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The Economic Impact of Deepening Trade Agreements

Abstract

This paper explores the economic impacts of preferential trade agreements, conditional on their level of ambition. We cluster 278 agreements, encompassing 910 provisions over 18 policy areas and estimate the trade elasticity for the different clusters. We then use these elasticities in a series of general equilibrium counterfactual situations for endowment economies, revealing that deepening existing agreements (the intensive margin of regional integration) could boost world trade by 5 percent and world GDP by 1 percent. The expected gains from deepening agreements within or across regions vary depending on the initial depth of agreements and the size of regional markets.

JEL-Codes: F140, F150.

Keywords: preferential trade agreements, deep integration, structural gravity, general equilibrium.

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Introduction

The content of Preferential Trade Agreements (PTAs) has largely changed over time. Trade agreements in the 1950s focused on few policy areas, mostly regulating border measures such as tariffs and quotas, and included a limited number of regulatory requirements and commitments in these areas. While many modern PTAs deal primarily with border measures, a growing number of the recent trade agreements, like the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) or the African Continental Free Trade Area (AfCFTA), are "deep"—i.e. they are complex legal documents covering a large array of border and behind the border policies and including liberalizing commitments, transparency, enforcement and other regulatory requirements. Despite the heterogeneous content of modern trade agreements, the large body of economic literature on PTAs mostly relies on dummy variables to identify their trade effects (Limão 2016). This approach fails to capture the multidimensional nature of the depth of trade agreements and can lead to measurement error bias in assessing their economic effects.

This paper takes a novel look at the economic impact of PTAs taking into account the *depth* of these agreements. We build on the recent strand of the structural gravity literature (Anderson & Van Wincoop 2003) and explore the uneven economic impacts deriving from the diverse provisions contained in PTAs—the *intensive margin* of regional integration. Different provisions have different effects on trade depending on how they affect trade costs. They may also affect differently PTA members and non-members. For instance, while discriminatory provisions such as rules on antidumping duties or export taxes ease restrictions to trade between members only, non-discriminatory provisions such as rules on subsidies or competition policy reduce trade costs for both members and non-members by allowing all foreign firms to benefit from undistorted competition in the PTA members' markets. In other words, the varying content of PTAs may be an important determinant of the uneven trade effects observed in Baier, Yotov & Zylkin (2019). Providing a new method to assess these effects and offering a first application using new data on the content of PTAs is the purpose of this paper.

The quantification analysis relies on a comprehensive characterization of the provisions included in PTAs based on a new database compiled by the World Bank (Mattoo, Rocha & Ruta 2020). We use information on all policy domains (excluding tariffs) covering objectives, substantive commitments, regulatory requirements and enforcement procedures included in legal texts and annexes of the 278 PTAs in force and notified to the WTO up to 2018. Examples of policy areas covered in the database include competition policy, State-Owned Enterprises (SOEs), subsidies, public procurement, Technical Barriers to Trade (TBTs), Sanitary and Phytosanitary Standards (SPS), labor rights, and environmental rules.

Such very rich set of information has to be collapsed in broad categories of PTAs in order to be tractable in a general equilibrium framework accounting for the complex impact of PTAs with various levels of ambition on the world matrix of bilateral trade costs. We go beyond the dummy approach – which does not capture depth

– used in the large majority of the literature, and the use of synthetic indicators of depth such as the count of provisions in PTAs (Mattoo, Mulabdic & Ruta 2017). We start by defining statistically significant groupings. We rely on a clustering approach to identify groups of trade agreements based on the provisions' content. In doing so, we opt for the iterative "kmean++" algorithm developed by Arthur & Vassilvitskii (2007) which ensures greater accuracy by randomizing starting points at each replication. Given the underlying distribution of provisions in each of the 18 policy areas in the data, the silhouette width criterion (which evaluates cluster fit on within-group cohesion and between-group separation) recommends 3 clusters, which minimizes the distance between observations within each group and maximizes the distance between groups.

The resulting classification helps in determining the "natural" groupings (i.e. "cluster") of observations in our data set based on a transparent statistical approach. The underlying assumption is that each group of PTAs has a similar content of provisions by policy areas, and thus should impact differently the trade costs between members of the agreement and between the latter and third countries. In order to gauge the contribution of different policy areas in the outcome of the clustering, we characterize each group of agreements in terms of provisions coverage by policy domain. Controlling for the development level of participating countries, and for time periods, we estimate the marginal effect of the 18 policy areas on the probability of an agreement being in one of the two extreme clusters with respect to the medium one.

In a second step we estimate an explicit bilateral trade function taking stock of the classification of agreements. Once more, we let the data speak and estimate the mean impact on trade for the PTAs belonging to each cluster. Note that a large part of the literature estimating the impact of PTAs on trade is flawed because it does not control for the appropriate benchmark in terms of trade cost, i.e. domestic sales. Importantly, we take the gravity equation seriously and integrate internal trade flows in the estimation of the trade impacts of the different types of PTAs. We compile the largest database for which internal and international trade is available in a panel, based on the last release of UNIDO data.

A challenge when assessing the trade impact of PTAs is endogeneity. Countries self-select in signing a PTA due to unobservable bilateral linkages (Baier & Bergstrand 2004). By the same token, the networks of firms and their joint involvement in Global Value Chains (GVCs) contribute to shape the geography of PTAs. "Lobbying for globalization" (Blanga-Gubbay, Conconi & Parenti 2020) is ascertained in the US case: large firms benefit more from regional integration because it reduces the trade frictions between affiliates and improves market access; consequently they spend more on lobbying for PTAs.[1] Hence, the endogeneity concerns that have been raised for PTAs in general are likely to bind also for their *depth*, which is a challenge to be addressed here. We address this issue in different ways. First, we rely on a conservative fixed effects strategy. Second, we control

[1] As evidenced in the case of US anti-dumping duties (Bown, Conconi, Erbahar & Trimarchi 2021), trade frictions propagate throughout global production networks. Similarly Blanchard, Bown & Johnson (2017) and Bown, Erbahar & Zanardi (2020) show respectively that offshoring shapes the optimal trade policy of a country and that the importing countries tend to remove anti-dumping duties from their main partner countries in GVCs.

for the indirect intensity of bilateral GVC relationships, which captures only the bilateral income generated throughout production linkages with third countries (i.e. excluding the potentially endogenous component related to direct trade). Third, we reallocate randomly country-pairs across groups of PTAs of different content and show after a large number of replications that the distribution of parameters for each group of PTAs is not statistically different.

The last step of the analysis illustrates how to perform counterfactual exercises in a theoretical consistent way, taking stock of general equilibrium effects. We firstly move all existing PTAs away from their cluster towards the most ambitious one (i.e. a PTA cluster associated to higher trade) and examine the effects of such policy reform of preferential trade agreements. Since we are not changing the network of agreements but only their content, this exercise captures a variation in the intensive margin of PTAs. We find that deepening all existing trade agreements could boost world trade by 5 percent and world GDP by 1 percent relative to the baseline. Few countries are negatively affected by the deepening of trade cooperation, but overall gains are significantly positive for most of the countries, illustrating the importance of the intensive PTA margin for international trade cooperation.

We then simulate the economic impacts of deepening separately the existing agreements within each region and between regions. Results are diverse across the regions of the world economy, given the current ambition of signed PTAs and the different sizes of regional markets. Countries in the East Asia and Pacific region would mostly benefit from deepening preferential trade agreements within the region, while countries in the Middle East and North Africa region would benefit more from deepening agreements with partners outside the region. All other regions fall somewhere these two extremes. Given the diversity of policy preferences may be larger across than within regions, the low hanging fruits when it comes to deepening trade agreements may be mostly regional. But the gains of these different integration strategies (within or between regions) would ultimately differ across countries.

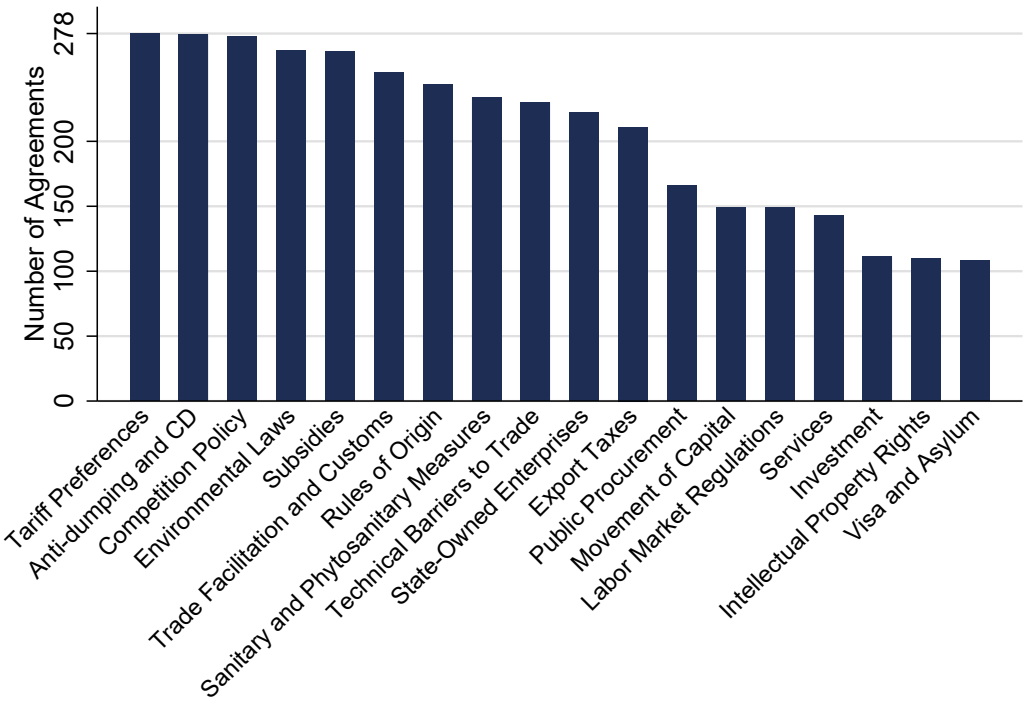
The rest of the paper is structured as follows. Section 1 describes the rich data set used in our exercise and characterizes the clusters of PTAs in terms of commonalities in their content. Section 2 presents the methodology used to measure the ex post impact of the different types of PTAs and characterizes these clusters in terms of their impact on trade. Section 3 addresses the issue of endogeneity in the relationship between trade and deep PTAs. Section 4 shows how to exploit the information on the trade impact of PTAs of different types in a general equilibrium framework for an endowment economy in order to simulate counterfactuals for the world economy. Section 5 concludes.

1 Clustering PTAs based on their content

1.1 Data on the provisions contained in PTAs

The analysis in this paper is based on a new database on the detailed content of deep trade integration -i.e. the depth of commitments that countries take in PTAs (Mattoo et al. 2020).[2] In particular, this database provides information on the content of 18 policy areas most frequently covered in PTAs (Figure 1). The list of policy areas mapped includes border measures such as anti-dumping duties or export taxes, and behind the border measures such as technical barriers to trade, competition policy and environmental law, among others.

Figure 1: Classifications of PTAs by objective of policy area



Source: Deep Integration Handbook, (Mattoo et al. 2020)

The analysis focuses on a sample of 278 trade agreements that have been signed between 1978 and 2018 and that are currently in force and notified to the WTO. For each agreement and policy area, the database provides a series of questions covering aspects such as stated objectives and substantive commitments, as well as aspects relating to transparency, procedures and enforcement. The number of provisions coded (910 in total) varies by policy area, reflecting differences in terms of coverage and complexity across policy areas that are negotiated in the agreements (Table 1). The share of provisions included in each policy area across agreements ranges between 7 percent on average for anti-dumping to more than 30 percent on average for policy areas such as competition

[2]The methodology and data are available in this link `https://datatopics.worldbank.org/dta/index.html`

policy or services. More than one-half of the agreements considered for this analysis cover 50 percent or more of the provisions included in policy areas such as subsidies, sanitary and phytosanitary measures, competition policy, rules of origin and services. The share of agreements covering 50 percent of provisions is much lower (below 30 percent) for policy areas such as anti-dumping, labor market regulation, intellectual policy rights and visa and asylum.

The rich information on the content of PTAs poses the challenge of how to aggregate it to define and quantify the agreements' overall depth. Different approaches can be contemplated from the simple count, or the coverage ratio of the provisions included in an agreement, where it is assumed that the relative importance of each provision is the same across policy areas and agreements. Alternative methods to assign different weights to different provisions according to their commonality or explanatory power across agreements include principal components analysis or machine learning algorithms. In this analysis we use an agnostic statistical procedure to classify PTAs into an optimal set of groups where agreements present both the maximum similarity in terms of provisions included within groups, and the maximum difference between groups.

1.2 The classification algorithm

We rely on a state-of-the-art statistical classification method, the "kmean++" clustering algorithm, which is a non-hierarchical iterative clustering method. This iterative algorithm partitions the data into a number of pre-determined clusters based on a dissimilarity matrix measuring the Euclidean distance between agreements across the 18 policy areas covered in each of the 278 treaties under analysis. In this approach, groups' centers are defined randomly and, at each iteration, the group center is chosen based on a probability proportional to the minimal distance to the closest previously defined center, ensuring a greater accuracy of the resulting classification.[3]

A challenge that we face applying this method is that, within a policy area, certain provisions are coded (1, 0) while other provisions are coded by increasing level of ambition (1, 2, ...n). Take for example the provision in the service policy area covering the obligations needed for a juridical person "to be considered a service supplier of a party to the agreement". This provision allows for 6 different options across the 278 agreements ranging from the most restrictive as "being incorporated under the domestic law of the party and have substantive business operations in the territory of a member" (coded with value 1); to the most liberal as "being owned or controlled by natural persons of the other party" (coded with value 6). The PTA between Australia and New Zealand (year 1983) by including the most liberal formulation of the provision (i.e. "being owned or controlled by natural persons of the other party") is an illustration of deeper cooperation in the service domain than, for

[3] We implement the classification using the "kmeapp" function in R. Although we allow for a fairly large number of iterations, i.e. 5,000, the algorithm converges to a stable classification after few rounds. As a robustness we test alternative classification setup in Section 2.2.

example, the Andean Community (1988); whose founding treaty mentioned the stricter requirement of being incorporated under the domestic law of the party and have substantive business operations in the territory of a member. To address this issue, we normalize the data. For each provision in the matrix composed by 278 agreements (columns) and 910 provisions (rows), we calculate the mean of each provision across agreements. This normalization has the double advantage of: (i) harmonizing the measuring scale across provisions (not all provisions are binary); ii) factoring in the frequency of the provision across agreements (if a provision is not present in a certain agreement it is coded as zero).

The implementation of the k-mean clustering poses some additional difficulties for data sets with high levels of dimensionality. To reduce the size of the matrix of the content of preferential trade agreements, the normalized scores assigned to each of the 910 provisions are aggregated using the simple average across all the provisions that are included in each of the 18 policy areas mapped. The "kmean++" algorithm is therefore applied to a reduced matrix composed by 18 rows (defined by the policy domains) and 278 columns (defined by the agreements).

Table 2 provides an example to illustrate how the data on the content of preferential trade agreements are normalized and aggregated in order to generate a set of clusters. We consider a hypothetical situation where we have a total of 5 PTAs that need to be grouped into 3 clusters which include only one policy area (area xx), which comprises 3 coded provisions (a, b, c). These provisions take values 1 to 3 according to their level of ambition and take value zero if they are not included in the agreement.

The first step is to construct a matrix with normalized scores capturing the average occurrence of each provision across PTAs. Consider provision "a". This provision is present in PTA-1 and is coded with the highest level of ambition (score=3). Provision "a" is also present in PTA-2, but with the lowest level of ambition (score=1). Provision "a" is absent from PTAs-3 to 5 (code=0). The average occurrence of provision "a" across the PTAs is therefore 0.8 ((3+1+0+0+0)/5). This value also captures the frequency of provision "a" across agreements. A similar exercise can be done with provisions "b" and "c", where the average occurrence is equal to 0.8 and 1, respectively. As a second step, we normalize the score provided to each provision by dividing the current score by the average occurrence (frequency). The normalized scores for provisions "a", "b" and "c" included in agreements PTA-1 to PTA-5 are provided in Table 3. The normalized score of provision "a" in agreement PTA-1 is equal to 3.75 (3/0.8) and captures the relative occurrence and intensity (gradient 1, 2, ... n) of this provision in this agreement. Finally, we aggregate all the provisions' scores within each policy area to reduce the dimensionality of the matrix.[4]

Using this normalization of the data, we classify PTAs into a series of clusters using the K-mean methodology.

[4] Table A1 in the Appendix provides a subset of actual data in the raw and normalized matrix for the area of services. Note that provision # 850 is coded 5 in EFTA (high ambition) and only 2 in the Chile-Japan PTA, which illustrates the (1,2,... n) coding afore mentioned. In Cluster #1 the final score is 0.840; it is 0.846 in cluster 3 and 1.362 in Cluster 2: these are also the scores indicated in table 5, row "Services", last three columns. The same exercise pertains for the 17 other policy areas and for other PTAs in order to obtain the score for each area and each PTA (an 18 x 278 matrix) thereafter used for the clustering.

Such clustering groups PTAs based on the proximity of their scores obtained for the different categories of provisions. We then identify the number of clusters that maximizes the distance between groups of PTAs and minimizes distance within them. In order to identify the optimal number of groups for the "kmean++" algorithm we rely on the silhouette width as a measure of cluster fit (Rousseeuw 1987). The silhouette width measures the separation between clusters by evaluating how similar agreements within a cluster are to each other with respect to those in the nearest group. Figure A1 in the Appendix reports the average silhouette width by number of clusters. The silhouette reaches its maximum when the data are partitioned across three clusters: Cluster #1 (29 agreements), Cluster #2 (96 agreements) and Cluster #3 (153 agreements). The complete list of PTAs within each cluster is available here. These three clusters are going to be used in the next section to assess the impact of PTAs on trade.

1.3 The marginal effect of provisions on the probability of an agreement

In order to provide an illustration of the policy content of PTAs in each cluster, we use a simple linear probability model to ask, what is the marginal effect of the 18 policy areas on the probability of an agreement being in clusters #1 or #3 with respect to cluster #2? Specifically, we run two separate regressions for the probability of an agreement being classified in cluster #1 or #3. The total number of observations in each regression is accordingly 278. In the right-hand side, we include the 18 scores by policy domain used in the clustering exercise. As additional controls we also include a dummy for the decade in which the agreement has been ratified and a series of dummies for the income level of participants: high-high, low-low, high-low income. In order to fix the reference group, we include in both regressions a dummy variable equal to 1 for the agreements classified in the cluster #2.

Taking all these elements on board, we plot in Figure 2 the 18 provision areas on the vertical axis and on the horizontal axis the marginal effect of each on the probability for a PTA of belonging to cluster #1 and #3, respectively. We observe that anti-dumping and competition provisions play an important role in cluster #1 relative to provisions in areas such as labor regulation. Following that line of reasoning, transforming a PTA classified in cluster #3 into a PTA classified in cluster #1 would on average require to put more emphasis on anti-dumping, competition or technical regulation for instance. This is the type of counterfactual exercise that we will perform below using a general equilibrium model for an endowment economy.

Table 1: Content of preferential trade agreements, 1978-2018

Policy Area	Number Provisions	Average Coverage by Policy Domain	Agreements with zero Provisions	Agreements with $< 25\%$ Coverage	Agreements between $25 - 50\%$ Coverage	Agreements between $50 - 75\%$ Coverage	Agreements with $> 25\%$ Coverage
Anti-dumping	36	0.10	2	267	9	0	0
Competition Policy	35	0.37	2	85	121	59	11
Countervailing duties	14	0.21	1	194	67	16	0
Environment	48	0.16	11	196	51	20	0
Export Taxes	46	0.20	68	94	106	10	0
IPR	120	0.07	170	78	28	1	1
Investment	56	0.18	168	6	49	55	0
Labor Market	18	0.16	128	98	9	18	25
Migration	30	0.13	169	31	59	19	0
Movement of Capitals	81	0.21	132	26	78	42	0
Public Procurement	95	0.15	111	98	14	54	1
Rules of Origin	38	0.36	35	35	126	82	0
SPS	53	0.14	47	168	61	2	0
STE	52	0.23	57	66	150	4	1
Services	62	0.33	136	3	21	78	40
Subsidies	36	0.33	10	51	176	41	0
TBT	34	0.18	51	136	83	8	0
Trade Facitlitation	52	0.25	30	120	90	38	0

Note: *Coverage* report the share of non-zero provisions within each cluster and policy Area.

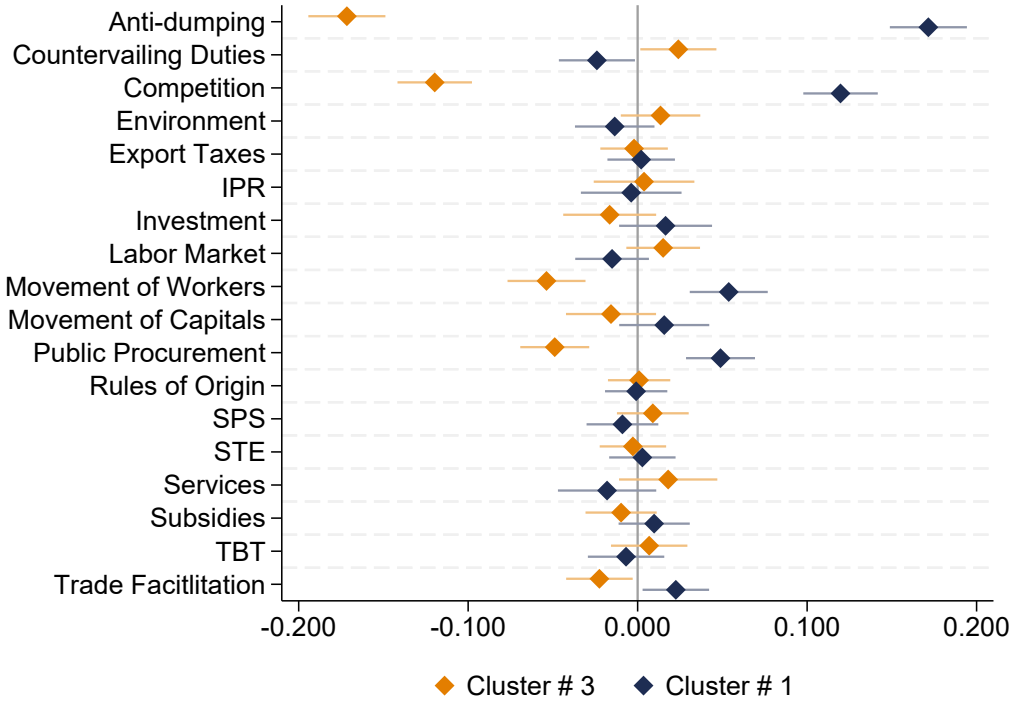
Table 2: Practical Example of Provisions aggregation (raw matrix)

Policy Area	Provision	Cluster # 1 PTA-1 (1)	Cluster # 2 PTA-2 (2)	PTA-3 (3)	Cluster # 3 PTA-4 (4)	PTA-5 (5)	Average (6)
Area xx	a	3	1	0	0	0	0.8
Area xx	b	2	1	0	1	0	0.8
Area xx	c	1	1	1	1	1	1
Coverage by PTA		1	1	0.33	0.66	0.33	
Coverage by Cluster		**1.00**	**0.67**		**0.5**		

Table 3: Practical Example of Provisions aggregation (normalized matrix)

Policy Area	Provision	Cluster # 1 PTA-1 (1)	Cluster # 2 PTA-2 (2)	PTA-3 (3)	Cluster # 3 PTA-4 (4)	PTA-5 (5)	Average (6)
Area xx	a	3.75	1.25	0.00	0.00	0.00	
Area xx	b	2.50	1.25	0.00	1.25	0.00	
Area xx	c	1.00	1.00	1.00	1.00	1.00	
Score by PTA		2.42	1.17	0.33	0.75	0.33	
Score by cluster		**2.42**	**0.75**		**0.54**		

Figure 2: Marginal Probability of being in Cluster # 1 and # 3



Notes: Marginal effect of the 18 different provision areas from a linear probability model for being in the corresponding cluster. The model controls for the decade of signature of the agreements. Cluster # 2 is the reference group.

2 Ex-post quantification of the impact of different types of PTAs

In this section, we estimate the trade impact of the 3 clusters of PTAs identified with the "kmean++" algorithm in a gravity framework in order to recover the partial effect on trade of PTAs associated with the different clusters. We also test for the robustness of our results to alternative classifications.

2.1 The structural gravity estimation

Specifically, we estimate, using PPML with panel data, the following structural gravity model:[5]

$$X_{ij,t} = exp\left(\sum_{z=1}^{3}\beta_z PTA^z_{ij,t} + \sum_{T=1978}^{2000}\beta_T INTL\ BRDR_{ij} * T + \pi_{i,t} + \chi_{j,t} + \mu_{ij}\right) + \epsilon_{ij,t} \quad (1)$$

Where $X_{ij,t}$ includes both intra-national and international manufacturing trade flows on 5-year intervals from 1978 to 2018.[6] Including intra-national sales is critical as the domestic economy is the most appropriate benchmark for trade integration (Yotov 2012). Otherwise the estimated coefficients would suffer from a missing variable bias. The data on inter- and intra-national trade come from, respectively, the UN-ComTrade and UNIDO-Indstat database.[7] Following standard practice, we fill in intra-national flows using linear interpolation between non-missing data and extrapolating remaining missing values using gross output to value added ratios as in Head & Mayer (2021). In each year only countries with non-missing intra-national trade flows enter the estimation sample.

Our main variable of interest, $PTA_{ij,t}$, is split across cluster groups: $PTA^{z=1}_{ij,t}$, $PTA^{z=2}_{ij,t}$ and $PTA^{z=3}_{ij,t}$. The dummy $INTL\ BRDR_{ij}$ takes the value of one in case of an international trade flow. We interact this dummy with decades indexed by T (leaving the period after 2010 as reference). Exporter-time, $\pi_{i,t}$, and importer-time, $\chi_{j,t}$, fixed effects control for time-varying Multilateral Resistance Terms, while bilateral fixed effects, μ_{ij}, control for time-invariant unobserved characteristics of the country pair potentially leading to self-selection into PTAs (Baier & Bergstrand 2007). As an additional control, we also include the variable $TransitoryPTAs_{ij,t}$, to control for agreements that are no longer in force.

The results presented in Table 4 provide the elasticity of bilateral trade to the different types of PTAS (as grouped by the clustering). This elasticity is here estimated within sample. As discussed in the Introduction, it will be introduced in a second step as a parameter in the estibration procedure.

The first five columns exploit the raw UNIDO data we rely on. There are 68,225 observations for about 133 countries for which we observe internal flows at least once over the estimation period (of which 61 in

[5] $X_{ij,t}$ is in levels in columns 1 to 4 of Table 4 and in shares of absorption at destination – namely $\frac{X_{ij,t}}{\sum_i X_{ij,t}}$ – in the remaining estimation tables. See discussion below.

[6] We test the robustness of our findings over the different periods in Table 7.

[7] ComTrade is used to retrieve information on international trade flows from 1978 up to 2018 whereas Indstat provides data on gross output used to compute domestic sales (as the difference between production ant total exports).

year 2018). In order to expand internal flows coverage, in column 6 we rely on a broad sample obtained by extrapolating domestic sales using output to value added ratios, as in Head & Mayer (2021), which leads to 122,633 "observations" for 142 countries (of which 112 in year 2018).

Column 1 is the standard estimation strategy with importer-time, exporter-time and dyadic fixed effects, and controlling for internal flows. Column 2 replicates column 1 by adding the control for transitory PTAs, which is not significantly affect the PTAs coefficient. Column 3 adds the control for internal flows (with a dummy taking the value of one in the case of international flows interacted with a decade specific indicator variable).[8] Comparing with columns 1 and 2 shows that this dramatically reduces the trade impact of PTAs. The second result is that the negative impact on commerce of crossing the border decreases progressively, which is the other side of the "globalization" coin.

The impact of PTAs shown in column 4 is then split by clusters of PTAs and the elasticity ranges from 0.109 to 0.595, with cluster #1 having the largest impact on trade. We refer to this cluster as the one of (revealed) "deep" PTAs, the second as "medium" and the third as "shallow" PTAs.

As our database also includes domestic sales, starting from column 5 we are able to control for the relative size of the trading partners. The PPML estimator, in fact, assigns more weight to countries with large imports volumes in the identification of the parameters (Eaton, Kortum & Sotelo 2013, Head & Mayer 2014). A way to eliminate differences in the penalization of large and small trade flows is to normalize trade flows by destination country total absorption (Eaton et al. 2013), this is what is done for specifications in columns 5 to 7 of Table 4 and the following.[9]

Finally, an important econometric issue is that our 3-way fixed effect panel PPML procedure with time-invariant country-pair, time-varying exporter and importer fixed effects is subject to an incidental parameter problem when the number of periods is small (such as ours), which biases the estimated parameter for PTAs in gravity equations as well as their confidence intervals.[10] Accordingly, in column 7 we replicate column 6 by relying on the fix developed by Weidner & Zylkin (2021) which confirms that point estimates and standard errors are both larger when the incidental parameter problem is properly addressed. Importantly, the statistical significance of our estimated parameters is confirmed.

Our preferred estimate in column 6 yield then a robust set of elasticities for a broad set of countries to simulate the welfare effect of trade policy shocks. Indeed, the identified trade elasticities to PTAs in column 6 will be the parameters introduced in the general equilibrium gravity model, jointly with the country-pair fixed effects and the international border effects.

[8] As the estimation sample covers 5-year intervals over the period 1978-2018, the years 2013 and 2018 represent the excluded decade.

[9] As shown by Sotelo (2019) poisson estimation on market share variable with country fixed effects is equivalent to the Multinomial PML proposed in (Eaton et al. 2013).

[10] In fact, the usual clustering procedures provide biased (too narrow) standard errors in such setting.

Table 4: PPML: Gravity Estimations of the elasticity of trade to PTAs by Cluster

Dep Var:	X_{ijt}				X_{ijt}/X_{jt}		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\text{PTA}_{ij,t}$	0.629	0.663	0.294				
	(0.051)	(0.059)	(0.043)				
$\text{PTA}_{ij,t}^{K\#1}$				0.595	0.535	0.512	0.529
				(0.045)	(0.043)	(0.069)	(0.087)
$\text{PTA}_{ij,t}^{K\#2}$				0.256	0.235	0.277	0.325
				(0.054)	(0.033)	(0.035)	(0.045)
$\text{PTA}_{ij,t}^{K\#3}$				0.109	0.153	0.164	0.184
				(0.045)	(0.048)	(0.044)	(0.053)
Transitory $\text{PTAs}_{ij,t}$		0.160	0.136	0.228	0.229	0.163	0.183
		(0.055)	(0.047)	(0.052)	(0.045)	(0.046)	(0.055)
INTL BRDR∗1980			-0.944	-0.933	-1.194	-1.135	-1.117
			(0.043)	(0.043)	(0.050)	(0.065)	(0.098)
INTL BRDR∗1990			-0.574	-0.576	-0.819	-0.859	-0.844
			(0.035)	(0.034)	(0.040)	(0.048)	(0.068)
INTL BRDR∗2000			-0.223	-0.223	-0.294	-0.361	-0.345
			(0.027)	(0.027)	(0.031)	(0.037)	(0.053)
Intra-National flows	Raw	Raw	Raw	Raw	Raw	Extrapolated	Extrapolated
Period	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018
N. Country ID	133	133	133	133	133	142	142
N. Country ID (year 2018)	61	61	61	61	61	112	112
Observations	68,225	68,225	68,225	68,225	68,225	122,633	122,633
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij three-way correction

Notes: Exporter-time (it), Importer-time (jt) and Exporter-Importer (ij) fixed effects are always included. From column 1 to column 6, standard errors in parentheses are clustered by country-pair. In column 7 both standard errors and point estimates are corrected using the Weidner & Zylkin (2021) procedure, implemented in Stata with *ppml_fe_bias*. In column 4 missing values in domestic sales are linearly interpolated; in column 5 to column 7 we extrapolate the remaining missing values using the evolution of a country total exports.

2.2 Alternative classification algorithm

In columns 1 and 2 of Table 5 we test the robustness of our main results using an alternative iterative algorithm (Partitioning Around Medoids, PAM); while in column 3 and 4 we classify agreements using a (non-iterative) hierarchical clustering procedure.

We lastly recalculate the estimated effects after reallocating the few "borderline" agreements to the closest alternative clusters in column 5 and 6 of Table 5. We manually re-classify "borderline" agreements as visualized in Figure 3 reporting the position of the 278 agreements over the cluster space. The coordinates represent the first two principal components extracted from the 18 features used in the clustering algorithm. The color and shape of each point represents the different clusters. While the separation between clusters is clear-cut with very few agreements at the "border" of their partition, and agreements in Cluster #1 (the "Deep" ones) standing apart from the rest of the sample, there are a couple of instance where the separation is less clear-cut. These are the PTAs that we reclassify.

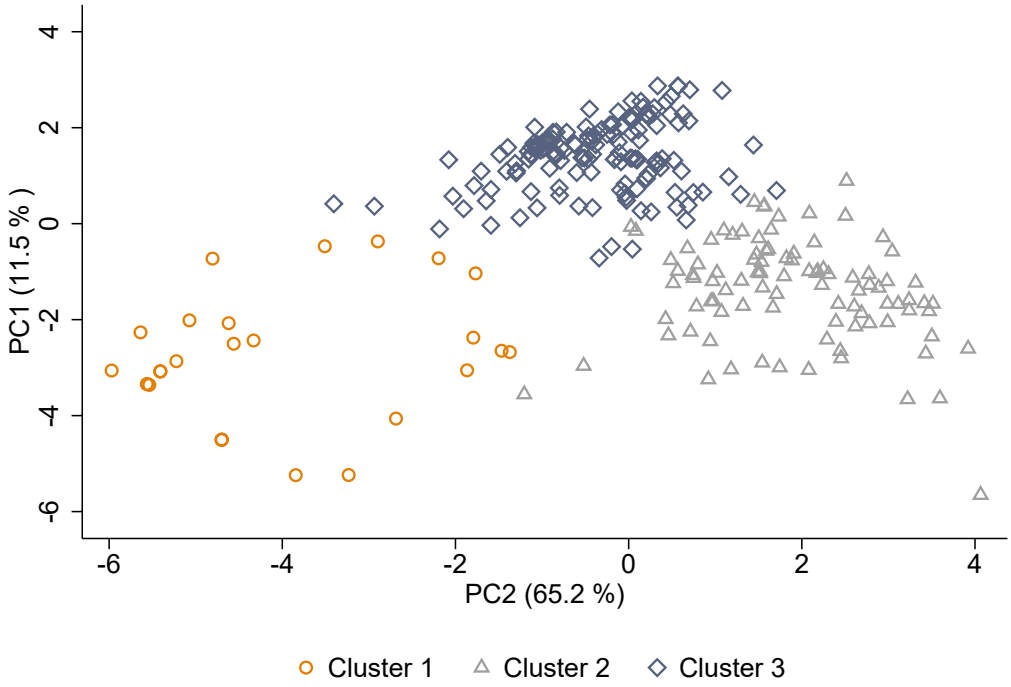
Overall, our results prove to be robust to the different classification algorithms. Most importantly, agreements with the higher trade effects (i.e. cluster #1) largely overlap with the ones identified by the preferred routine hence the magnitude of the trade premium associated with the most ambitious group is hardly affected.

Table 5: PPML: Gravity Estimations of the elasticity of trade to PTAs by Alternative Cluster Definitions

Dep Var:	X_{ijt}/X_{jt}					
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{PTA}_{ij,t}^{K\#1}$	0.508	0.524	0.472	0.491	0.470	0.489
	(0.069)	(0.087)	(0.061)	(0.078)	(0.061)	(0.078)
$\text{PTA}_{ij,t}^{K\#2}$	0.298	0.343	0.295	0.343	0.284	0.330
	(0.038)	(0.049)	(0.036)	(0.046)	(0.036)	(0.046)
$\text{PTA}_{ij,t}^{K\#3}$	0.138	0.157	0.151	0.168	0.164	0.185
	(0.043)	(0.052)	(0.045)	(0.054)	(0.043)	(0.052)
Transitory $\text{PTAs}_{ij,t}$	0.159	0.176	0.161	0.180	0.158	0.177
	(0.045)	(0.055)	(0.046)	(0.055)	(0.046)	(0.055)
INTL BRDR∗1980	-1.131	-1.113	-1.146	-1.128	-1.136	-1.118
	(0.065)	(0.098)	(0.065)	(0.098)	(0.065)	(0.098)
INTL BRDR∗1990	-0.855	-0.841	-0.862	-0.848	-0.860	-0.846
	(0.048)	(0.069)	(0.048)	(0.068)	(0.048)	(0.068)
INTL BRDR∗2000	-0.361	-0.344	-0.366	-0.349	-0.365	-0.349
	(0.037)	(0.053)	(0.037)	(0.053)	(0.037)	(0.053)
Cluster definition	PAM		Hierarchical		Reclassify "borderline" PTAs	
Period	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018	1978-2018
N. Country ID	142	142	142	142	142	142
N. Country ID (year 2018)	112	112	112	112	112	112
Observations	122,633	122,633	122,633	122,633	122,633	122,633
FEs	it, jt, ij	it, jt, ij three-way correction	it, jt, ij	it, jt, ij three-way correction	it, jt, ij	it, jt, ij three-way correction

Notes: Exporter-time (it), Importer-time (jt) and Exporter-Importer (ij) fixed effects are always included. Standard errors in parentheses are clustered by country-pair. In column 2, column 4 and column 6 both standard errors and point estimates are corrected using the Weidner & Zylkin (2021) procedure, implemented in Stata with *ppml_fe_bias*. In all columns missing values in domestic sales are linearly extrapolated using output to value added rations. The Genetic algorithm in column 1 and column 2 classifies: 24 PTAs in cluster #1; 113 PTAs in cluster # 2 and the remaining 141 PTAs in cluster # 3. The Hierarchical algorithm in column 3 and 4 classifies: 33 PTAs in cluster #1; 103 PTAs in cluster # 2 and the remaining 142 PTAs in cluster # 3. The manual reclassification in column 5 and 6 implies: 34 PTAs in cluster #1; 94 PTAs in cluster # 2 and the remaining 150 PTAs in cluster # 3. In column 2, 4 and 6 both standard errors and point estimates are corrected using the Weidner & Zylkin (2021) procedure, implemented in Stata with *ppml_fe_bias*.

Figure 3: Cluster Space



Note: spatial representation of the 3 clusters. Each point represents a trade agreement; x-axis and y-axis are defined using the first two principal components of the 18 features used by the clustering algorithm, centered around zero.

3 Addressing the endogenity of the content of PTAs

As discussed in the Introduction, Blanga-Gubbay et al. (2020) find evidence that big firms in the United States tend to lobby for specific provisions to be included in PTAs. We consequently need to control also for the intensity of bilateral (time-varying) economic interests that may encourage lobbing activity. Baier & Bergstrand (2007) show that dyadic fixed effects are required to control for self-selection of country pairs into PTAs. We already introduced these fixed effects in the estimated equations, in this section we go beyond this approach to investigate endogeneity concerns. As cross-country data on political economy incentives to lobbying – generally used as instrumental variables – are not available, we proceed in three steps. First, we reallocate randomly country pairs into groups of RTAs, keeping the number of groups and the number of pairs in each group constant.

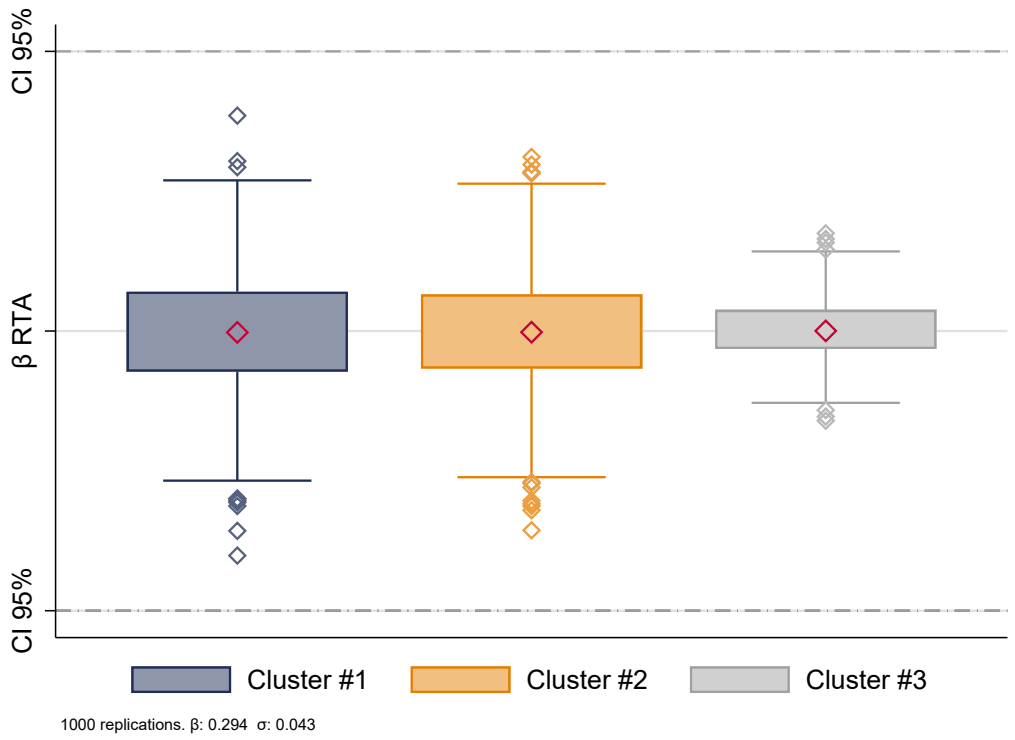
Second, we introduce a control for the bilateral intensity of GVC income by country pair. This measure traces the income of domestic factors (capital and labor) generated through foreign production chains, thus capturing the intensity of bilateral economic interests (Johnson 2018). Importantly, there is also a potential issue of endogeneity in such metric, as bilateral trade flows are partly determined by GVCs. This is why we rely on the extraction method to filter the contribution of direct trade to ensure we only use "Indirect" GVC income flows.[11] Third, we control for the "dependency" of the importing country vis-a-vis its partner country by normalizing trade flows by destination country total absorption.

[11] See Borin & Mancini (2019) for a presentation of the extraction method as well as other insightful decompositions.

3.1 Randomization of the grouping of country pairs

Figure 4 reports the distribution of the estimated coefficients when the country-pairs sharing a trade agreement in the estimation sample are randomly assigned to a given cluster. After 1,000 replications the estimated coefficient for each cluster is not statistically different from the main PTAs coefficient reported in column 3 of Table 4. If the different impact of PTAs grouped in different clusters is not an artefact, then randomly allocating PTAs to three clusters (and keeping the number of PTAs in each cluster unchanged) should end up in all clusters having the same impact on trade.

Figure 4: Distribution of estimated coefficients for randomly defined clusters (1,000 replications)



Note: The boxes plot the distribution of the estimated partial trade effects of randomly defined clusters. In each of the 1,000 replications we randomly assign country pairs with an PTA to a given cluster.

3.2 Controlling for indirect GVC participation and alternative timing

In order to control for the intensity of country pair production linkages, which may encourage lobbying for selected provisions, we include as a control variable bilateral (indirect) GVC income flows. As the measure is built with an extraction method, it excludes income generated through bilateral trade flows between countries i and j and captures only the bilateral income generated throughout production linkages with third countries. We rely on the EORA MRIO database to trace income flows through production chains; as the data cover the period 1990-2015 we restrict the estimation sample accordingly to 1993-2018, leaving a 3-year lag between the GVC participation and trade variables.[12] Results of this new specification are shown in Table 6. Column 1 replicates the baseline specification (i.e. column 6 of Table 4) but on a shorter period, due to the availability of the multi-region input-output database needed to compute bilateral GVC income flows. In columns 2 to 4 we include, as a control for the intensity of bilateral production linkages, a dummy variable taking the value of 1 if GVC income flows are above the 99th, 90th and 75th percentile respectively. Finally, in column 5 we introduce in the estimated equation an hyperbolic transformation of the indirect GVC income variable instead of a dummy; while column 6 replicates the last estimation using the correction for incidental parameter problem from Weidner & Zylkin (2021).

In Table 7, we test across periods the robustness of our main finding, i.e. preferential trade agreements in cluster # 1 are more effective in promoting trade between members. To proceed we first report in column 1 the same specification as in column 3 of Table 6, and then replicate the same specification over shorter and more recent time periods: 1998-2018 (column 2), 2003-2018 (column 3), and 2008-2018 (column 4). As in the previous tables, column 5 of Table 7 replicates the last estimation using the correction for incidental parameter problem.

Reassuringly, neither the inclusion of the indirect GVC intensity nor the change in time horizons affects the relative magnitude of the estimated coefficients for the different clusters.

[12] The EORA database provides sectoral input-output (IO) tables for 189 countries (and a Rest of the World aggregate) `https://worldmrio.com/eora26/`.

Table 6: Elasticity of trade to PTAs by Cluster controlling for GVC^{Indirect} income flows

Dep Var:	X_{ijt}/X_{jt}					
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{PTA}_{ij,t}^{K\#1}$	0.475	0.481	0.474	0.475	0.460	0.486
	(0.080)	(0.076)	(0.080)	(0.080)	(0.080)	(0.099)
$\text{PTA}_{ij,t}^{K\#2}$	0.235	0.236	0.235	0.235	0.225	0.258
	(0.035)	(0.035)	(0.035)	(0.035)	(0.036)	(0.045)
$\text{PTA}_{ij,t}^{K\#3}$	0.148	0.150	0.148	0.148	0.150	0.183
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)	(0.055)
$\text{GVC}_{ij,t-3}^{99pc}$		-0.090				
		(0.072)				
$\text{GVC}_{ij,t-3}^{90pc}$			0.007			
			(0.031)			
$\text{GVC}_{ij,t-3}^{75pc}$				0.005		
				(0.043)		
$IHS(GVC_{ij,t-3})$					0.050	0.057
					(0.020)	(0.028)
Period	1993-2018	1993-2018	1993-2018	1993-2018	1993-2018	1993-2018
N. Country ID	142	142	142	142	142	142
N. Country ID (year 2018)	112	112	112	112	112	112
Observations	93,525	93,525	93,525	93,525	93,525	93,525
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij three-way correction

Exporter-time (it), Importer-time (jt), Exporter-Importer (ij) FEs, International Border and Transitory PTAs always included. Standard errors in parentheses clustered by country-pair. $GVC_{ij,t-3}$) measures the income generated through *indirect* supply chain linkages between country i and j, excluding any direct effect of trade in intermediate goods between country pair by extraction method. In column 2 to 4 *indirect* $GVC_{ij,t-3}$) income is included as a dummy variable if bilateral flows are above the 95th, 90th or 75th percentile respectively. In column 5 and 6 $IHS(GVC_{ij,t-2})$ refers to inverse hyperbolic sine function (IHS). In column 6 both standard errors and point estimates are corrected using the Weidner & Zylkin (2021) procedure, implemented in Stata with *ppml_fe_bias*.

Table 7: Elasticity of trade to PTAs by Cluster and Period, controlling for $\text{GVC}^{Indirect}$ income flows

Dep Var:			X_{ijt}/X_{jt}		
	(1)	(2)	(3)	(4)	(5)
$\text{PTA}_{ij,t}^{K\#1}$	0.474	0.328	0.321	0.405	0.428
	(0.080)	(0.079)	(0.077)	(0.109)	(0.131)
$\text{PTA}_{ij,t}^{K\#2}$	0.235	0.181	0.208	0.203	0.229
	(0.035)	(0.037)	(0.038)	(0.044)	(0.050)
$\text{PTA}_{ij,t}^{K\#3}$	0.148	0.041	0.073	0.076	0.079
	(0.046)	(0.051)	(0.053)	(0.072)	(0.081)
Period	1993-2018	1998-2018	2003-2018	2008-2018	2008-2018
Observations	93,525	78,749	61,792	44,982	44,982
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij three-way correction

Exporter-time (it), Importer-time (jt), Exporter-Importer (ij) FEs, International Border and Transitory PTAs always included. Standard errors in parentheses clustered by country-pair. $\text{GVC}_{ij,t-3}^{90pc}$ is included in all the regressions. $\text{GVC}_{ij,t-3}^{90pc}$ is a dummy variable taking the value of 1 if bilateral GVC income flows is higher than the 90th percentile. GVC measures the income generated through *indirect* supply chain linkages between country i and j, excluding any direct effect of trade in intermediate goods between country pair by extraction method.

4 General equilibrium gravity and counterfactuals

Relying on the analysis of the impact of different clusters of signed PTAs, in this section we assess the economic consequences of deepening existing trade agreements.

4.1 Background

A large body of literature focusing on PTAs and trade relies on the assessment of the *partial* impact of agreements on trade within the countries that are signatories of such agreements (see Limão (2016) for a survey). However, PTAs affect the global matrix of relative trade costs between country pairs and the prices faced by exporters and importers in any country through general equilibrium effects. Thus, quantifying the trade effects of PTAs of uneven ambition can be done in calibrated Computable General Equilibrium (CGE) models or in estimated structural gravity models. Notwithstanding the drawback to rely on elasticities estimated outside the model, CGE models offer a flexible tool to assess the sectoral impact of detailed tariff shocks. However, when the information on trade cost reduction is not sector-specific (as it would be with tariffs or with the sector level estimation of the trade impeding impact of regulations), but origin-destination specific, with no sectoral dimension, as in the case of the used database on PTAs, the advantage of the large sectoral decomposition of these models vanishes, making the structural gravity approach more appealing.

Against this background a recent strand of literature is using estimated models (or a combination of estimation and calibration) inspired by the structural gravity literature initiated by Anderson & Van Wincoop (2003), to assess the GE effects of shocks to the matrix of trade costs (see Yotov, Piermartini, Monteiro & Larch (2017) for a didactic presentation). A first intrinsic advantage of these models is to have the trade elasticity estimated with the data used for the counterfactual exercise. The second advantage is to be rather agnostic in terms of the trade effects of provisions of PTAs going beyond the phasing out of tariffs among signatory countries.[13] A natural extension of such modeling approach, in line with the spirit of this paper, is to assess the uneven impacts of PTAs (Baier et al. 2019), provided that the "ambition" of signed agreements differs strongly.

4.2 Quantification strategy

We rely on a general equilibrium gravity model for and endowment economy and change the ambition of existing agreements between country pairs. The first consequence of deepening agreements, as evidenced above by our gravity estimation, is to modify the overall structure of trade costs. The bilateral trade adjustment, induced by

[13]The last generation of these models relies on the properties of the Poisson Pseudo Maximum Likelihood (PPML) estimator (Silva & Tenreyro 2006) demonstrated by Fally (2015): the solution of the GE system of equations derived from a gravity model can indifferently be estimated (Anderson, Larch & Yotov 2018, Fontagné & Santoni 2021) or computed with a solver Head & Mayer (2014). And when the error term is in a multiplicative form (Anderson et al. 2018) this is equivalent to the so-called "hat algebra" resolution in line for instance with the approach coined as "trade theory with numbers" (Arkolakis, Costinot & Rodríguez-Clare 2012) – and thus not fundamentally different from what a resolution of a CGE implies.

the change in the policy, manifests through two channels: (i) a direct effect driven by the estimated parameters $\beta_z, z = (1, ...3)$ in Equation 1; (ii) an indirect (general equilibrium) effect induced by third countries adjustments. In our case, the typical example is the impact on trade between the United States and Brazil of a simulated deepening of MERCOSUR. The usual trade diversion effect will show up, which here depends on the content of the agreement. The multilateral resistance terms (MRT thereafter) *à la* Anderson & Van Wincoop (2003) act as general equilibrium trade cost indices transmitting local policy shocks to the overall matrix of trade frictions (these effects are formally described using the standard gravity system of equations reported in Appendix A). The inward MRT P_j on the importer side accounts for the impact on consumers and the outward MRT Π_i for the impact on producers in the exporter country. Ultimately, the effects spill also on the price of the exported variety (by the representative producer) and on the expenditure in the importing country. This corresponds to the *general equilibrium effects* for an endowment economy (Head & Mayer 2014).

Three types of counterfactuals can be contemplated at the intensive margin of regional integration. We firstly deepen all the existing agreements in the world economy. In a second counterfactual, we deepen trade agreements involving countries in a given region of the world economy with other countries in the region. In a third counterfactual, we proceed in the same way but for existing PTAs involving countries in different regions. In these simulations, positive entries in either $PTA_{z=3}$ or $PTA_{z=2}$ are switched to zero while the corresponding entries in $PTA_{z=1}$ are set to 1.

In each simulation, X_{ijt} is predicted using the new matrix of PTAs while constraining the coefficients β_z, β_T and the μ_{ij} of equation 1 to their initial value, to obtain counterfactual values for the MRTs and eventually solving for the associated general-equilibrium effects in an endowment economy.

Starting from the baseline trade costs matrix, $t_{ij,t}$:

$$\widehat{t_{ij,t}^{1-\sigma}} = exp(\widehat{\mu_{ij}} + \sum_{z=1}^{3} \widehat{\beta_z} PTA_{ij,t}^{z} + \widehat{\beta_T} INTL\ BRDR_{ij} * T + ln(X_{ij,t}/\widehat{X_{ij,t}}))$$

where the inclusion of the ratio between observed and predicted trade from Equation 1, $ln(X_{ij,t}/\widehat{X_{ij,t}})$, ensures a perfect fit for the observed trade flows; the equilibrium in each counterfactual derives directly from the adjustments in our system of equations induced by the change in the trade costs vector, $t_{ij,t}$.

In order to trace these effects we follow Yotov et al. (2017) and Fontagné & Santoni (2021), using the following notations[14]: Y_i the value of production in the exporting country, E_j the expenditure at destination, and Y the value of world output. Q_i is the endowment (the quantity produced) by the exporter country, p_i the factory-gate price of the exporter and ϕ_i is related to the trade balance. The direct effect of a change in trade costs on trade flows between exporter i and importer j, X_{ij}, can be inferred from the estimated coefficients of the structural gravity equation, holding the MRTs Π_i and P_j constant. In turn, MRTs are impacted by

[14]See Appendix A for a more detailed presentation

the change in trade costs implied by our counterfactuals, because deepening an existing PTA or signing a new between countries i and j will affect the overall matrix of trade costs and thus the structure of relative prices. These indirect effects as well as their feedbacks on exporter and importer countries relative prices concur in determining the final GE effects for an endowment economy.

As the series of bilateral estimated fixed effects are the counterparts of the MRTs when relying on a PPML estimator (Fally 2015), we follow Anderson et al. (2018), Yotov et al. (2017) and solve our system of equations accordingly. The same approach pertains to our counterfactuals, whereby the system is solved with the alternative trade frictions derived from signing missing PTAs among countries in a region or alternatively deepening the already signed ones. We firstly recover β_z (the average trade cost elasticity over the period considered) and μ_{ij} (the bilateral fixed effects) from the baseline gravity Equation (1) including both intra-national and international trade flows on 5-year intervals covering the period 1978-2018; then we solve the counterfactual gravity system and compute the associated general equilibrium indices. We solve the model using the "estibration" procedure (Anderson et al. 2018, Yotov et al. 2017) which gives a solution identical to the "exact hat" algebra (Dekle, Eaton & Kortum 2007).

4.3 Deepening existing PTAs

We proceed in this section in two steps. In a first counterfactual, we switch region by region all the existing agreements from their current level of ambition to the highest level of ambition and compute the change in total exports and GDP for the countries in each region separately. Results for the different regions are reported in the seven first rows in column (1) and (2) of Table 8. As an extension, we replicate this exercise but for all PTAs simultaneously. Figure 5 details the estimated general equilibrium effects at the country level of such deepening of existing PTAs worldwide (5 percent increase in exports and 1 percent increase in GDP for the world economy as a whole).[15] Few countries are negatively affected by the global deepening of trade cooperation but overall gains are significantly positive for most of the countries, including for many developing economies.[16]

The second step proceeds exactly the same way but now by deepening separately the existing agreements within each region and between different regions. Specifically, in columns (3) and (4) of Table 8, we report the results for trade and GDP when we switch all the existing agreements within each region of the world economy from their current level of ambition to the highest level of ambition, and keep constant the content of all current extra-regional PTAs. Columns (5) and (6) present the results when we switch all the existing agreements with

[15] All computations are done for the year 2018. Individual effects are weighted by country GDP or export and adds up to the overall effects reported in Table 8.

[16] As an illustration, deepening all existing agreements among countries in the East Asia and Pacific region would lead to, on average, a 6 percent increase in their exports and a 1 percent in their GDP, compared to a baseline where these agreements have the current level of depth. This is an average increase since computation is done in general equilibrium but at the country level before aggregation, as shown in Table A2 in the Appendix for this region. The two first columns in the second to last row of Table A2 are accordingly the same as in the first row of Table 8.

partners outside of the region from their current level to the highest level of ambition while keeping unaltered the content of PTAs with other regional partners. As before, we compute the change in total exports and GDP of each region to illustrate the results.

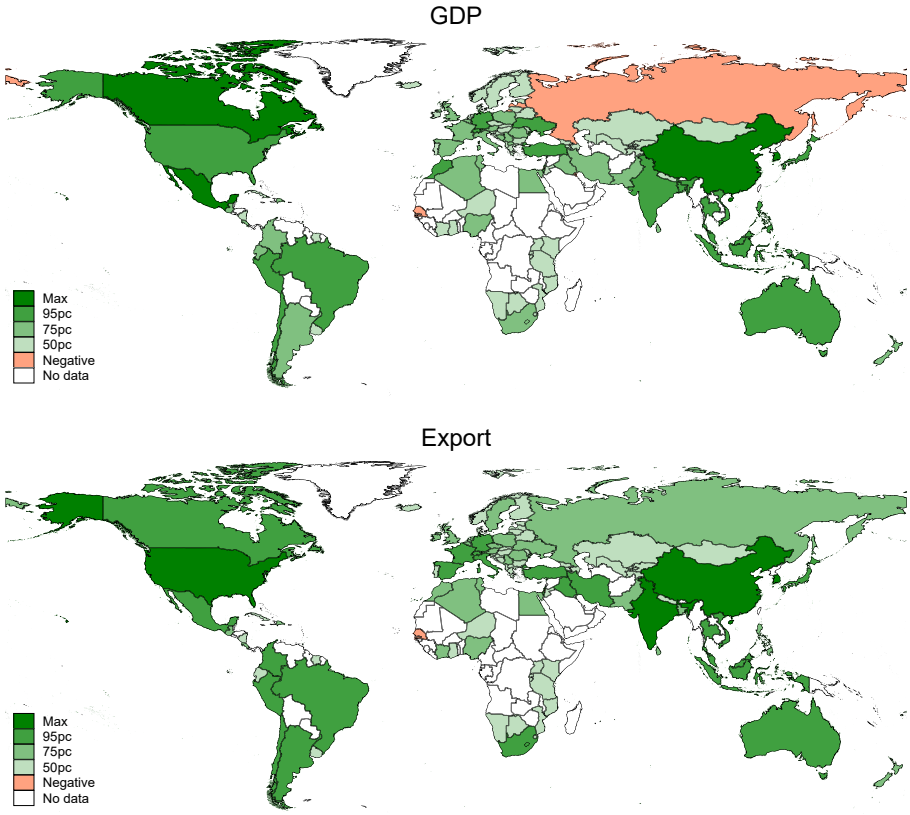
This decomposition provides interesting new insights and helps explaining the mechanisms at play. The economic effect of deepening existing trade agreements within regions is driven by two factors. First, the actual level of ambition of existing agreements within the different regions, as opposed to between regions. Second, the economic size of trading partners with whom the deepening of an existing agreement is envisaged. Given the geography and depth of the existing agreements, the situations are very different for our broad regions. On one extreme, we have a situation where most of the potential gains come from deepening intra-regional PTAs, as in the East-Asia and Pacific case where agreements in the baseline are relatively shallow and the economic size of partners is significant. On the other extreme, we have a situation where all the gains come from deepening agreements with partners outside the region. This is the case for a region like the Middle East and North Africa where larger markets are predominantly extra-regional. In between these situations, Latin America, Africa, South Asia and Europe and Central Asia would have similar gains in deepening trade agreements within or outside the region.

Table 8: General-Equilibrium effects of deeper trade integration by Region, year 2018.

Country Name	Iso3	*All* PTA^{Deep}		*Within Region* PTA^{Deep}		*With RoW* PTA^{Deep}	
		Δ Export	Δ GDP	Δ Export	Δ GDP	Δ Export	Δ GDP
		(1)	(2)	(3)	(4)	(3)	(4)
East Asia & Pacific	EAP	6.10	1.08	4.74	0.88	1.26	0.05
Europe & Central Asia	ECA	2.60	0.76	1.15	0.57	1.96	0.09
Latin America & Caribbean	LAC	8.82	3.98	2.78	0.74	4.79	1.52
Middle East & North Africa	MENA	8.25	0.40	0.89	0.04	4.83	0.18
North America	NA	6.65	1.12	3.05	0.68	2.25	0.24
South Asia	SA	15.61	1.68	1.95	0.17	5.05	0.45
Sub-Saharan Africa	SSA	8.09	1.72	1.33	0.46	2.63	0.60

Note: percent change compared to the baseline in total exports and GDP of participating countries. We assume $\sigma = 5$. The reference country for the normalization is South Africa.

Figure 5: General equilibrium effects of deepening existing PTAs



Note: the map above shows the contribution of each country to the "World" effect as reported in column 1 and 2 of Table 8. Three countries report a moderate contraction in GDP following a global deepening of trade cooperation: Russia (0.076 percent), Kuwait (0.009), Senegal (0.003), Palestine and Latvia (both < 0.002)

5 Conclusion

This paper uses new data on the content of trade agreements and a structural gravity general equilibrium model to quantitatively assess the economic impacts of deepening trade agreements. Based on a clustering of 278 PTAs, comprising 910 provisions grouped in 18 policy areas, we have shown that PTAs of higher ambition are associated with a much larger trade elasticity to PTAs. This finding confirms that using an average effect of PTAs, disregarding the depth and content of trade agreements, is misleading. We then simulated a series of full general equilibrium counterfactual situations for endowment economies, revealing the economic impacts of deepening all existing PTAs, and of deepening trade agreements within regions and between regions. These exercises focusing on the intensive margin of PTAs suggest that deepening trade agreements can have significant effects on trade and GDP. The effects of deepening trade agreements within and between regions vary across countries and world regions depending on the initial depth of trade agreements and on the size of regional markets, but are largely positive. Potential differences in collective preferences between regions, which make

negotiating deep trade agreements more difficult, suggest that for most countries the low-hanging fruits may be in deepening trade agreements within regions.

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Appendix

A The Calculation of the General-Equilibrium Baseline and Counterfactual

Partial- and general equilibrium effects can be described using a standard gravity system reported in Equations A1 to A3, following typical notation: t_{ij} is the vector of trade frictions, Y_i the value of production in the exporting country, E_j the expenditure at destination, and Y the value of World output. Q_i is the endowment (the quantity produced) in the exporting country, p_i the factory-gate price, and ϕ_i is capturing trade balance. The direct effect of a change in trade costs on trade flows between exporter i and importer j, X_{ij}, can be inferred by the estimated coefficients from Equation A1, holding the MRTs Π_i and P_j constant. However, MRTs are not constant, as changing bilateral trade costs between any i and j affects the world structure of trade frictions and relative prices. The indirect (general equilibrium) effect on i and j can accordingly be derived from Equation A2, which is the solution of the conditional General-Equilibrium effects. As a PTA between i and j becomes deeper, this reduces the MRTs for this country pair but increases them for third countries. The feedback on i and j of these changes is given by the General-Equilibrium effect described in terms of the price of the representative firm and expenditure in i (Equation A3).

$$\text{Partial Equilibrium} \begin{cases} X_{ij} = & (\frac{t_{ij}}{\Pi_i P_j})^{1-\sigma} \frac{Y_i E_j}{Y} \end{cases} \tag{A1}$$

$$\text{Conditional GE} \begin{cases} \Pi_i^{1-\sigma} = & \sum_j (\frac{t_{ij}}{P_j})^{1-\sigma} \frac{E_j}{Y} \\ P_j^{1-\sigma} = & \sum_i (\frac{t_{ij}}{\Pi_i})^{1-\sigma} \frac{Y_i}{Y} \end{cases} \tag{A2}$$

$$\text{GE} \begin{cases} p_i = & \frac{(Y_i/Y)^{\frac{1}{1-\sigma}}}{\alpha_i \Pi_i} \\ E_i = & = \phi_i Y_i = \phi_i Q_i p_i \end{cases} \tag{A3}$$

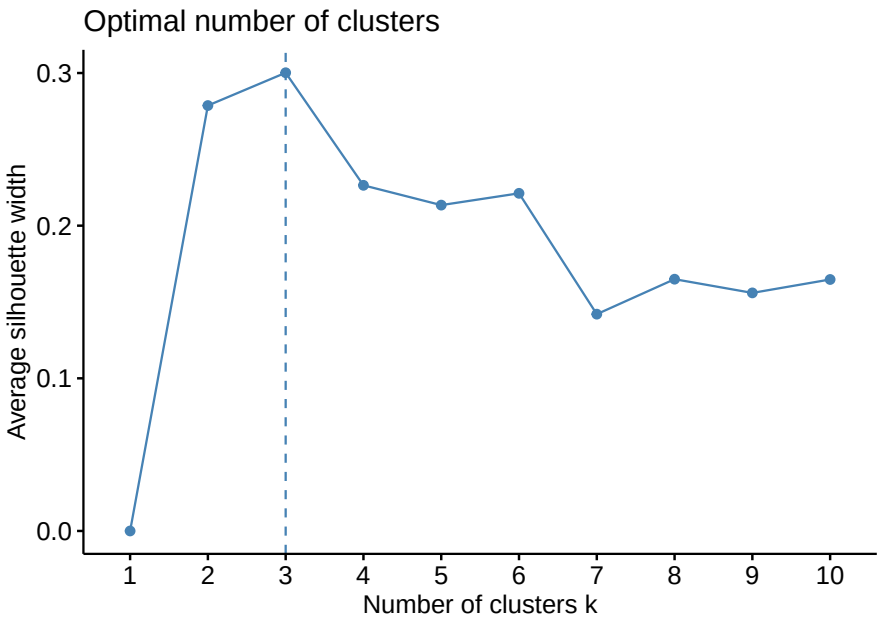
B Additional tables and figures

Table A1: Actual values of the raw and normalized matrix for the area "Services"

Policy Area	Provision	Cluster # 1 EFTA	...	Cluster # 2 PAN-SGP	CHL-JPN	...	Cluster # 3 APTA	TUR-GEO	...	Average
Raw Matrix										
Services	836	0	...	1	1	...	0	0	...	0.29
Services	837	1	...	1	0	...	0	0	...	0.27
Services	850	5	...	1	2	...	1	0	...	1.68
Services	...	...	...	...	...	...	...	...	...	...
Provisions by PTA	62	22	...	50	48	...	17	0	...	
Coverage by cluster		**0.289**			**0.460**			**0.267**		
Normalized Matrix										
Services	836	0.00	...	3.43	3.43	...	0.00	0.00	...	
Services	837	3.71	...	3.71	0.00	...	0.00	0.00	...	
Services	850	2.97	...	0.59	1.19	...	0.59	0.00	...	
Services	...	...	...	...	...	...	...	...	...	...
Score by PTA		0.952	...	2.483	2.901	...	1.084	0.000	...	
Score by cluster		**0.840**			**1.36**			**0.846**		

Notes: APTA Asia Pacific Trade Agreement, EFTA European Free Trade Association. Provisions: # 836, Are there sector-specific chapters (e.g. financial services, telecommunications)? Code: $Services - struc_{chapt}$. # 837, Are there sector-specific provisions in an annex to a chapter on investment or CBTS (such as express delivery as an annex to CBTS chapter)? Code: $Services - struc_{chapt1}$. # 850, To be considered a service supplier of a party to the agreement, in the case of the supply of services through commercial presences, does a juridical person have to: "being incorporated under the domestic law of the party and have substantive business operations in the territory of a member" (coded with value 1, most restrictive), ... , "being owned or controlled by natural persons of the other party" (coded with value 6, most liberal). Code: $Services - roo_{m3}$.

Figure A1: Average Silhouette Value



Note: Optimal number of clusters of Regional Trade Agreements over 18 provision areas.

Table A2: General-Equilibrium effects of deeper trade integration for EAP countries, year 2018.

Country Name	Iso3	*All* PTA^{Deep}		*Within Region* PTA^{Deep}		*With RoW* PTA^{Deep}	
		Δ Export	Δ GDP	Δ Export	Δ GDP	Δ Export	Δ GDP
		(1)	(2)	(3)	(4)	(5)	(6)
Australia	AUS	5.57	6.24	5.18	5.55	0.72	0.18
China	CHN	4.99	0.31	4.24	0.27	0.69	-0.01
Fiji	FJI	7.62	1.81	5.14	1.29	2.03	0.18
Hong Kong	HKG	-4.19	-0.46	-3.05	-0.33	-1.67	-0.24
Indonesia	IDN	14.34	4.62	12.59	4.11	1.91	0.20
Japan	JPN	3.93	0.40	2.88	0.30	1.17	0.03
Korea	KOR	13.41	2.78	7.27	1.49	4.54	0.46
Malaysia	MYS	3.59	8.35	3.14	7.62	0.92	0.31
Mongolia	MNG	-0.14	0.28	-0.26	0.25	0.45	0.14
New Zealand	NZL	7.01	3.34	7.05	3.38	0.37	-0.03
Philippines	PHL	4.06	9.88	3.81	9.64	0.70	0.04
Singapore	SGP	4.18	8.60	2.82	6.11	1.70	1.09
Thailand	THA	11.16	5.40	9.99	4.91	1.39	0.21
Viet Nam	VNM	4.41	9.11	3.89	8.50	0.78	0.05
EAP		6.10	1.08	4.74	0.88	1.26	0.05
RoW		0.38	0.09	-0.37	-0.07	0.15	0.10

Note: percent change compared to the baseline in total exports and GDP of participating countries. We assume $\sigma = 5$. The reference country for the normalization is South Africa. EAP: East Asia & Pacific.