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On PTAs and Bilateral Trade: Is GVC Trade Sensitive to the Breadth of Trade Policy Cooperation?

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Abstract: We study the relationship between the scope of trade policy cooperation and bilateral trade flows with a particular focus on global value chain (GVC) trade using data on the core and non-core provisions included in preferential trade agreements (PTAs). We find that broader PTAs have a larger impact on trade flows involving intermediates relative to flows involving all products, suggesting that GVC trade is particularly sensitive to the scope of trade policy cooperation. We also investigate different dimensions of heterogeneity in PTAs. We find that core provisions tend to drive the effect of PTAs on the level of GVC trade and that PTAs are particularly effective in raising the level of GVC trade between developing economies. We explore these issues using a sample of 189 countries over the period 1990–2015, with data obtained from the latest release of the EORA multi-regional input–output tables and UN-COMTRADE data.

Keywords: PTAs; PTA breadth; horizontal depth; GVCs; structural gravity model

JEL Classification: F10; F14; F15; F63

1. Introduction

Preferential trade agreements (PTAs) are increasingly common between countries. PTAs are international treaties with restrictive membership, which include any article that applies only to its members and that aims at securing or increasing their respective market access. The share of world trade accounted for by trade between PTA members increased from 22% in 1965 to 60% in 2015 (Limão 2016). The membership of PTAs has also expanded. Countries that are engaged in preferential liberalisation include both developed and developing countries, with north–south PTAs becoming increasingly common (Cheong et al. 2015). The stalemate in the process of multilateral liberalisation since the conclusion of the Uruguay Round in 1994 is often considered an important driver behind the rise of PTAs (Baccini 2019). In the absence of prospects for multilateral liberalisation, PTAs have become the main tool for countries to liberalise their trade—almost by default (Falvey and Foster-McGregor 2019).

Perhaps more remarkable than the sheer number of PTAs having come into force in recent years is the growing array of domestic policy domains that PTAs have come to regulate (Baccini 2019). Not only do PTAs reduce tariffs. They also increasingly regulate 'behind the border' issues such as investment, intellectual property rights (IPRs), and competition policies. The average PTA now covers approximately 23 domestic policy domains, the result of a trend toward deeper cross-country integration that is reshaping the governance of international trade. In this paper, we ask whether the trend toward broader trade policy cooperation has facilitated the rise of global value chains (GVCs), another key development in the organisation of international trade over the course of the past two decades.

We estimate the relationship between the level of bilateral GVC trade and the breadth of trade policy cooperation between PTA partners for a panel of 189 countries over the period 1990–2015 using

a structural gravity model with fixed effects. We measure bilateral GVC trade in two different ways, relying on gross and value-added trade data derived, respectively, from the UN-COMTRADE and EORA datasets. We start by asking whether bilateral GVC trade is particularly sensitive to the breadth of trade policy cooperation relative to total trade. Economic theory suggests that this should be the case because the contractual imperfections affecting the organisation of cross-border production are easier to address when trade partners commit to a broad scope of integration in domestic policy (Antràs and Staiger 2012; Bickwit et al. 2018). We find that the breadth of trade policy cooperation does have an important effect on the level of GVC trade and that this effect is indeed larger than the effect on total trade flows.

Our findings also highlight the significance of the 18 'core' provisions identified by Hofmann et al. (2019) in driving the relationship between the breadth of trade policy cooperation and the level of bilateral GVC flows between trading partners. We find that each additional 'core' provision contained in PTAs tends to increase value added trade between two countries by 0.3 percentage points and trade in parts and components by 0.5 percentage points. When introducing our breadth variable in quadratic form, we find that the relationship between the scope of trade policy cooperation and the level of GVC trade appears to be hump-shaped, suggesting that there might be a threshold above which the returns to the inclusion of additional PTA provisions tend to decrease. Finally, we also investigate the heterogeneity that arises due to differences in the income levels of PTA signatories. Our results suggest that PTAs are particularly relevant in increasing the level of trade between developing economies, possibly because prior liberalisation trends have proceeded more slowly in these contexts.

Our focus on GVC trade flows makes our work similar to Laget et al. (2018) and Boffa et al. (2019). Similar to Laget et al. (2018), we use trade data in both value-added and gross form to provide as complete a picture of GVC trade as possible. We follow Boffa et al. (2019), however, in drawing from the EORA multi-regional input–output (MRIO) data to derive our variables for trade in value added, as these offer greater country coverage (Lenzen et al. 2013). Our paper differs from these studies primarily in that we place greater emphasis on the different impact that the scope of trade policy cooperation has on GVC trade relative to all trade.

The remainder of this paper is organised as follows. Section 2 provides a brief description of the evolution of empirical and theoretical work around PTAs. Section 3 outlines our empirical strategy and describes the data, providing information on the heterogeneity of PTAs. Section 4 presents and discusses our results. Section 5 concludes the paper.

2. Related Literature

A large body of empirical literature has emerged to study the relationship between PTAs and bilateral trade flows. Much of this literature employs some variant of the gravity model, interpreted as a reduced-form equation which can be generated by a range of models explaining bilateral trade flows. One early approach consisted of including a dummy variable in the gravity equation indicating whether or not a bilateral trade flow was covered by a PTA, with the estimated coefficient on this dummy being interpreted as indicating the average effect of a PTA. While this literature does find positive effects of PTAs on trade flows, it also finds significant heterogeneity in the outcomes (Cipollina and Salvatici 2010; Baier and Bergstrand 2009; Eicher and Henn 2011; Cheong et al. 2015). Recent work argues that to understand differences in the impact of trade agreements upon trade flows, one should look at the heterogeneity existing among PTAs (Limão 2016; Falvey and Foster-McGregor 2018; Baier et al. 2019). Our paper fits within this call.

One source of heterogeneity is related to the scope of trade policy cooperation between PTA partners. Limão (2016) suggests that there may be two dimensions to consider when studying the extent to which an agreement increases market access: the 'depth' of PTAs and their 'breadth'. In principle, the former reflects a quantifiable change in the intensity of trade policy cooperation between two partners. Yet, while in some areas, such as tariffs, the extent to which an agreement is deeper is easily apparent—the lower a tariff, the deeper an agreement—other trade policy areas tend to defy

measurement. When it comes to non-tariff barriers to trade, for instance, a qualitative understanding of depth becomes more important. Countries that harmonise or mutually recognise each other's product standards, for instance, may be said to have a deeper PTA relative to PTAs that shy away from addressing standards—even though it is not always easy to say by 'how much'.

The breadth of trade policy cooperation, by contrast, reflects the span of PTAs across different types of markets. A broader PTA is one where partners seek to increase market access not only in product markets, but also in markets for capital, labour, and technology (Limão 2016). Distinguishing between these two dimensions is not straightforward. We follow recent empirical studies and focus on the measures of breadth, or 'horizontal' depth made available by Hofmann et al. (2017, 2019). These measures typically consist of a count of the provisions covered by a PTA and can focus either on the 18 'core' provisions identified in Hofmann et al. (2019) or on all provisions that a PTA might possibly include. Tables A1 and A2 provide an overview of core and non-core provisions.

The scope of trade policy cooperation is potentially relevant for trade flows within GVCs. Theory highlights the relevance of contractual imperfections arising from suppliers having to customise inputs to meet their buyers' requirements (Nunn 2007; Antràs and Chor 2013). While value chain partners may develop 'sticky' relationships as a response to contractual frictions (Antràs and Chor 2013)—an observation corroborated by a large case study literature (Ponte et al. 2019)—trade policy can also contribute to mitigate these failures. Antràs and Staiger (2012) develop a model where incomplete contracts result in under-investment and a decrease in cross-border trade, which can only be addressed by a commitment to 'deep integration' in domestic policy areas going beyond market access. Bickwit et al. (2018) also consider contractual frictions, and suggest that broader PTAs—those including, for instance, clauses on the protection of IPR—boost bilateral intermediate trade by enhancing the effective level of investment protection for MNCs and their suppliers.

Incomplete contracts over trade in intermediate inputs magnify the need for trading partners to commit to improving their institutions while also enhancing coordination in a wide range of domestic policies (Levchenko 2007; Antràs and Staiger 2012). More broadly, however, GVC operations hinge on the availability of services—such as logistics and distribution—and on the possibility to move capital, workers, and technology across borders, requiring a degree of policy coordination which goes significantly beyond tariff reductions (Baldwin 2012). Trade agreements which seek not only to eliminate tariff and non-tariff barriers to trade but also to broaden the scope of trade policy cooperation to other issues may therefore facilitate countries' integration into GVCs by disciplining a range of policies—including investment policy, IPR protection, or competition policy—that are needed to reduce contractual uncertainties between value chain partners (Antràs and Staiger 2012; Bickwit et al. 2018) and to improve the viability and efficiency of firms active in GVCs (Baldwin 2012).

3. Methodology and Data

We are interested in estimating the effects of trade policy agreements, and their scope, on the level of bilateral GVC trade. Our point of departure for estimating these effects is a structural gravity equation with fixed effects. Gravity equations are premised on the idea that bilateral trade flows are related to the economic size of the two trading partners, and inversely related to trade barriers between them—usually proxied by distance. Structural gravity models qualify this view by introducing the idea of multilateral resistance. In structural gravity models, bilateral trade flows do depend on bilateral trade costs, but only relative to the average barrier of the two regions to trade with all their partners—their multilateral resistance—rather than to absolute trade barriers (Anderson and Wincoop 2003; Baier and Bergstrand 2007). Our baseline estimating equation is

$$lnGVCtrade_{ijt} = \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \beta_1 PTAscope_{ijt} + \varepsilon_{ijt} \quad (1)$$

where *GVCtrade* is a measure of GVC mediated value-added trade (or trade in intermediates) between country i and j at time t, and *PTAscope* captures the scope of trade policy cooperation between the

two countries. These variables are described further below. The terms α_{ij}, α_{it}, and α_{jt} represent country-pair, exporter-time, and importer-time fixed effects, respectively. These three terms control for potential endogeneity of the PTA variable. Self-selection into PTAs provides one source of endogeneity (Baier and Bergstrand 2007), with country-pairs with existing large bilateral trade flows more likely to join in a PTA. In addition, the latter two terms control for multilateral resistance, that is, the observation that bilateral trade costs depend on bilateral barriers to trade and also on trade costs across all possible export and import destinations.

The use of fixed effects in structural gravity equations also addresses concerns raised by recent work on the gravity model which suggests that, in a context of value-added rather than gross trade, the mass variables risk being incorrectly specified (Baldwin and Taglioni 2011). The gravity model typically employs the GDPs of destination and origin countries to proxy for, respectively, import demand and supply capacity. With the rise of intermediate trade, however, these proxies no longer fully reflect economic reality: a country's demand for parts and components increasingly derives from its gross production rather than from its value-added in production. Using GDP as a proxy for economic mass is therefore more appropriate in a world where consumer goods trade dominates. To the extent that structural gravity models use fixed effects to control for the mass variables, however, these considerations need not apply (Baldwin and Taglioni 2011).

We are particularly interested in two dimensions of the relationship between PTAs and GVC trade. First, we aim to understand whether there are differences in the sensitivity to increases in the scope of trade policy cooperation when we isolate trade flows that involve production sharing across borders (and that are therefore associated with GVCs) from 'all' trade flows. Second, we are interested in estimating the relative impact of different dimensions of PTA breadth on GVC trade. In Section 3, we start by estimating our baseline model using data on 'all' trade and on GVC trade, respectively, as dependent variables, and compare the results. We then extend our model by disaggregating our PTA variables along different dimensions, and by including interaction terms to capture differences in the effect of PTAs across income groups.

3.1. Measuring the Scope of Trade Policy Cooperation

To measure the scope of trade policy cooperation, we build on a novel World Bank database covering the PTAs currently in force and notified to the World Trade Organization (WTO) up to the end of 2015 (Hofmann et al. 2017). As a first measure, we use the count of legally enforceable provisions that are included in an agreement, as reported in the World Bank database. We define this as $Total\ breadth_{ijt} = \sum_{k=1}^{52} Provisions_{ijt}^{k}$. As a second measure of breadth, we use the count of 'core' provisions, applying both at and behind the border, defined as $Core\ breadth_{ijt} = \sum_{c=1}^{18} Provisions_{ijt}^{c}$. This is the approach employed by both Falvey and Foster-McGregor (2018, 2019) and Laget et al. (2018). Following these studies, we also implement a principal component analysis (PCA) to define an additional measure of breadth. This can be thought of as a weighted average of provisions, with the loadings associated to each variable of the first component as weights. We define this variable as $PCA\ depth_{ijt} = \sum_{k=1}^{52} \omega_k Provisions_{ijt}^{k}$, where ω_k represents the weights.[1]

Table 1 provides summary statistics for our variables capturing the scope of trade policy cooperation between countries. The summary statistics below refer only to the sub-sample of country pairs that do have a PTA in force. Of the total and 'core' number of provisions which are typically included in a PTA, the average trade agreement in our database contains, respectively, 23 and 12 provisions. More generally, it appears that on average it is more likely for PTAs to include a higher number of

[1] The first component accounts for approximately 55% of the variation in our data.

'core' and WTO+ provisions than 'non-core' and WTO-X provisions. The same applies to provisions applying at the border, relative to provisions applying behind the border. The broadest PTA in our data contains a total of 48 provisions.

Table 1. Heterogeneous preferential trade agreements (PTAs): summary statistics.

Variable	obs	Mean	sd	Min	Max
Core breadth	68,514	12.557	4.893	1	18
Total breadth	68,514	23.289	12.011	1	48
PCA Depth (18)	68,514	12.252	5.457	−0.307	18.816
PCA Depth (52)	68,514	16.750	9.851	−7.104	37.945
WTO +	68,514	10.032	3.715	1	14
WTO-X	68,514	13.256	9.398	0	35
At the border	68,514	8.273	2.696	1	11
Behind the border	68,514	4.093	2.528	0	7
Intra-regional	68,514	6.802	4.663	0	1
Inter-regional	68,514	3.197	4.663	0	1
North–north	68,514	3.168	4.652	0	1
South–north	68,514	1.795	3.838	0	1
South–south	68,514	5.035	4.999	0	1

Table 1 also reports information on the geographical coverage of PTAs in our dataset. Approximately 68% of trade agreements in our data have been signed between country pairs or groups of countries belonging to the same region.[2] The remaining 32% of PTAs regulate trade between country pairs belonging to different regions. Additionally, it is worth noting that over half of the agreements in our data are between developing economies. PTAs between countries in the global North account for a little over 30% of agreements in our data, while those between industrialised and developing economies constitute around 18 percent of the total.

There are significant differences between these different types of PTAs in terms of breadth. Table 2 above provides summary statistics for our core breadth variable across the different categories of PTAs in our data. Trade agreements signed between industrialised economies tend to be broader, on average, than PTAs involving developing economies.[3] The average north–north PTA contains 15 provisions, whereas a PTA between developing economies includes, on average, approximately 11 provisions. A similar pattern emerges with regard to trade agreements between partners belonging to different regions. Relative to intra-regional PTAs, inter-regional agreements include, on average, a larger number of provisions. Section 3 investigates some of these differences empirically.

Table 2. Core breadth across heterogeneous PTAs: summary statistics.

Variable	obs	Mean	sd	Min	Max
North–north	21,710	15.344	3.933	1	18
South–north	12,305	12.486	4.931	1	18
South–south	34,499	10.727	4.612	1	18
Intra-regional	46,604	11.850	5.295	1	18
Inter-regional	21,910	14.061	3.452	1	18

[2] We define regions in line with the World Bank classification. These reflect broad geographical areas, such as East Asia and the Pacific, or North America.

[3] In the 'north' category, we include economies that are classified as high-income by the World Bank. The 'south' category includes all economies that the World Bank classifies as low- or middle-income.

3.2. Measuring GVC Trade

We use data from different sources to measure bilateral GVC trade. We first use the EORA multiregional input-output (MRIO) tables to gather data on gross final exports and on the export of intermediates. Since intermediate exports are closely associated with trade in GVCs (Johnson and Noguera 2012), we take this as a first indicator of GVC trade flows. We then construct two value-added measures of GVC trade, building upon the work of Koopman et al. (2014). The first is domestic value-added embodied in the final demand of a country's trade partners, or *DVX*. This measures the exports of intermediates that are used as inputs in the production of final goods by other countries, and thus captures the extent of a country's forward participation in GVCs. The second is foreign value added embodied in a country's own final demand (*FVA*). Since this term captures imported intermediates that are then used to produce final goods domestically, it is a measure of backward GVC participation. In what follows, we describe the construction of these measures in further detail.

The calculation of foreign value added in trade requires an MRIO table, which builds on national input–output tables by breaking down the use of products by origin. The rows in an MRIO table indicate the use of gross output from a particular industry in a particular country and comprise two main components. The first is intermediate use, which provides information on intermediate use by both domestic industries and industries in other countries. The second is information on final demand, which is again split between demand for final goods from both domestic and foreign sources. The columns of the MRIO table provide information on the amounts of intermediates needed for the production of gross output. The column sum thus gives the sum of the domestic and foreign production of intermediates that are used in the production of output in a particular industry and country. Combining this sum with the sum of value added generated in each industry and country gives the value of gross output. The information given by an MRIO table can be translated into a standard input–output matrix form by stacking all industries and countries, such that we have $(i \times s)$ rows and columns, with i being the number of countries and s the number of industries. Gross output can then be expressed as

$$x = Z + y$$

$$x = Ax + y$$

$$(I - A)x = y$$

$$x = (I - A)^{-1}y = Ly$$

with x being gross output, Z intermediate demand, y final demand, I the identity matrix, A the technological coefficient matrix (i.e., the ratio of intermediate use to gross output by intermediate) and L the Leontief inverse. Our indicators of trade in value added can then be calculated as

$$\begin{pmatrix} T_v^{11} & \dots & T_v^{1i} \\ \vdots & \ddots & \vdots \\ T_v^{i1} & \dots & T_v^{ii} \end{pmatrix} = \begin{pmatrix} v^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & v^i \end{pmatrix} \begin{pmatrix} L^{11} & \dots & L^{1i} \\ \vdots & \ddots & \vdots \\ L^{i1} & \dots & L^{ii} \end{pmatrix} \begin{pmatrix} y^1 & 0 & 0 \\ 0 & \ddots & 0 \\ 0 & 0 & y^i \end{pmatrix}$$

with v^i an $s \times 1$ (diagonalized) row vector giving the value added per unit of output for each industry in country i, L^{ii} the $s \times s$ Leontief inverse for country i, and y^i the $s \times 1$ (diagonalized) row vector of final demand for each industry in country i. The first column of the trade-in value-added matrix describes the value added contained in the final demand of country 1 and can be split into a domestic and foreign component. The term T_v^{11} gives the domestic value-added content of final demand. The term T_v^{j1} $(j \neq 1)$ gives the foreign value-added content of final demand of country 1 generated by country j, which provides a bilateral variable capturing backward GVC participation. An analogous interpretation holds for all other columns.

The trade-in value-added matrix can also be used to obtain information on the domestic value added that enters as an intermediate input in the final demand of other countries. This is found by looking at the rows (rather than the columns) of the T_v matrix. The term T_v^{12}, for example, which can be written as $T_v^{12} = v^1 L^{12} y^2$, indicates the value of country 2's finale demand that depends on value added from country 1, which can be used as a bilateral indicator of forward GVC participation.

Our variables of interest—the presence and the horizontal depth of a preferential trade agreement between two countries—are the same for any given pair of country *i* and country *j*, because if country *i* has signed a PTA with country *j*, the reverse is also true. Since our value-added indicators of GVC participation are extracted from the same input–output matrix of cross-country intermediate flows, the results from estimating a regression model with either *DVX* or *FVA* as the dependent variable would be identical for country *i* and country *j*. To overcome this issue, in our analysis, we construct an aggregate variable by taking the sum of these two indicators: *GV C trade* = *DVX* + *FVA*. This allows us to capture the level of GVC trade at the bilateral level in a way that is as complete as possible, as it includes both backward and forward GVC participation.

The EORA input–output tables have the distinct advantage of offering very wide country coverage when compared with other input-output databases: our sample includes 189 economies over the 1990–2015 period. EORA also has an important disadvantage, however. Data for countries where national input–output tables are not available are imputed from countries with similar economic characteristics. Moreover, EORA data only allows for a distinction between final and intermediate flows—not between different types of intermediates. We therefore complement EORA data with mirror data from UN-COMTRADE. We construct mirror flows by using imports into the partner country to measure exports from the reporter. When the mirror flow is not available, we use the raw export data instead. To proxy for GVC trade, we start by focusing on trade in intermediates. We then identify those trade flows involving parts and components. These are categories 42 and 53 of the broad economic classification (BEC). Table 3 reports summary statistics on our GVC variables.

Table 3. Trade and global value chain (GVC) trade: summary statistics.

Variable	obs	Mean	sd	Min	Max	Source
Final exports (logs)	909,048	5.799	2.947	−5.637	19.132	EORA
Intermediate exports (logs)	922,060	6.984	2.561	−4.138	19.715	EORA
GVC trade (logs)	919,206	7.774	2.753	−6.098	19.831	EORA
Gross exports (logs)	403,640	8.128	3.726	0	19.856	UN-COMTRADE
Parts & components (logs)	269,552	6.374	3.510	0	18.439	UN-COMTRADE

4. Results and Discussion

4.1. Is GVC Trade Sensitive to PTAs?

Table 4 reports results from estimating equation (1) on two separate dependent variables constructed using EORA data. These capture, respectively, total bilateral exports—in columns (1) to (3)—and intermediate exports—columns (4) to (6)—between country *i* and country *j*. All coefficients for our trade policy variables are positive and significant, suggesting that PTAs, and their scope, affect both trade in final goods and trade in intermediates only. Signing a PTA appears to increase the level of exports in intermediate goods by over six percentage points on average. Moreover, each additional 'core' provision is associated with an increase in intermediate exports of 0.4 percentage points.

Results from estimating Equation (1) on total gross bilateral trade flows from UN-COMTRADE are reported in Table 5. Coefficients for our trade policy variables are positive and significant. Signing a PTA is associated, on average, with an increase in the level of gross trade of approximately 4 percentage points and with an increase in the bilateral flow of parts and components of over 7 percentage points. Each additional 'core' provision increases the level of gross and intermediate exports by, respectively, 0.3 and 0.5 percentage points. These findings suggest that bilateral trade in intermediate products

appears to be more sensitive to the scope of PTAs than 'all' trade flows. Overall, results reported in Tables 4 and 5 are qualitatively similar. Coefficients for our PTA and breadth variables tend to be larger when considering intermediate exports relative to total export flows, suggesting that GVC trade may be particularly sensitive to the scope of trade policy cooperation.[4]

Table 4. PTAs and final vs. intermediate exports (EORA).

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Final Exports (Logs)	Final Exports (Logs)	Final Exports (Logs)	Intermediate Exports (Logs)	Intermediate Exports (Logs)	Intermediate Exports (Logs)
PTA	0.0544 ***			0.0631 ***		
	(0.00513)			(0.00400)		
Core breadth		0.00339 ***			0.00427 ***	
		(0.000341)			(0.000253)	
Total breadth			0.00147 ***			0.00202 ***
			(0.000169)			(0.000128)
Observations	909,029	909,029	909,029	922,060	922,060	922,060
R-squared	0.994	0.994	0.994	0.994	0.994	0.994
Country-pair FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. PTAs and total trade vs. trade in parts and components (UN-COMTRADE).

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Gross Exports (Logs)	Gross Exports (Logs)	Gross Exports (Logs)	Parts and Components (Logs)	Parts and Components (Logs)	Parts and Components (Logs)
PTA	0.0382 **			0.0714 ***		
	(0.0192)			(0.0219)		
Core breadth		0.00273 **			0.00488 ***	
		(0.00129)			(0.00148)	
Total breadth			0.00175 ***			0.00269 ***
			(0.000645)			(0.000761)
Observations	402,392	402,392	402,392	266,885	266,885	266,885
R-squared	0.900	0.900	0.900	0.900	0.900	0.900
Country-pair FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Finally, Table 6 reports results from estimating Equation (1) on our aggregate measure of GVC trade derived from EORA. Entering into a PTA is associated with an increase in bilateral value-added trade of approximately four percentage points. Moreover, each additional 'core' provision appears to increase the domestic and foreign value added embodied in exports between countries i and j by close to 0.2 percentage points. The addition of any other additional provision, whether 'core' or not, is also positively and significantly associated with GVC trade. Columns (4) and (5) report results from using our PCA variables. Coefficients are similar to our count variables, suggesting that the latter are to a large extent able to capture these two dimensions of horizontal depth. Column (6) reports results from including our 'core breadth' in quadratic form. The negative and significant coefficient suggests that the relationship between the scope of trade policy cooperation and the level of GVC trade may be hump-shaped. The estimated turning point is at a value of around 9.8 provisions, a number not dissimilar to results found by Falvey and Foster-McGregor (2018).

[4] Table A3 reports results from estimating our model with a PPML estimator on the full sample—including zero observations—of gross total and intermediate flows. Coefficients on our PTA and core breadth variables are often found to be insignificant when we include country-pair fixed effects. We speculate that these differences may be due to the fact that the inclusion of country-pair fixed effects removes the impact of any PTA signed before 1995—the first year for which we have data on gross export flows in our sample. PTAs signed before 1995 include NAFTA, MERCOSUR, EFTA, etc.

Table 6. The scope of PTAs and GVC-mediated trade (EORA).

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	GVC Trade (Logs)	GVC Trade (Logs)	GVC Trade (Logs)	GVC Trade (Logs)	GVC Trade (Logs)	GVC Trade (Logs)
PTA	0.0406 ***					
	(0.00313)					
Core breadth		0.00185 ***				0.00871 ***
		(0.000196)				(0.00112)
Total breadth			0.000893 ***			
			(0.0000997)			
PCA Depth (18)				0.00174 ***		
				(0.000183)		
PCA Depth (52)					0.00111 ***	
					(0.000127)	
Core breadth^2						−0.000443 ***
						(0.0000688)
Observations	919,204	919,204	919,204	919,204	919,204	919,204
R-squared	0.995	0.995	0.995	0.995	0.995	0.995
Country-pair FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Our results are comparable to the results reported by Laget et al. (2018) and Boffa et al. (2019)—the two studies which are most closely related to ours. Focusing on EORA data for the period 1995–2014, Boffa et al. (2019) find that signing a PTA increases bilateral value-added trade by between 0.8 and 2.8 percentage points depending on the measure of GVC trade they employ. Using WIOD data for the same time period, Laget et al. (2018) find that the effect on GVC trade is stronger when considering 'core' relative to non-core provisions. They report that each additional 'core' provision increases bilateral value-added trade by between 0.5 and 0.8 percentage points, depending on the measure of GVC trade. Moreover, they generally find that the effect of PTA breadth is stronger for value added embodied in intermediate compared with value added embodied in final exports (Laget et al. 2018).

Our results also corroborate the insights of theoretical literature. While on average both GVC and total trade appear to be sensitive to the entry into force of a PTA, results reported in Tables 4 and 5 provide evidence that the former is particularly sensitive to the scope of trade policy cooperation between countries relative to total trade. In addition, results reported in Tables 4–6 point to the relevance of the 'core' dimensions of PTA breadth, ranging from the elimination of tariffs and technical barriers to trade to provisions that characterise 'deeper' forms of integration, such as IPR protection and capital movement liberalisation.

4.2. The Scope of PTAs and the Level of Development

We now explore whether the results reported in Section 3.1 vary across income levels. The scope of PTAs varies significantly across trading relationships between different income groups, with trade agreements between partners based in industrialised economies being, on average, broader relative to south–south PTAs (Table 2). Moreover, the very reason for signing a PTA in the first place could be different depending on what countries are involved and on the level of liberalisation that has already been achieved (Laget et al. 2018). These considerations suggest that the effects of PTAs may not only be heterogeneous with respect to the number and type of provisions which are typically included in a PTA, but also with respect to the income level of its signatories.

Table 7 report results from estimating Equation (1) on the level of bilateral GVC trade, for three mutually exclusive groups: north–north, south–north, and south–south trading relationships. Columns (1) to (3) report results with the dependent variable measured in terms of value-added trade from EORA, whereas columns (4) to (6) employ gross trade flows in parts and components from UN-COMTRADE

data as the dependent variable. We find that the impact of changes in the scope of trade policy cooperation does tend to vary across income levels.

Table 7. The scope of PTAs and the level of development.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	GVC Trade (Logs)	GVC Trade (Logs)	GVC Trade (Logs)	Parts & Comp. (Logs)	Parts & Comp. (Logs)	Parts & Comp. (Logs)
PTA * north–north	0.0179 ***			0.142 ***		
	(0.00404)			(0.0372)		
PTA * north–south	0.00586			−0.118 ***		
	(0.00490)			(0.0447)		
PTA * south–south	0.0729 ***			−0.0236		
	(0.00893)			(0.0690)		
Core breadth * north–north		0.00102 ***			0.00881 ***	
		(0.000239)			(0.00229)	
Core breadth * north–south		0.000360			−0.00767 ***	
		(0.000304)			(0.00286)	
Core breadth * south–south		0.00366 ***			0.00240	
		(0.000685)			(0.00506)	
Total breadth * north–north			0.000464 ***			0.00536 ***
			(0.000119)			(0.00118)
Total breadth * north–south			0.000293 *			−0.00454 ***
			(0.000164)			(0.00146)
Total breadth * south–south			0.00177 ***			−0.000305
			(0.000299)			(0.00315)
Observations	919,204	919,204	919,204	266,885	266,885	266,885
R-squared	0.995	0.995	0.995	0.900	0.900	0.900
Country-pair FE	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results reported in Table 7 suggest that, when considering value-added measures of GVC trade flows, the magnitude of the effect of an increase in the scope of trade policy cooperation on the level of bilateral trade is larger when both trading partners are developing economies. Each additional 'core' provision, for instance, raises the level of south–south value-added GVC trade by 0.36 percentage points—a three- and ten-fold greater magnitude than for north–north and north–south trading relationships, respectively. Yet when considering gross trade flows in parts and components, it is north–north trading relationships which appear to be particularly sensitive to the scope of PTAs.

These findings may have two plausible explanations. The first has to do with the level of liberalisation between trading partners prior to the entry in force of a PTA. Barriers to trade tend to be lower among industrialised economies than among developing economies. As a result, south–south trade flows may be more sensitive to trade liberalisation because tariffs and other barriers to trade are still, on average, relatively high between developing economies. By contrast, for industrialised economies who already achieved a significant degree of trade liberalisation, a further movement toward liberalisation may not yield as significant an effect. This is the reasoning in Laget et al. (2018), who find similar results.

That the level of bilateral trade in parts and components should be more sensitive to the scope of trade agreements when all trading partners are industrialised economies relative to the other trading relationships may have to do with the underlying nature of these trade flows. Parts and components flows may reflect trade in intermediate inputs that are characterised by a higher-than average degree of customisation—a characteristic which sectoral, value-added measures deriving from input–output tables do not necessarily capture. To the extent that these flows do include complex or customised goods, they might be more sensitive to PTAs covering trading relationships that are more intensive in

the exchange of these goods, such as trading relationships between industrialised economies where intra-industry trade in high-technology industrial sectors is more prevalent than in the Global South.

4.3. The Effects of PTAs Over Time

Finally, we consider whether the effects of trade agreements on the level of bilateral GVC trade change over time. The majority of PTAs is negotiated over a considerable period of time and, once signed, allow for a five- to 10-year phase-in period (Baccini 2019). During this period, different provisions tend to take effect at different times. While a long negotiation period may allow for some changes to be anticipated, leading to significant effects on trade in the same year that a PTA comes into force, the phasing-in of some provisions implies that not all the effects need to be contemporaneous (Falvey and Foster-McGregor 2019).

Table 8 reports results from including lagged PTA and PTA breadth variables to our analysis. We allow the explanatory variables to have three temporal effects—a contemporaneous effect at time t, an additional effect at time $t + 5$, and a further, decadal effect at time $t + 10$. Our results on the dynamic effects of PTAs are mixed. We find that PTAs do appear to have significant short run effects both when considering value-added and gross trade flows. These may reflect an anticipation effect. PTAs also seem to have positive and significant effects over the longer run, particularly five years after the entry in force of an agreement.

Table 8. The dynamic effects of PTAs on GVC trade, EORA, and UN-COMTRADE.

Variable	**(1)**	**(2)**	**(3)**	**(4)**
	GVC Trade (Logs)	**GVC Trade (Logs)**	**Parts and Comp. (Logs)**	**Parts and Comp. (Logs)**
PTA	0.0347 ***		0.0544 **	
	(0.00295)		(0.0213)	
PTA (five-year lag)	0.0107 ***		0.0637 ***	
	(0.00253)		(0.0216)	
PTA (10-year lag)	0.0120 ***		0.0173	
	(0.00406)		(0.0241)	
Core breadth		0.00188 ***		0.00409 ***
		(0.000193)		(0.00143)
Core breadth (five-year lag)		−0.00000393		0.00276 *
		(0.000176)		(0.00144)
Core breadth (10-year lag)		−0.000382		−0.000803
		(0.000308)		(0.00166)
Observations	919,204	919,204	266,885	266,885
R-squared	0.995	0.995	0.900	0.900
Country-pair FE	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

By contrast, our lagged variables for PTA breadth—coefficients for which are reported in columns (2) and (4)—are either weakly positive or negative and not significant, depending on the definition of GVC trade which we employ. Our results suggest that, when considering the scope of trade agreements as opposed to trade agreements per se, phasing-in effects do not have as marked an impact on the level of bilateral GVC trade. Since these are count measures of breadth, our results may also be driven by differences in the long-run effect of different types of 'core' provisions, as these need not be a homogenous group.

5. Concluding Remarks

This paper contributes to the literature on the effects of heterogeneous PTAs on bilateral trade by analysing the relationship between the scope of trade policy cooperation and the level of bilateral trade within GVCs. We explore these questions in the context of a structural gravity model with fixed effects. We employ both gross and value-added trade data, derived, respectively, from the UN-COMTRADE and EORA databases to proxy for GVC trade. We start by asking whether there are differences, in the impact of PTAs and their breadth, on the level of GVC trade relative to total trade. We find that those trade flows which are typically associated with GVCs, such as trade in intermediates, are indeed particularly sensitive to increases in the scope of trade policy cooperation between countries. Such results highlight the role of PTAs as an important means of entering into GVCs.

We also investigate the relative roles of different dimensions of PTA breadth in stimulating bilateral GVC trade. In line with previous literature (Falvey and Foster-McGregor 2018; Laget et al. 2018) we find that it is the 18 'core' provisions identified by Hofmann et al. (2019) (see Table A1) which primarily drive the relationship between the breadth of trade policy cooperation and the level of bilateral GVC flows between trading partners. By contrast, non-core provisions tend to have a null effect on the level of GVC trade. Taken together, our findings corroborate the insights of theoretical literature. While, on average, both GVC and total trade appear to be sensitive to the entry into force of a PTA, we show that the former is particularly sensitive to the breadth of trade policy cooperation. In addition, we provide evidence into the relevance, for GVC trade, of 'core' dimensions of PTA breadth, such as IPR protection and capital movement liberalisation. These are typically associated with the 'deeper' forms of integration which theory suggests are particularly important to enable the cross-border organisation of GVCs.

Our results, however, also point to the existence of non-linearities in the relationship between PTA breadth and GVC trade. When including our breadth variable in quadratic form, we find that the relationship the breadth of PTAs and GVC trade is hump-shaped, which might suggest that there is a threshold above which returns to adding more PTA provisions tend to decrease. We also explore heterogeneity among signatories of PTAs belonging to different income groups. When considering value-added measures of GVC trade, we find that changes in the scope of trade policy cooperation have a particularly large effect on the level of trade between developing economies relative to trading relationships which involve at least an industrialised economy. When considering trade in parts and components, however, it is north–north trading relationships which appear to be more sensitive to the scope of PTAs relative to the rest. We speculate that these differences are driven by differences in the level of liberalisation already achieved between partners at different income levels, and by differences in the underlying nature of trade flows, with trade in parts and components being more closely associated with trade in complex, customised inputs, which is prevalent between high-income economies. Conversely, the value-added measures of GVCs are likely to be broader indicators, with the relatively strong effects of PTAs on these indicators for developing country relationships potentially highlighting the role of PTAs in developing regional value chains among developing countries.

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Appendix A.

Appendix A.1. 'Core' and Non-Core Provisions

Table A1. 'Core' PTA provisions: description and coverage.

Provision	Description	WTO	Border
Free Trade Area	Tariff liberalisation with regard to industrial	WTO+	Border
(FTA) Industrial	goods; elimination of non-tariff measures.		
Free Trade Area	Tariff liberalisation with regard to agricultural	WTO+	Border
(FTA) Agriculture	goods; elimination non-tariff measures.		
Customs	Provision of information; publication online of new laws and regulations.	WTO+	Border
Export taxes	Elimination of export taxes, e.g. customs duties on exports.	WTO+	Border
General Agreement on	Liberalisation of trade in services.	WTO+	Behind
Trade in Services (GATS)			the border
Trade-Related Aspects	Harmonisation of standards; enforcement;	WTO+	Border
of Intellectual Property	national treatment; MFN treatment; any other		
Rights (TRIPS)	policy covered by TRIPS.		
Countervailing measures	Retention of countervailing measures rights and	WTO+	Border
(CVM)	obligations under WTO Agreement (Art. VI GATT).		
Trade-Related Investment	Provisions concerning requirements for local content	WTO+	Border
Measures (TRIMS)	and export performance on FDI. Applies only to measures affecting trade in goods.		
Public procurement	Progressive liberalisation; national treatment and/or	WTO+	Behind
	non-discrimination principle; publication online of laws and regulations.		the border
Sanitary & Phytosanitary	Affirmation of rights and obligations under the WTO	WTO+	Border
Measures (SPS)	Agreement on SPS. Harmonisation of SPS measures.		
Technical Barriers	Affirmation of rights and obligations under the WTO	WTO+	Border
to Trade (TBT)	Agreement on TBT; provision of information; harmonisation of regulations.		
State trading	GATT Art. XVII. Establishment of a state enterprise	WTO+	Behind
Enterprises (STE)	in accordance with GATT		the border
Anti-dumping	Retention of anti-dumping rights and obligations under the WTO Agreement (Art. VI GATT).	WTO+	Border
State aid	Assessment of anticompetitive behaviour; reporting on	WTO+	Behind
	the value and distribution of state aid given.		the border
Intellectual Property	Accession to international treaties not referenced	WTO-X	Behind
Property Rights (IPR)	in the TRIPs Agreement.		the border
Competition policy	Provisions on competition policy, e.g. anticompetitive	WTO-X	Behind
	business conduct.		the border
Labour market	Regulation of the national labour market; affirmation	WTO-X	Behind
regulation	to ILO commitments and standards.		the border
Movement of capital	Liberalisation of capital movement.	WTO-X	Border

Table A2. Non-core PTA provisions: description.

Provision	Description
Agriculture	Policies and technical assistance to conduct modernisation projects
Anti-corruption	Regulations concerning criminal offence measures in matters affecting international trade and investment.
Approximation of legislation	Application of international legislation in national legislation.
Audio-visual	Promotion of the industry, encouragement of co-production.
Civil protection	Implementation of harmonised rules.
Consumer protection	Harmonisation of laws and policies; exchange of information; training.
Cultural cooperation	Promotion of joint initiatives and local culture.
Data protection	Exchange of information; joint projects.
Economic policy dialogue	Exchange of ideas; joint studies.
Education & training	Measures to improve the level of education.
Energy	Exchange of information; technology transfer; joint studies.
Environmental laws	Development of environment standards or policies; enforcement of national and international environmental laws.
Financial assistance	Policies on the granting and administration of financial assistance.
Health	Monitoring of diseases; development of health information systems.
Human rights	Respect for human rights; human rights policies.
Illegal immigration	Conclusion of re-admission agreements; control of illegal immigration.
Illicit drugs	Joint projects on prevention of consumption; reduction of drug supply.
Industrial cooperation	Assistance in modernisation projects; facilitation of access to credit.
Information society	Exchange of information; technology dissemination; training.
Innovation policies	Participation in framework programmes; technology transfer.
Investment	Legal frameworks development; harmonisation of procedures; national; treatment; establishment of dispute settlement mechanisms.
Mining	Exchange of information; development of joint initiatives.
Money laundering	Harmonisation of standards; technical assistance.
Nuclear safety	Development of laws and regulations; supervision of the transport of radioactive material.
Political dialogue	Convergence on international issues; increased political dialogue.
Public administration	Technical assistance; exchange of information; training.
Regional cooperation	Promotion of regional cooperation; technical assistance.
Research & technology	Joint research projects; mobility of researchers; development of publicprivate partnerships.
SMEs	Technical assistance; facilitation of access to credit.
Social matters	Coordination of social security systems.
Statistics	Harmonisation/development of statistical methods and statistics; training.
Taxation	Assistance in conducting fiscal system reforms.
Terrorism	Exchange of information and experience; joint research.
Visa and asylum	Exchange of information; drafting of legislation; training.

Appendix A.2. PPML Estimates

An important methodological issue is the potential bias arising when failing to take account of observations where reported trade is zero. Since the dependent variable in the gravity equation is typically expressed in log form, it is not possible to include observations for which reported trade is zero. Yet, their omission can lead to biased coefficient estimates (Santos Silva and Tenreyro 2006; Falvey and Foster-McGregor 2018). EORA data, once aggregated at the country level, does not include zero trade flows. Our data on gross trade, however, does. Table A3 reports results from estimating a Poisson pseudo maximum likelihood (PPML) model to control for selection bias deriving from the presence of these zero trade flows (Santos Silva and Tenreyro 2006).

Results are broadly comparable with those reported in Table 5, particularly when considering the models without country-pair fixed effects. These are reported in columns (1), (3), (5) and (7). The inclusion of country-pair fixed effects reduces the significance of the association between our PTA variables and the dependent variables because they exclude the effect of any trade agreements signed before 1995, the first date for which we have data on trade in parts and components. Pre-1995 PTAs include several potentially significant agreements such as MERCOSUR, NAFTA, and a number of EU enlargement agreements.

Table A3. PTAs and total trade vs. trade in parts and components (UN-COMTRADE), PPML estimator.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gross Exp.	**Gross Exp.**	**Gross Exp.**	**Gross Exp.**	**Parts and Comp.**	**Parts and Comp.**	**Parts and Comp.**	**Parts and Comp.**
PTA	1.610 ***	0.0405			1.588 ***	−0.0180		
	(0.0697)	(0.0297)			(0.0931)	(0.0367)		
Core breadth			0.106 ***	0.00311 *			0.105 ***	−0.000204
			(0.00479)	(0.00185)			(0.00621)	(0.00226)
Observations	403,640	402,392	403,640	402,392	403,640	373,410	403,640	373,410
Country-pair FE	YES	YES	YES	YES	YES	YES	YES	YES
Exporter-time FE	YES	YES	YES	YES	YES	YES	YES	YES
Importer-time FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors clustered at the country-sector level in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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