that detailed product-level data is important, because heterogeneity between products is high, although it does not vary much over time. In other words, collapsing into the 7 broad categories does substantially impact the coefficients in least squares estimation. In particular, it enlarges tariff reduction elasticities to the -1.5 range at the expense of counterintuitive signs of tariff elimination (Regression 15).

[32] Time fixed effects' dimensionality is sufficiently low for them to be created in memory. The country-pair-product fixed effects, which are high dimensional, are absorbed in the regression.

[33] In contrast, we find that country-pair-product fixed effect values vary considerably across products.

Table 4: Robustness II: Addressing zero trade flows with Poisson estimation

Estimation technique	Least Squares		Poisson
Data disaggregation	6-digit	Categories[5]	Categories[5]
Zero trade flows	No	Yes	Yes
Regression No.	14	15	16
ln(1+tariff)	-0.416***	-1.576***	-3.855***
	(-4.47)	(-4.78)	(-4.26)
Zero tariff	0.067***	-0.176***	-0.215**
	(12.02)	(-6.41)	(-3.21)
Active ITA Importer[1]	0.333***	0.390***	0.012
	(10.16)	(4.00)	(0.08)
Passive ITA Importer[1]	0.350***	0.489***	0.794***
	(12.73)	(6.30)	(5.24)
Non-ITA WTO Importer[1]	0.318***	0.459***	0.396***
	(11.01)	(5.29)	(3.54)
ITA Commitment effect on Imports:[3]			
Active ITA Importer minus non-ITA WTO Importer	0.015	-0.069	-0.385***
	(0.86)	(-1.39)	(-4.18)
Passive ITA Importer minus non-ITA WTO Importer	0.031	0.030	0.398***
	(1.93)	(0.50)	(4.13)
Active ITA Exporter	-0.134***	-0.036	-0.629***
	(-5.83)	(-0.62)	(-5.30)
Passive ITA Exporter	0.413***	0.315***	
	(21.79)	(5.38)	(8.35)
Passive ITA Exporters other than China[4]	0.058*	0.162*	0.245
	(2.41)	(2.22)	(1.58)
Observations	2477294	230386	262011
R^2	0.7964	0.8579	...
Adjusted R^2	0.7539	0.8392	...

Notes: Notes of Table 2 apply, including for [1], [3], and [4]. Regressions are based on all goods in the ITA product sample and all include country-pair-product category and time fixed effects. While the time fixed effects would be statistically rejected in favor of product-time fixed effects at the 0.1 percent level or higher by F-Statistics, Poisson estimation does not achieve convergence in the presence of the high dimensional product-time fixed effects.

[5] For these regressions the dataset is collapsed to the 7 broad ITA product categories described in Section 2. In addition, all countries are dropped which do not make up at least 0.25 per cent of either world imports or exports within at least one of these categories; this reduces the number of countries to 112 (from 235), while retaining more than 97 percent of global trade. This reduction in the dimensionality of the dataset is necessary in order to include zero trade flows, while still allowing the Poisson estimation to converge. In these regressions the Zero tariff variable, instead of being a 0-1 dummy, describes the fraction of product tariff lines within the category in which the tariff is zero. Thus, it takes values between 0 and 1.

We are, however, not overly concerned because the objective of these regressions is mainly to provide a benchmark for the analogue Poisson estimates (Regression 16). We indeed find that the general pattern of results remains similar in the Poisson regressions. Although absolute values of tariff reduction elasticities increase somewhat further and lead to changes in commitment effect coefficients for active signatories, we take confidence in the fact that including zeros does not change the pattern of results dramatically.[34]

7. Heterogeneity of ITA export commitment effects depending on country-specific determinants

This section illustrates that ITA commitment effects on exports can vary substantially depending on country circumstances. To quantify these country circumstances we focus on four determinants that are often mentioned in the global value chain literature as important for achieving GVC participation. They are geographical remoteness, education levels, the general business environment, and institutions. For remoteness, we devise a custom ITA-specific measure quantifying the distance from large ITA importers; this measure attributes greater weight to distances from those importers that import large quantities of ITA goods. For landlocked countries, we refine this measure further by including a multiplicative penalty obtained by dividing the countries' export costs per container by that of the most proximate coastal country. Education is proxied by secondary school completion rates (Prati et al., 2013). We use control of corruption (from the World Bank's World Governance Indicators) as a proxy for the overall business environment; Breen and Gillanders (2012) have shown these two variables to be highly correlated. Finally, institutions are proxied by the rule of law, taken from the same source.

We report here results on interactions of these determinants with the ITA export commitment effects for active and passive exporters. We add these interactions to a version of our Regression 2 excluding China's exports. We then combine the regression results and percentile values of determinants for passive signatories in the year 2010 to compute Table 5 presented here.[35] It illustrates for passive signatories that deviations are large from the baseline commitment effect on exports (of 0.165). This underscores that country circumstances play an important role in how much countries benefit from ITA membership. The results suggest that the most remote 25 percent of passive signatories did not benefit from a positive ITA commitment effect on exports, unless they managed to outweigh their remoteness by particularly favorable education levels, business environments or institutions. Likewise,

[34] In Table A6 of the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015, Appendix Table A6), we extend our robustness check for zero trade flows further, because we note that in Table 4 the number of observations increases by less than 15 percent from including zero trade flows. In this further analysis we drop the tariff as an explanatory variable because it is unavailable for many country pairs in years with zero trade flows. Again, when moving to the Poisson regression, the general pattern of results remains the same. The working paper version also reports two additional robustness checks of (i) constraining in the control sector regressions the tariff reduction and elimination effects to be the same for the ITA and control sectors and (ii) dropping the it and jt fixed effects in control sector regressions. The latter check confirms that time variation of multilateral resistance within countries is not very large in our sample. It thus strengthens our confidence in Regressions 1, 4, and 7 which are estimated on the simplified model of equation 6.

[35] See Table A7 in the working paper version (Henn and Gnutzmann-Mkrtchyan, 2015) for these regression results. There we also describe that interactions with layer 1-3 effects return intuitive results.

Table 5: Export commitment effect for passive ITA signatories in 2010, by percentile of interaction variable

Interaction Variable	Remoteness[1]	Education	Business environment	Rule of law
10th percentile	0.169***	0.005	-0.039	-0.088
25th percentile	0.159***	0.008	-0.010	-0.034
Median	0.126***	0.094**	0.044	0.018
75th percentile	-0.033	0.177***	0.163***	0.172***
90th percentile	-0.052	0.216***	0.284***	0.267***

Notes: *, **, *** denote 5, 1, 0.1 per cent significance levels obtained by the delta method based on robust standard errors clustered by country-pair-product combinations. The figures in the tables are computed from percentile-specific interaction variable values and coefficients for passive signatories as displayed in Henn and Gnutzmann-Mkrtchyan (2015, Appendix Table A7). For example, the 0.128 value for the 50th percentile in the "Remoteness" column is obtained by -0.0088+(-0.0472)*(-2.864), where -0.0088 is the passive ITA exporter dummy, -0.0472 is the coefficient on the interaction of this dummy with remoteness, and -2.864 is the median value of the remoteness variable.
[1] Remoteness to world ITA goods import markets.

we find that those countries with low education, unfavorable business environments or weak institutions struggled to reap export benefits from the ITA. These results are in line with the consensus of the GVC literature, which suggests that broad reforms are needed to create a favorable environment in which GVC participation can be achieved and deepened (see WTO (2014)).

8. Conclusion

We demonstrate that durable tariff elimination affects trade patterns through several layers. The magnitudes of these effects are sizable and the impact of tariff changes is non-linear. We focus on the WTO Information Technology Agreement (ITA) because it provides a unique opportunity to study complete, durable, and nondiscriminatory tariff elimination in a global value chain setting.

Using a large panel data set of product-level data, we can integrate tariffs directly into the analysis. We are able to first dissect three layers through which the ITA affects imports: tariff reduction, tariff elimination, and commitment effects related to higher trade policy certainty implied by binding commitments at the WTO. Moreover, we find that there is a fourth layer because commitment effects also affect exports, with investment and firm location/sourcing decisions likely playing an important role. Therefore we illustrate that import tariff elimination can help in developing export industries – an angle which gravity literature has thus far neglected. Commitment effects for exports are found to be most important for developing countries (our passive signatory group), where ITA accession has supported development of downstream export activities.

Our paper has implications, on the one hand, for gravity methodologies aiming to quantify trade agreements' impacts and, and on the other hand, for policy.

With regards to gravity methodology, tariff data should be integrated directly into the analysis. Doing so produces a wealth of new policy-relevant information by returning several layers of impacts. It shows that there is a premium to complete tariff elimination, especially for goods with high value chain integration potential, as suggested by the time in trade

literature. This layered structure also allows dummy variables of trade agreement membership to be interpreted as commitment effects. This is an important advantage compared to many traditional gravity studies of trade agreements, where a single membership dummy is introduced and captures the impact of a host of policy changes.

With regards to trade policy, we show that tariff elimination can cause considerable trade expansion, particularly if backed by strong commitments convincing agents of its durability. In instances where tariffs are already low, their elimination could return large trade benefits with only small fiscal revenue losses. Policymakers should bear in mind that there seem to be strong synergies between education, institutions, overall business environment and the gains from durable tariff elimination. Therefore, complementary reforms are often necessary to fully reap the benefits of durable tariff elimination. Finally, it would seem important to safeguard zero tariffs wherever they have been achieved.

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References

Anderson, J. E., Van Wincoop, E., 2003. Gravity with Gravitas: A Solution to the Border Puzzle. The American Economic Review 93 (1), 170–192.

Anderson, J. E., Yotov, Y. V., 2010a. Specialization: pro-and anti-globalizing, 1990-2002. Working Paper No. w16301, National Bureau of Economic Research.

Anderson, J. E., Yotov, Y. V., 2010b. The Changing Incidence of Geography. American Economic Review 100 (5), 2157–86.

Anderson, M., Mohs, J., 2010. The information technology agreement: An assessment of world trade in information technology products. Journal of International Commerce and Economics 3, 109–154.

Antras, P., Helpman, E., 2008. Contractual Frictions and Global Sourcing. In: Helpman, E., Verdier, T., Marin, D. (Eds.), The Organization of Firms in a Global Economy. Harvard University Press, Cambridge, MA.

Antràs, P., Staiger, R. W., 2012. Offshoring and the role of trade agreements. The American Economic Review 102 (7), 3140–3183.

Bagwell, K., Bown, C. P., Staiger, R. W., 2015. Is the WTO passé? Working Paper No. w21303, National Bureau of Economic Research.

Baier, S. L., Bergstrand, J. H., 2007. Do free trade agreements actually increase members' international trade? Journal of international Economics 71 (1), 72–95.

Baldwin, R., Taglioni, D., 2007. Trade effects of the euro: A comparison of estimators. Journal of Economic Integration 22 (4), 780–818.

Blyde, J., Graziano, A., Volpe Martincus, C., 2015. Economic integration agreements and production fragmentation: evidence on the extensive margin. Applied Economics Letters 22 (10), 835–842.

Bora, B., Liu, X., 2010. Evaluating the Impact of the WTO Information Agreement. In: Findlay, C., Pangestu, M., Parsons, D. (Eds.), Light the Lamp: Papers on World Trade and Investment in Memory of Bijit Bora. World Scientific.

Breen, M., Gillanders, R., 2012. Corruption, institutions and regulation. Economics of Governance 13 (3), 263–285.

Caliendo, L., Feenstra, R. C., Romalis, J., Taylor, A. M., December 2015. Tariff reductions, entry, and welfare: Theory and evidence for the last two decades. Working Paper No. 21768, National Bureau of Economic Research.

Clausing, K. A., 2001. Trade creation and trade diversion in the Canada–United States free trade agreement. Canadian Journal of Economics/Revue canadienne d'économique 34 (3), 677–696.

Djankov, S., Freund, C., Pham, C. S., 2010. Trading on time. The Review of Economics and Statistics 92 (1), 166–173.

Dreyer, I., Hindley, B., 2008. Trade in Information Technology Goods: Adapting the ITA to 21st Century Technological Change. Working Paper No. 06/2008, European Centre for International Political Economy.

Eicher, T. S., Henn, C., Papageorgiou, C., 2012. Trade creation and diversion revisited: Accounting for model uncertainty and natural trading partner effects. Journal of Applied Econometrics 27 (2), 296–321.

Feenstra, R. C., 2008. Offshoring in the global economy. The Ohlin Lectures, 17–18.

Freund, C., Pierola, M. D., 2015. Export superstars. Review of Economics and Statistics 97 (5), 1023–1032.

Gawande, K., Hoekman, B., Cui, Y., 2011. Determinants of trade policy responses to the 2008 financial crisis. World bank policy research working paper series.

Groppo, V., Piermartini, R., 2014. Trade policy uncertainty and the WTO. Working Paper No. ERSD-2014-23, World Trade Organization.

Grossman, G. M., Helpman, E., 1994. Protection for Sale. American Economic Review 84 (4), 833–850.

Handley, K., Limão, N., 2013. Policy Uncertainty, Trade and Welfare: Theory and Evidence for China and the US. Working Paper No. w19376, National Bureau of Economic Research.

Handley, K., Limão, N., 2015. Trade and investment under policy uncertainty: theory and firm evidence. American Economic Journal: Economic Policy 7 (4), 189–222.

Head, K., Mayer, T., 2014. Chapter 3 - Gravity Equations: Workhorse, Toolkit, and Cookbook. Vol. 4 of Handbook of International Economics. Elsevier, pp. 131 – 195.

Helpman, E., Melitz, M., Rubinstein, Y., 2008. Estimating trade flows: Trading partners and trading volumes. The Quarterly Journal of Economics 123 (2), 441–487.

Henn, C., Gnutzmann-Mkrtchyan, A., 2015. The layers of the IT Agreement's trade impact. Working Paper No. ERSD-2015-01, World Trade Organization.

Hummels, D. L., Schaur, G., 2013. Time as a trade barrier. The American Economic Review 103 (7), 2935–2959.

Joseph, K., Parayil, G., 2006. Trade liberalization and digital divide: An analysis of the Information Technology Agreement of WTO.

Kee, H. L., Nicita, A., Olarreaga, M., 2008. Import demand elasticities and trade distortions. The Review of Economics and Statistics 90 (4), 666–682.

Keller, W., Yeaple, S. R., 2013. The gravity of knowledge. The American Economic Review 103 (4), 1414–1444.

Lee, J.-W., Swagel, P., 1997. Trade barriers and trade flows across countries and industries. Review of Economics and Statistics 79 (3), 372–382.

Maggi, G., Rodrıguez-Clare, A., 2000. Import penetration and the politics of trade protection. Journal of International Economics 51 (2), 287–304.

Mann, C., Liu, X., 2009. The information technology agreement: sui generis or model stepping stone? In: Baldwin, R., Low, P. (Eds.), Multilateralizing Regionalism: Challenges for the Global Trading System. Cambridge, pp. 182–216.

Martincus, C. V., Carballo, J., Graziano, A., 2015. Customs. Journal of International Economics, 119–137.

Office of the Revenue Commissioners, 2013. A guide to customs import procedures. `http://www.revenue.ie/en/customs/leaflets/import-procedures-guide.pdf`.

Olivero, M. P., Yotov, Y. V., 2012. Dynamic gravity: endogenous country size and asset accumulation. Canadian Journal of Economics/Revue canadienne d'économique 45 (1), 64–92.

Orefice, G., Rocha, N., 2014. Deep integration and production networks: An empirical analysis. The World Economy 37 (1), 106–136.

Organization for Economic Cooperation and Development, 2003. A proposed classification of ICT goods.

Organization for Economic Cooperation and Development, 2011. OECD Guide to Measuring the Information Society.

Ornelas, E., Turner, J. L., 2008. Trade liberalization, outsourcing, and the hold-up problem. Journal of International Economics 74 (1), 225–241.

Osnago, A., Piermartini, R., Rocha, N., 2015. Trade policy uncertainty as barrier to trade. Working Paper No. 2015-05, World Trade Organization.

Osnago, A., Rocha, N., Ruta, M., 2016. Do Deep Trade Agreements Boost Vertical FDI? The World Bank Economic Review.

Portugal-Perez, A., Reyes, J.-D., Wilson, J. S., 2010. Beyond the Information Technology Agreement: Harmonisation of Standards and Trade in Electronics. The World Economy 33 (12), 1870–1897.

Prati, A., Onorato, M. G., Papageorgiou, C., 2013. Which Reforms Work and under What Institutional Environment? Evidence from a New Data Set on Structural Reforms. Review of Economics and Statistics 95 (3), 946–968.

Rose, A. K., 2004. Do WTO members have more liberal trade policy? Journal of international Economics 63 (2), 209–235.

Senhadji, A., 1998. Time-Series Estimation of Structural Import Demand Equations: A Cross-Country Analysis. IMF Staff Papers 45 (2), 236–268.

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

Sturgeon, T. J., Memedovic, O., 2010. Mapping global value chains: Intermediate goods trade and structural change in the world economy. Working Paper No. 05/2010, United Nations Industrial Development Organization.

Tang, M.-K., Wei, S.-J., 2009. The value of making commitments externally: evidence from WTO accessions. Journal of International Economics 78 (2), 216–229.

Tokarick, S., 2014. A method for calculating export supply and import demand elasticities. The Journal of International Trade & Economic Development (ahead-of-print), 1–29.

Trefler, D., 1993. Trade liberalization and the theory of endogenous protection: an econometric study of US import policy. Journal of Political Economy, 138–160.

Wiese, R., Grant, L., Smyth, F., 2014. Zero duty does not equal zero risk. `http://www.hunthunt.com.au/SiteMedia/W3SVC1265/Uploads/Documents/CGT%2014-09-16.pdf`, accessed on 16/11/2016.

World Trade Organization (WTO), 2012. 15 Years of the Information Technology Agreement. Report, World Trade Organization.

World Trade Organization (WTO), 2014. World Trade Report 2014 – Trade and Development: Recent Trends and the Role of the WTO. Report, World Trade Organization.

Yeats, A. J., 2001. Just how big is global production sharing. In: in S. Arndt and H. Kierzkowski (eds), Fragmentation: New Production Patterns in the World.

Yi, K.-M., 2003. Can vertical specialization explain the growth of world trade? Journal of Political Economy 111 (1), 52–102.