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A General Equilibrium Assessment of the Economic Impact of Deep Trade Agreements

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Abstract

This paper explores the economic impacts of preferential trade agreements, focusing on the provisions they contain, beyond phasing out tariffs. Clustering 278 preferential trade agreements based on 906 provisions grouped into 18 policy areas, three clusters are obtained for which a trade elasticity to preferential trade agreement is estimated using structural gravity. A series of full general equilibrium counterfactual situations for endowment economies is simulated, revealing the economic impacts of deepening existing trade agreements and signing new ones—that is, the intensive and extensive margins of preferential trade agreements. The paper illustrates the method with a general deepening of existing preferential trade agreements worldwide. Focusing on the examples of the Latin America and the Caribbean and East Asia and Pacific regions, the paper shows that deepening preferential trade agreements leads to higher trade and welfare effects than signing new ones.

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A General Equilibrium Assessment of the Economic Impact of Deep Trade Agreements*

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Introduction

A large body of literature focusing on the linkages between Preferential Trade Agreements (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 (GE) effects. Typically, a PTA will reduce trade cost between signing parties and possibly increase the relative trade cost of the signing countries *vis-à-vis* third countries. The final outcome is determined by the precise nature of provisions contained in the agreements. Mattoo, Mulabdic & Ruta (2017) build on Baldwin (2014) and point out that the depth (or content) of trade agreements matters for third-country effects: deep agreements lead to more trade creation and less trade diversion than shallow agreements. Some provisions are purely discriminatory, while some others (e.g. subsidies, competition) do not discriminate between members and non-members of a PTA. So, some provisions will reduce trade costs between members and increase trade costs to non-members, while others can reduce trade costs for both members and non-members.

A proper quantification of the trade effects of PTAs requires a GE framework controlling for the depth of trade agreements. This can be done in calibrated Computable General Equilibrium models (CGEs) or in estimated structural gravity models. The first category of models has the advantage of sectoral decomposition. Notwithstanding the drawback to rely on elasticities estimated outside the model, CGEs offer a flexible tool to assess the sectoral impact of detailed tariff shocks. However, when it comes to assessing the non-tariff dimension of the commitments made in the multilateral arena or in preferential agreements, two problems arise with CGEs: which elasticity of trade flows to changes in non-tariff obstacles to use, and how to assess the tariff equivalent of regulatory obstacles. Were these two pieces of information available (which is not out of reach), another difficulty would be to assess whether the regulation is rent creating (for origin or destination), or pure inefficiency. Indeed, 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 destination specific, 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 from 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, although elasticities "borrowed" from the literature could be used as well in a consistent way. 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. 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.

A natural extension of such modeling approach is to assess the uneven impacts of PTAs (Baier, Yotov & Zylkin 2019), provided that the "ambition" of signed agreements differs strongly. In this paper, we explore the uneven economic impacts deriving from the diverse provisions contained in PTAs. Indeed, competition policy, by allowing foreign competitors to benefit from a level playing field should have more trade creation and less trade diversion effects compared to a simple phasing out of tariffs among members of the PTA. Alternatively, a provision on government procurement might facilitate trade between members of the agreement but increases trade costs vis-a-vis third countries that do not receive the same access to members' public procurement markets. In other words, the varying content of PTAs may be an important determinant of their uneven trade effects. 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.

Our starting point is to rely on an exhaustive description of the provisions included in PTAs based on a new database on the content of PTAs that has been collected by the World Bank (Mattoo, Rocha & Ruta 2020). We use information on all policy areas (except tariffs) encompassing objectives, substantive commitments and enforcement procedures present in legal texts and available 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) and Sanitary and Phytosanitary Standards (SPS), labor rights, or environment.

Such very rich set of information has to be collapsed in broad categories of PTAs in order to be tractable in a GE framework. The first step of the analysis is therefore to define 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 criterium (which evaluates cluster fit on within-group cohesion and between-group separation) recommends 3 clusters. In words, with 3 groups the distance between observations within each group of PTAs is minimized and the distance between groups is maximized. The underlying assumption is that each group of PTAs has a similar content of provisions by policy subject, and thus should impact differently the trade costs between members of the agreement and between the latter and third countries. This classification helps in determining the “natural” groupings (i.e. “cluster”) of observations in our data set based on a transparent statistical approach. 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 clustering of agreements. Here again, we let the data speak and estimate what is the mean impact on trade of belonging to a PTA positioned in a certain 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 right benchmark in terms of trade cost, namely domestic trade. Importantly, we take the gravity equation seriously and embark internal trade flows in our estimation of the trade effects 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.

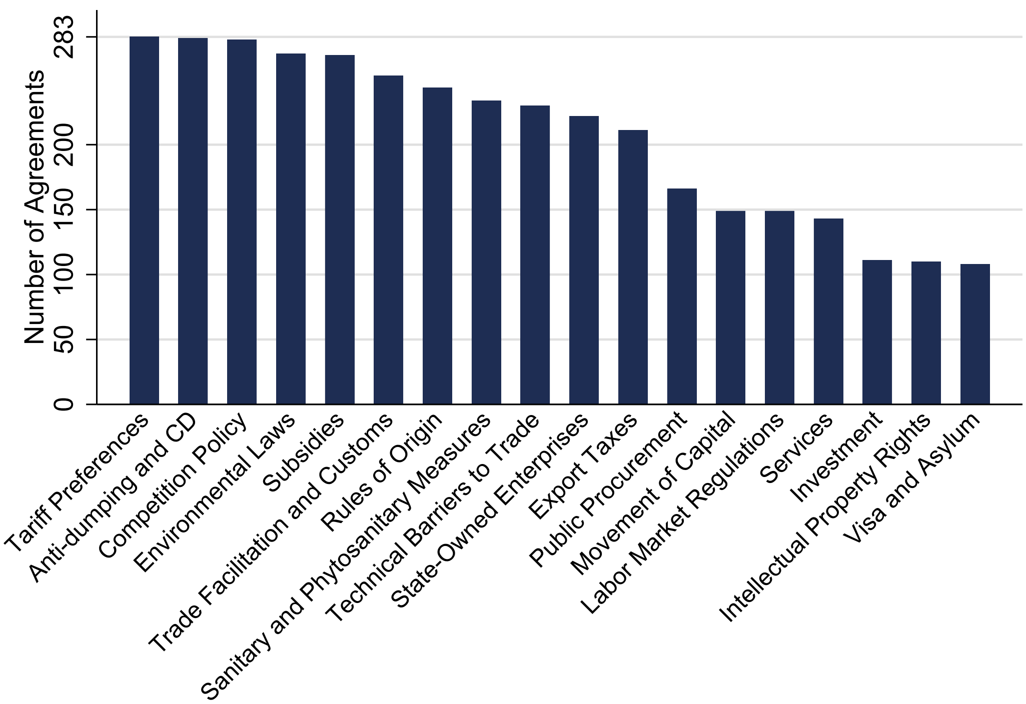
The last step of the analysis illustrates how to perform counterfactual exercises. We firstly move PTAs of interest away from their cluster towards a more ambitious one (i.e. a PTA cluster associated to higher trade, as estimated in the second step) and examine the effects of such policy reform of preferential agreements in general equilibrium. Since we are not changing the network of trade agreements but only their content, this exercise captures a variation in the intensive margin of PTAs. We then simulate the economic impacts of a policy at the extensive margin, consisting in signing new agreements (with different content and, hence, at different levels of ambition). To provide a quantitative illustration, we concentrate on the Latin America and the Caribbean and the East Asia and Pacific regions, although the approach could be applied to a more general and systematic analysis of prospects for PTAs.

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 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, countries in Latin America and the Caribbean,and countries in East Asia and Pacific. Section 4 concludes.

1 Clustering PTAs based on their content

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).[1] 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 1980 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 (906 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 policy or services. More than one-half of the agreements considered for this analysis cover 50 percent or more

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

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.

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.[2]

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 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

[2] 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 converge to a stable classification after few rounds. As a robustness we also test a non-iterative setup in Section 2.1.

agreements (columns) and 906 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 906 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.

Table 4 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.

Using this normalization of the data, we classify PTAs into a series of clusters using the K-mean methodology. 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 2 reports the average silhouette width by number of clusters. The silhouette reaches its maximum when the data are partitioned across three clusters: Cluster #1 (28 agreements), Cluster #2 (83 agreements) and Cluster #3 (167 agreements). Table A1 in the Appendix details the composition of the first two clusters. These three clusters are going to be used in the next section to assess the impact of PTAs on trade.

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 3 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 GE approach.

Table 1: Content of preferential trade agreements, 1980-2018

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 RCA-1 (1)	Cluster # 2 RCA-2 (2)	 RCA-3 (3)	Cluster # 3 RCA-4 (4)	 RCA-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)

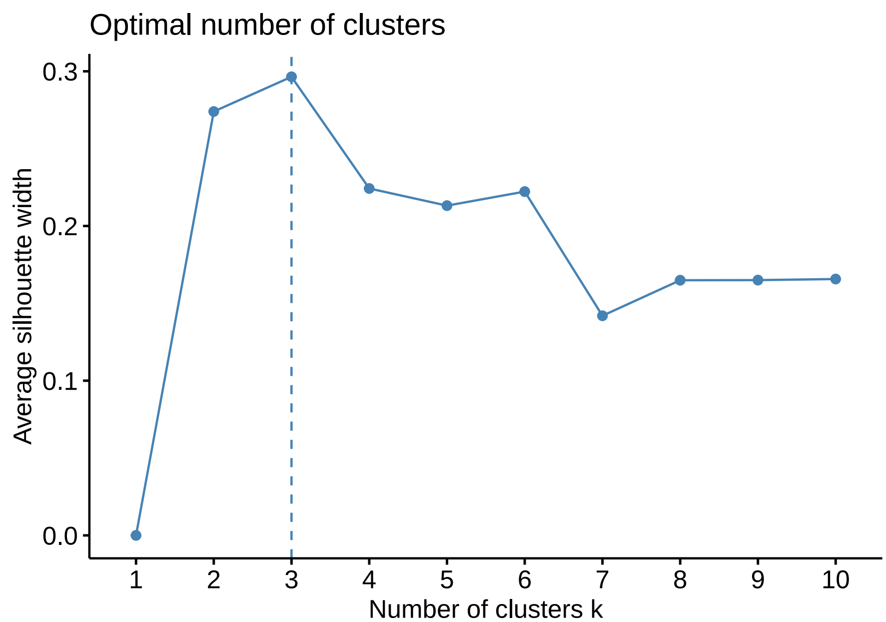
Policy Area	Provision	Cluster # 1 RCA-1 (1)	Cluster # 2 RCA-2 (2)	 RCA-3 (3)	Cluster # 3 RCA-4 (4)	 RCA-5 (5)	Average (6)
Area xx	a	3.75	1.25	0.00	0.00	0.00	
Area xx	b	2.50	1.25	0.00	1.25	0.00	
Area xx	c	1.00	1.00	1.00	1.00	1.00	
Score by PTA		2.42	1.17	0.33	0.75	0.33	
Score by cluster		**2.42**	**0.75**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

Table 4: 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**			

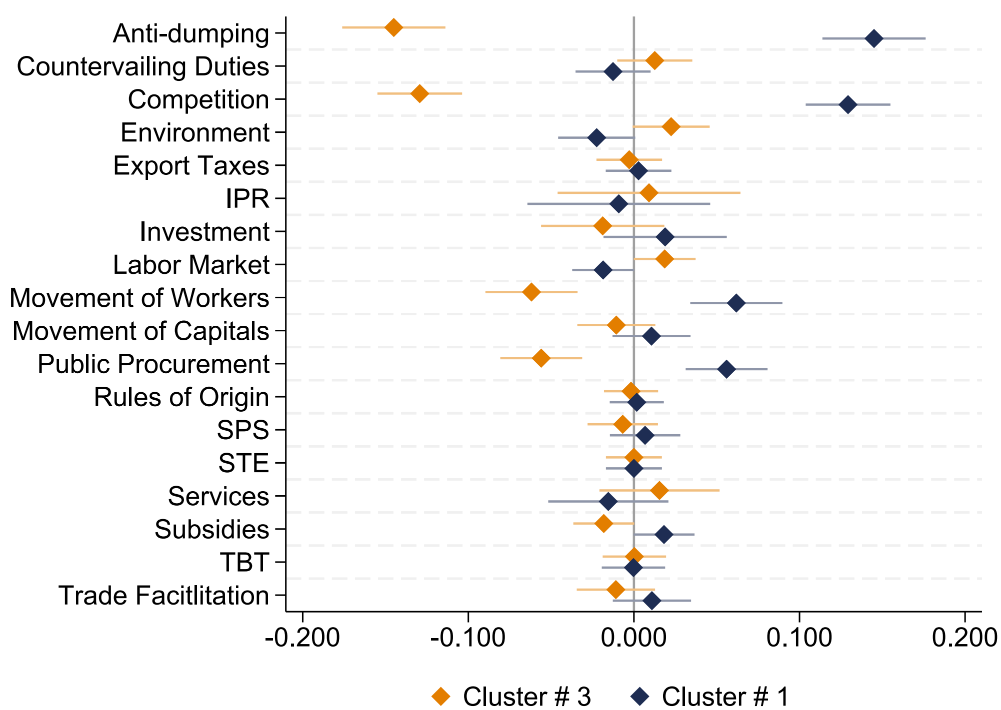
Notes: APTA Asia Pacific Trade Agreement, EFTA European Free Trade Association. Provisions: # 836, Are there sector-specific chapters (e.g. financial services, telecommunications)? Code: $Services - struc_{chapt}$. # 837, Are there sector-specific provisions in an annex to a chapter on investment or 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 2: Average Silhouette Value



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

Figure 3: 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 trade 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. Specifically, we estimate the following structural gravity model, using PPML with panel data:[3]

$$X_{ij,t} = exp\left(\sum_{z=1}^{3} \beta_z PTA^{z}_{ij,t} + \sum_{T=1980}^{2000} \beta_T INTL\ BRDR_{ij} * T + \pi_{i,t} + \chi_{j,t} + \mu_{ij}\right) + \epsilon_{ij,t} \quad (1)$$

Where $X_{ij,t}$ includes both intra-national and international manufacturing trade flows on 5-year intervals from 1982 to 2017.[4] Intra-national sales are needed as the correct benchmark for trade integration is the domestic economy (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 CEPII BACI database and TradeProd combined with UNIDO INDSTAT2 2019.[5] Following standard practice, we fill in intra-national flows using linear interpolation between non-missing data and extrapolate remaining missing values using the evolution of country total exports as in Baier et al. (2019). 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 and importer-time fixed effects control for time-varying Multilateral Resistance Terms, while bilateral fixed effects 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 5 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 three columns exploit the raw UNIDO data we rely on. There are 99,000 observations for only 114 countries for which we observe internal flows. In order to expand internal flows coverage, in column 4 we rely

[3] $X_{ij,t}$ is in levels in columns 1 to 7 of Table 5, and in shares of absorption at destination – namely $\frac{X_{ij,t}}{\sum_i X_{ij,t}}$ – in column 8. See discussion below.

[4] We tested the robustness of our findings over the period 1980-2015: the estimation results are not affected, see Table A2 in the Appendix.

[5] BACI is used to retrieve information on international trade flows from 1990 up to 2017 Gaulier & Zignago (2010), TradeProd provides data on both inter-national and intra-national trade from 1980 up to 2006 de Sousa, Mayer & Zignago (2012), whereas UNIDO INDSTAT2 2019 combined with BACI is used to derive domestic sales from 2007 to 2017. For the overlapping years we find a very high correlation (close to 99%) between TradeProd and the other sources for both inter-national and intra-national trade flows. When multiple sources are available for a given year we take the geometric average of the corresponding flows.

on a linear interpolation to complete the dataset and add 17 countries. [6] Columns 5 to 7 go one step further by extrapolating the missing observations for internal flows following Baier et al. (2019) procedure, which leads to approximatively 154,000 "observations" for 153 countries.

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 significant. 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).[7] 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 5 (extrapolating the missing observations for internal flows and thus considering 153 countries) is then split by clusters of PTAs. In column 6 the elasticity ranges from 0.17 to 0.36, with cluster #1 having the largest impact on trade.[8] We refer to this cluster as the one of (revealed) "deep" PTAs, the second as "medium" and the third as "shallow" PTAs. It is worth emphasizing that as the parameter estimates for both cluster #2 and cluster #3 are considerably close to each other whereas cluster #1 seems to be associated with a statistically higher effect, the counterfactual exercise in Section 3 concentrates on the general equilibrium effects of "deep" agreements only.

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.[9] Accordingly, in column 7 we rely on the fix developed by Weidner & Zylkin (2019) 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, with the exception of the $TransitoryPTAs$ variable turning insignificant, is confirmed.

Also, the PPML estimator assigns more weight to countries with large imports 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). We evaluate to what extent a differential weight might affect our results and report the results from a PPML in shares in column 8 of Table 5. Although when estimated in shares the elasticity of the PTA dummy is statistically unaffected with a point estimate of 0.256 (s.e. 0.037) whereas in levels the point

[6] As mentioned in the previous section, only countries with non-missing intra-national trade flows join the estimation sample.

[7] As the estimation sample covers 5-year intervals over the period 1982-2017, the years 2012 and 2017 represent the excluded decade.

[8] As reported in Table A2, we would have a slightly higher trade impact considering the 1980-2015 period; hence our estimation is more conservative.

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

estimate is 0.242 (s.e. 0.053), the estimates by cluster bring insightful evidence. On one hand, the estimated effect for Cluster #1 is only marginally affected by the normalization: this is reassuring as the counterfactual design, presented in Section 3, focuses on the expected general equilibrium effects of being part of a "deep" agreement. On the other hand, as a result of putting more weight on small flows, the order of the remaining two clusters is now reversed, although the point estimates still largely overlap. Cluster #3 becomes relatively more trade enhancing than cluster #2.[10]

Our preferred estimate in column 6 yield then a more conservative set of elasticities to simulate the welfare effect of trade policy shocks.[11] Indeed, the identified trade elasticities to PTAs in column 6 will be the parameters introduced in the general equilibrium gravity model, jointly with the pair fixed effects and the international border effects.

Figure 4 reports 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 reflects the strength of the trade elasticity by cluster estimated in Table 5. As shown in the figure, the separation between clusters is clear-cut with very few agreements at the "border" of their partition. Most importantly, agreements in Cluster # 1 (the "Deep" ones) appear to stand apart from the rest of the sample. In Section 2.1 we present the estimated effects after reallocating the few "borderline" agreements to the closest alternative cluster; our results are hardly affected. The figure also reports the position of PTAs signed by Latin America and the Caribbean and East Asian and Pacific countries that will be analyzed in the counterfactuals in the next section.

[10] When estimated in shares, PPML "down-weights" the influence of the observations pertaining to importers with large absorption (Sotelo 2019). In our sample, cluster #1 comprises larger countries with relatively less dispersed import shares. The average country absorbs, within cluster #1, 0.16 percent of world trade with a coefficient of variation (CV) of 1.94; within cluster #2 the average country absorption is much lower at 0.024 percent with a CV of 2; whereas within cluster #3 despite the fact that the average country absorbs 0.027 percent of world trade, the CV is higher at 2.63. This evidence seems to suggests an heterogenous effect for the policy portfolio covered in both clusters #2 and #3; we leave this topic as a relevant task for further research.

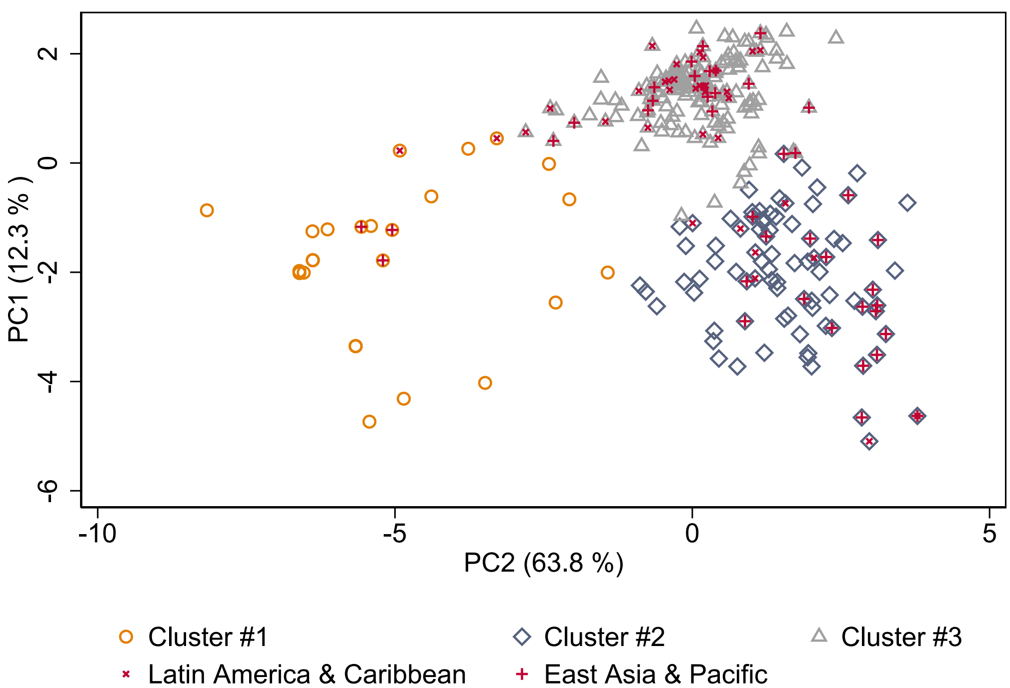
[11] Moreover, with a coverage of 153 countries the intra-national extrapolation procedure proved to be valuable as it authorizes a variety of counterfactuals.

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

Dep Var: X_{ijt}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	X_{ijt}/X_{jt} (8)
$PTA_{ij,t}$	0.610***	0.620***	0.271***	0.279***	0.242***			
	(0.057)	(0.070)	(0.050)	(0.050)	(0.054)			
$PTA^{K\#1}_{ij,t}$						0.364***	0.407***	0.393***
						(0.105)	(0.137)	(0.077)
$PTA^{K\#2}_{ij,t}$						0.200***	0.228***	0.179***
						(0.043)	(0.052)	(0.045)
$PTA^{K\#3}_{ij,t}$						0.170***	0.185***	0.238***
						(0.056)	(0.066)	(0.040)
Transitory $PTAs_{ij,t}$		0.044	0.109*	0.130**	0.109*	0.171**	0.186*	0.201***
		(0.072)	(0.056)	(0.057)	(0.058)	(0.077)	(0.108)	(0.048)
INTL BRDR∗1980			-1.103***	-1.115***	-1.166***	-1.154***	-1.171***	-1.815***
			(0.051)	(0.051)	(0.052)	(0.054)	(0.096)	(0.061)
INTL BRDR∗1990			-0.569***	-0.572***	-0.600***	-0.600***	-0.605***	-1.069***
			(0.040)	(0.039)	(0.039)	(0.039)	(0.058)	(0.043)
INTL BRDR∗2000			-0.142***	-0.141***	-0.156***	-0.159***	-0.168***	-0.279***
			(0.029)	(0.029)	(0.027)	(0.028)	(0.053)	(0.029)
Period	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017
Treatment for missing Intra-National flows	UNIDO	UNIDO	UNIDO	Linear Interpolation	Col (4) plus Extrapolation	Col (4) plus Extrapolation	Col (4) plus Extrapolation	Col (4) plus Extrapolation
N. Countries (max)	114	114	114	131	153	153	153	153
N. Countries (end year)	87	87	87	91	153	153	153	153
Observations	99,363	99,363	99,363	111,632	156,789	156,789	156,789	156,789
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij

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 (2019) procedure, implemented in Stata with *ppml_fe_bias*. In column 4 missing values in domestic sales are linearly interpolated; in column 5 to column 8 we extrapolate the remaining missing values using the evolution of a country total exports.

Figure 4: 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.

2.1 Robustness checks

We now perform three robustness tests addressing the potential impact of the classification of country-pairs with a PTA within our three clusters. The first and second tests consider alternative classifications: we use a different classification algorithm before and alternatively switch clusters for countries at the border of a neighboring cluster. The third test is more demanding: we keep the three clusters, and the number of country pairs in each one, but reallocate country pairs randomly across clusters. At each replication we re-estimate the trade impact of the three clusters. If the estimated difference in PTA's impact shown in column 6 of Table 5 is robust, after a large number of replications the distribution of the estimated parameter for each of the three clusters will be centered on the value obtained in column 5 where clusters are disregarded.

In Table 6 we test the robustness of our main results against two alternative classifications: i) grouping agreements based on a different clustering algorithm (columns 1 to 3)[12] and ii) manually reclassifying few "borderline" agreements in the baseline grouping (columns 4 to 6). In columns 3 and 6 we eliminate differences in the penalization of large and small trade flows by normalizing trade flows by destination country total absorption, as discussed above.

As for option i), the clustering procedure allocates 23 PTAs in cluster #1, 58 PTAs in cluster #2 and the remaining 197 PTAs in cluster #3. The most important difference with respect to the baseline ordering is that a few agreements, NAFTA, Chile-Japan and Peru-Mexico, are no longer classified as "Deep" under i).

As for option ii) we manually recode 3 agreements from cluster #2 to cluster #1 (i.e. EFTA-Hong Kong, EFTA-Montenegro and EFTA-Bosnia and Herzegovina) and 3 from cluster #1 to cluster #3 (Andean Community, Commonwealth of Independent States and Peru - Mexico) as were placed at the border of the corresponding group in Figure 4. Reassuringly, estimated coefficients are only marginally affected by the alternative classifications, especially the magnitude of the trade premium associated with the most ambitious group is hardly affected.

Figure 5 finally reports the distribution of the estimated coefficients when the (24,162) 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 5 of Table 5

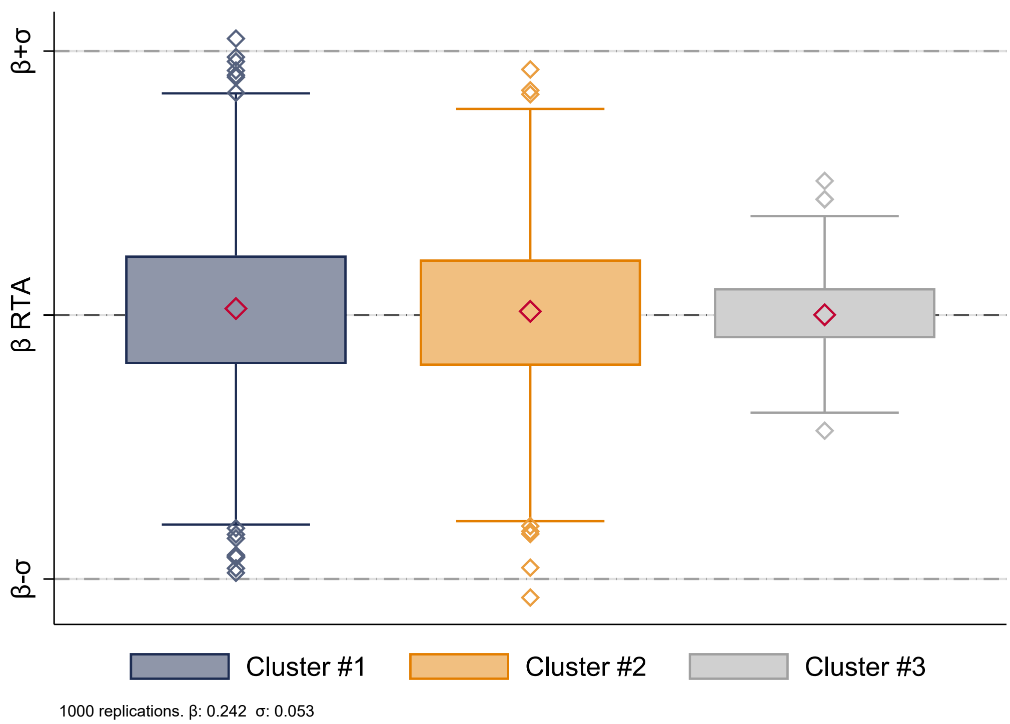
[12]The clustering procedure here relies on the "KmeansPP" function in R (Ostrovsky, Rabani, Schulman & Swamy 2013), with non-iterative setup.

Table 6: PPML: Gravity Estimations of the elasticity of trade to PTAs by Alternative Cluster Definitions

Dep Var: X_{ijt}	(1)	(2)	X_{ijt}/X_{jt} (3)	(4)	(5)	X_{ijt}/X_{jt} (6)
$PTA^{K\#1}_{ij,t}$	0.347***	0.379**	0.402***	0.380***	0.421***	0.372***
	(0.128)	(0.167)	(0.083)	(0.103)	(0.133)	(0.078)
$PTA^{K\#2}_{ij,t}$	0.274***	0.309***	0.248***	0.183***	0.211***	0.172***
	(0.059)	(0.081)	(0.048)	(0.042)	(0.052)	(0.045)
$PTA^{K\#3}_{ij,t}$	0.167***	0.192***	0.209***	0.165***	0.180***	0.251***
	(0.047)	(0.055)	(0.038)	(0.056)	(0.066)	(0.040)
Transitory $PTAs_{ij,t}$	0.147**	0.151	0.211***	0.176**	0.191*	0.192***
	(0.074)	(0.106)	(0.047)	(0.076)	(0.107)	(0.048)
INTL BRDR∗1980	-1.158***	-1.176***	-1.815***	-1.153***	-1.170***	-1.817***
	(0.053)	(0.094)	(0.061)	(0.054)	(0.096)	(0.061)
INTL BRDR∗1990	-0.599***	-0.604***	-1.067***	-0.601***	-0.606***	-1.069***
	(0.039)	(0.058)	(0.043)	(0.039)	(0.058)	(0.043)
INTL BRDR∗2000	-0.155***	-0.164***	-0.275***	-0.159***	-0.169***	-0.279***
	(0.027)	(0.053)	(0.029)	(0.028)	(0.053)	(0.029)
Cluster definition	Non-iterative setup			Reclassify "borderline" PTAs		
Period	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017	1982-2017
N. Countries (max)	153	153	153	153	153	153
N. Countries (end year)	153	153	153	153	153	153
Observations	156,789	156,789	156,789	156,789	156,789	156,789
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij

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 and column 4 both standard errors and point estimates are corrected using the Weidner & Zylkin (2019) procedure, implemented in Stata with *ppml_fe_bias*. In column 3 and 6 the dependent variable is normalized using destination country total imports. In all columns missing values in domestic sales are linearly interpolated and the remaining missing values are extrapolated using the evolution of a country total exports. The "kmean++" algorithm in column 1 and column 2 classifies: 23 PTAs in cluster #1; 58 PTAs in cluster # 2 and the remaining 197 PTAs in cluster # 3. Agreements with the higher trade effects (i.e. cluster #1) largely overlap with the ones identified by the preferred routine. A notable exception is NAFTA that is now classified as "medium" depth agreement (i.e. cluster # 2) but was classified as high elasticity agreement by the preferred algorithm.

Figure 5: 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 General equilibrium gravity and counterfactuals

We can now quantify the trade and welfare impacts of counterfactual PTAs. Thanks to the analysis of the impact of different clusters of signed PTAs in the previous section, we not only assess the economic consequences of signing new agreements but also of deepening existing ones. To illustrate our approach, we firstly shift all PTAs worldwide to the highest ambition and then focus on two regions: (i) Latin America and the Caribbean countries (hereafter "LAC countries") and (ii) the East Asia and Pacific region (hereafter "EAP countries"). Indeed the method can be applied to any other region. Concerning the latter counterfactuals, we simulate in GE a deepening of existing PTAs within the two regions, meaning switching existing PTAs from cluster #2 and #3 to cluster #1, or between countries in the two regions and the Rest of the World. Second, we simulate a scenario where LAC (or EAP) countries sign unsigned agreements with each other, with different level of ambition. The first consequence of deepening agreements and signing new ones, as evidenced above by our gravity estimation, is to modify the overall structure of trade costs.

3.1 Quantification strategy

To proceed we rely on a GE gravity model, we change the vector of agreements between country pairs (deepening existing agreements or signing new agreements of one of the three types). Bilateral trade between each country pair will react to the simulated policy change through two channels: (i) a direct effect driven by the estimated parameters $\beta_z, z = (1, ...3)$ in Equation 1; (ii) an indirect 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 agreements. Here, the multilateral resistance terms (MRT thereafter) *à la* Anderson & Van Wincoop (2003) act as GE trade cost indices transmitting local policy shocks to the overall matrix of trade frictions. 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 variety exported by the representative producer and expenditure in the exporting country. This corresponds to the *general-equilibrium effects* for an endowment economy (Head & Mayer 2014).

Two types of counterfactuals can be contemplated. At the extensive margin, we impose the ratification of new agreements at different depth within a region of the world economy. In this scenario, we impose that non-positive entries in $PTA_{z\#}$ are switched to 1 separately for each depth class $z = 1, 2, 3$. At the intensive margin, we deepen the existing agreements involving countries in a given region of the world economy, both with other countries in the region and with countries outside the region. In this simulation, 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. Alternatively, we can deepen all the existing agreements in the world economy.

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} to their initial value, to obtain counterfactual values for the MRTs and eventually solving for the general-equilibrium effects for an endowment economy.

Starting from the baseline (BLN) 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: t_{ij} for trade costs, 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 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 EAPs 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 inter-national trade flows and covering the years 1990, 1995, 2001, 2007 and 2014; then we solve the counterfactual gravity system and compute the associated GE 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).

3.2 Deepening existing PTAs worldwide

We can now implement our modeling strategy. Considering the deepening of existing PTAs worldwide is associated with significant aggregate gains both for exports and GDP at the world level.

The expansion of the scope of all the Medium and Shallow agreements in force in year 2017 is associated to an increase of 2.49 percent in world exports and 0.41 percent in world GDP.[13] With 0.91 percent increase in exports and 0.16 percent in GDP due to the transition of "Medium" agreements to "Deep". Trade costs fall between members as depth increases, leading to higher trade and GDP. Non-members may see their trade costs with members increase or decrease, depending on the content of PTAs. On net, most countries benefit from the global deepening of trade agreements, but we still observe losses for some.

The suggested magnitude seems meaningful, considering the fact that for some economy relative trade costs may actually increase in the counterfactual scenario, negatively impacting both exports and income: 17 countries reported a decline in total exports, the more pronounced being - 2.5 percent in Eritrea/Ethiopia; while 16 countries experienced a decline in GDP, with Hong Kong SAR, China being the worst affected, at -0.8 percent.

3.3 Deepening regional integration in the LAC region

In this counterfactual exercise, we focus on the LAC region and assume that the existing PTAs involving LAC countries became as deep as those in cluster #1. LAC countries record a total of 36 agreements within the region, classified as follow: 2 in the cluster #1 (Andean Community, Peru-Mexico); 8 in cluster #2; and 26 in cluster #3. With respect to the rest of the world LAC countries are engaged in 61 agreements: 4 in cluster #1 (NAFTA, Canada-Chile, EFTA-Chile, Chile-Japan); 27 in cluster #2; and 30 in cluster #3. The results for this intensive margin of policy integration are shown in Table 7. As expected, intensifying cooperation enhance trade among participating countries, with only marginal diversion from countries in the Rest of the World and Barbados.

We can now implement our modeling strategy and proceed with the two counterfactuals: PTA^{CFL}_{Deep} and PTA^{CFL}_{All}. These two exercises correspond respectively to the intensive and extensive margins of regional integration in Latin America and the Caribbean.

The results for the intensive margin of policy integration are shown in Table 7. As expected, intensifying cooperation enhances trade among participating countries, with only marginal diversion from countries in the Rest of the World and isolated Caribbean countries. A good illustration of the impact of reinforcing integration within the LAC region is given by Argentina: 6.2 percent increase in exports and 0.8 percent increase in GDP. If

[13] Detailed results are not reported here for the sake of brevity since we focus on two regions of the world economy in the next sections.

one extends the measured impact to relations between Argentina and the Rest of the World, these impacts are magnified (respectively +8.35 and +1.11 percent). Impacts are even larger for smaller economies in the region (e.g. Colombia, Paraguay or Peru).

Diversion effects are present, but concentrated on relatively disconnected and small economies in the region such as: Barbados and Haiti. At the regional level both countries only participate in the Caribbean Community (Caricom), which belongs to the cluster of medium cooperation agreements, hence the indirect trade cost channel is likely to play a major role. As other countries in the region become more closely integrated - i. e. bilateral trade costs decline - shipping from/to Caricom countries becomes relatively more costly. The third country trade costs adjustment channel is also manifest for Paraguay and Uruguay: for these two countries, the simulated impact of deepening cooperation with all the partners (column 3 and column 4) are smaller than the effect of increasing cooperation within the region only (column 1 and 2). This outcome is driven by the fact that Paraguay and Uruguay do not have any agreement outside the LAC area. Thus, when other countries in the region intensify cooperation with the rest of the world relative trade costs from/to Paraguay and Uruguay increase.[14]

Peru and Colombia stand out as peculiar cases: being two relatively small LAC countries both reveal sizeable gains in terms of exports and GDPs in columns 3 and 4 of Table 7. By deepening their existing PTAs, Peru (Colombia) would record a 17.40 (19.68) percent increase in exports and a 1.75 (0.99) percent increase in GDP. For both countries, this result is mostly driven by the agreements with the EU, in force since 2013 and graded, in the baseline, as a "medium" cooperation agreement (cluster #2), and with the USA, in force since 2009 with Peru and since 2012 with Colombia both ranked as a "shallow" treaty (cluster #3). By shifting the agreements to cluster #1, the counterfactual exercise assumes that Peru and Colombia will become much more closely integrated with both the European Union and the United States, which already absorb a large share of their exports.

After the quantification of the economic impacts of the intensive margin of integration among the LAC countries, our aim is to quantify the impact of the extensive margin of integration. To proceed, we simulate the effect of ratifying all the vacant agreements within the LAC region at different levels of integration. As of 2017, the PTA network for the LAC region appears to be relatively dense with 40 percent of the country pairs sharing an agreement (although only 2 of them are classified as "Deep"). Practically this second counterfactual exercise evaluates the expected gains of signing the remaining 60 percent of bilateral agreements at different level of ambition.

The results for the *stricto sensu* extensive margin of trade integration are shown in column 5 and 6 of Table 7. Here, small LAC countries signing with large countries in the region see their trade (and GDP) increase much,

[14]Both Paraguay and Uruguay only participate in the Latin American Free Trade Association (LAFTA, ended in 1980), Southern Common Market (MERCOSUR) and Latin American Integration Association (LAIA).

by sake of gravity forces. Barbados is an extreme example of such country, whereby exports would increase by 3.45 percent and GDP by 1.11 percent even by adopting the less ambitious trade agreement configuration.[15] Reciprocally, there is little gain for large countries such as Argentina signing with small ones. More interestingly for our exercise, singing deep agreements (of cluster #1) would magnify those gains for small countries. Keeping the extreme example of Barbados, exports would increase by 7.96 percent with a deep agreement and GDP by 2.59 percent (columns 5 and 6).

This set of results point to two main policy implications on the path forward for regional integration in the Latin America and the Caribbean region. The first policy message is that relatively large LAC countries already engaged in networks of PTAs would benefit more from a deepening of existing agreements than from extending such network to new partners. The second policy message is that small LAC countries would gain from signing new agreements, even of a shallow type, although gains would be higher with deeper agreements.

Table 7: General-Equilibrium effects of deeper trade integration for LAC countries, year 2017.

		Intensive Margin PTA^{CFL}_{Deep}				*Extensive Margin* PTA^{CFL}_{All}	
		Within LAC		Within LAC plus ROW		Within LAC, Cluster #1	
Country Name	Iso3	Δ Export (1)	Δ GDP (2)	Δ Export (3)	Δ GDP (4)	Δ Export (5)	Δ GDP (6)
Argentina	ARG	6.20	0.82	8.35	1.11	0.28	0.03
Bahamas	BHS	0.00	0.01	2.97	1.69	1.77	0.96
Barbados	BRB	-0.19	-0.06	2.19	0.67	7.96	2.59
Belize	BLZ	0.28	0.09	3.45	1.49	3.85	2.42
Bolivia	BOL	7.84	1.43	9.24	1.67	0.13	0.02
Brazil	BRA	3.56	0.18	5.81	0.28	0.30	0.02
Chile	CHL	2.86	0.62	13.78	3.15	0.04	0.01
Colombia	COL	8.58	0.43	19.68	0.99	1.55	0.08
Costa Rica	CRI	2.91	0.66	11.46	2.78	1.11	0.28
Cuba	CUB	3.51	0.17	5.86	0.28	1.30	0.06
Dominican Republic	DOM	0.13	0.17	3.90	4.75	1.64	2.01
Ecuador	ECU	4.83	0.55	7.24	0.82	3.19	0.36
El Salvador	SLV	3.06	2.19	5.90	4.53	0.26	0.31
Guatemala	GTM	4.33	1.58	8.74	3.60	0.95	0.38
Haiti	HTI	0.02	0.00	-0.71	-0.43	3.91	2.51
Honduras	HND	1.38	1.87	4.89	5.91	0.25	0.43
Jamaica	JAM	0.76	0.17	4.28	0.90	2.89	0.71
Mexico	MEX	0.24	0.32	0.92	2.12	0.02	0.02
Nicaragua	NIC	0.86	2.78	3.30	6.66	-0.02	-0.01
Panama	PAN	1.25	0.78	2.34	1.90	5.89	3.11
Paraguay	PRY	8.95	1.39	8.83	1.39	0.21	0.03
Peru	PER	4.15	0.40	17.40	1.75	0.32	0.03
Saint Lucia	LCA	3.08	1.39	3.68	1.81	3.15	1.55
Suriname	SUR	0.87	0.00	3.60	0.01	1.79	0.00
Trinidad and Tobago	TTO	1.69	0.50	3.35	1.13	1.53	0.43
Uruguay	URY	5.19	1.09	4.97	1.06	0.41	0.07
Venezuela, RB	VEN	4.10	0.24	6.53	0.39	2.28	0.14
LAC		1.96	0.31	4.44	1.01	0.29	0.05
RoW		-0.02	0.00	0.08	0.01	0.00	0.00

Note: percent change compared to the baseline in total exports and GDP of participating countries.

[15] Results for the counterfactuals addressing less ambitious agreement types are not reported in the table but available upon request.

3.4 Deepening regional integration in the East Asian & Pacific region

We finally illustrate our method considering the depth of regional integration in the EAP region. We proceed with two counterfactuals, PTA^{CFL}_{Deep} and PTA^{CFL}_{All} that correspond respectively to the intensive and extensive margins of regional integration.

In the first counterfactual exercise, we are assuming that the existing PTAs involving EAP countries became as deep as those in cluster #1. EAP countries record a total of 40 agreements within the region, classified as follow: 3 in the cluster #1 (ANZCERTA,[16] China - Macao, China - Hong Kong SAR, China); 20 in cluster #2; and 17 in cluster #3. With respect to the rest of the world EAP countries are engaged in 56 agreements: 1 in cluster #1 (Chile - Japan); 22 in cluster #2; and 33 in cluster #3. The results for this intensive margin of policy integration are shown in Table 8. As expected, intensifying cooperation enhance trade among participating countries, with only marginal diversion from countries in the Rest of the World and Hong Kong SAR, China. A good illustration of the impact of reinforcing integration within the EAP region is given by the Republic of Korea: 4.74 percent increase in exports and 0.8 percent increase in GDP. If one extends the measured impact to relations between Korea and the Rest of the World, these impacts are only marginally smaller (respectively +4.35 and +0.7 percent). Impacts are even larger for smaller economies in the region (e.g. the Philippines, Thailand and Vietnam).

Diversion effects are present only for Hong Kong SAR, China, experiencing a reduction in total exports of 0.49 percent and a decline in GDP of 0.7 percent. The diversion effect for Hong Kong is due to the fact that the country already has a deep trade partnership with China. Hence the main channel affecting Hong Kong in the simulation is the indirect trade cost effect. As other countries in the region become more closely integrated – i. e. bilateral trade costs decline – shipping from/to Hong Kong becomes relatively more costly, confirming the strength of general equilibrium adjustment forces.

The Lao People's Democratic Republic and Tonga stand out as peculiar cases: being two relatively small EAP countries both reveal sizeable gains in terms of exports and GDPs in columns 1 and 2 of Table 8. By deepening their existing regional PTAs, Lao PDR (Tonga) would record a 10.37 (6.65) percent increase in exports and a 2.54 (1.27) percent increase in GDP. For Lao PDR , this result is mostly driven by the agreements within AFTA and APTA,[17] in force since 1992 and 1976 respectively and both graded as "shallow" cooperation agreements (cluster #3). For Tonga the effect seems to be driven by the PICTA and SPARTECA agreements,[18] in force since 2003 and 1981 respectively, and both ranked as "shallow" treaties (cluster #3). By shifting such agreements to cluster #1, the counterfactual exercise assumes that Laos and Tonga will become much more closely integrated within the region, which already absorbs a large share of their exports.

[16] Australia - New Zealand, Closer Economic Relations Trade Agreement.
[17] AFTA stands for ASEAN Free Trade Area; whereas APTA stands for Asia Pacific Trade Agreement.
[18] PICTA stands for Pacific Island Countries Trade Agreement; whereas SPARTECA stands for South Pacific Regional Trade and Economic Cooperation Agreement.

In the second counterfactual exercise, we are simulating the effect of ratifying all the vacant agreements within the EAP region at different levels of integration. As of 2017, the PTA network for the EAP region appears to be fairly dense with 51 percent of the country pairs sharing an agreement (although only 3 of them are classified as "Deep"). Practically this second counterfactual exercise evaluates the expected gains of signing the remaining 49 percent of bilateral agreements at a different level of ambition. The results for the *stricto sensu* extensive margin of trade integration focusing on deep regional integration (i.e. cluster #1) are shown in columns 5 and 6 of Table 8. Here, small EAP countries signing with large countries in the region see their GDP increase by a lot, due to gravity forces. Papua New Guinea is an extreme example of such country, whereby exports would increase by 4.3 percent and GDP by 6.4 percent. Reciprocally, there is little gain for large countries such as China and Australia; with the notable exception of Japan recording an increase of about 11 percent in exports and 0.84 percent in GDP, most likely driven by the intensification of bilateral trade with China (as of 2017 there are no direct PTAs between the two countries, expect the mutual association to the ASEAN in 2005 for China and 2008 for Japan).

This set of results point to two main policy implications on the path forward for regional integration in the East Asia and Pacific region. The first policy message is that relatively large EAP countries already engaged in networks of PTAs would benefit more from a deepening of existing agreements than from extending such network to new partners. The second policy message is that small EAP countries would gain from signing new agreements, even of a shallow type, although gains would be higher with deeper agreements although the latter might be out of reach as a first shot.

Table 8: General-Equilibrium effects of deeper trade integration for EAP countries, year 2017.

Country Name	Iso3	*Intensive Margin* PTA^{CFL}_{Deep} Within EAP Δ Export (1)	Δ GDP (2)	Within EAP plus ROW Δ Export (3)	Δ GDP (4)	*Extensive Margin* PTA^{CFL}_{All} Within EAP, Cluster #1 Δ Export (5)	Δ GDP (6)
Australia	AUS	8.66	1.12	10.87	1.39	2.07	0.25
Burma	MMR	13.95	0.10	14.96	0.10	-0.16	0.00
Cambodia	KHM	3.58	2.51	3.41	2.36	0.23	0.13
China	CHN	2.38	0.09	2.83	0.10	2.11	0.08
Fiji	FJI	2.23	1.49	3.29	1.98	5.48	4.74
Hong Kong SAR, China	HKG	-0.49	-0.71	-0.27	-0.59	3.35	6.22
Indonesia	IDN	8.14	1.19	9.33	1.31	-0.05	-0.01
Japan	JPN	1.92	0.14	2.63	0.17	10.85	0.84
Korea, Rep.	KOR	4.74	0.81	8.88	1.53	2.89	0.59
Lao PDR	LAO	10.37	2.54	11.06	2.62	-0.16	-0.03
Macao SAR, China (Aomen)	MAC	0.09	0.14	0.12	0.04	7.63	8.28
Malaysia	MYS	3.79	2.79	4.22	2.99	0.38	0.19
Mongolia	MNG	0.13	0.26	-0.02	0.14	3.67	4.36
New Zealand	NZL	7.39	1.37	7.49	1.38	-0.36	-0.07
Papua New Guinea	PNG	2.19	2.27	3.11	2.92	4.32	6.40
Philippines	PHL	2.69	4.59	2.89	4.69	1.06	1.03
Singapore	SGP	2.38	3.71	3.26	5.25	1.24	1.19
Thailand	THA	4.97	2.70	5.55	2.89	0.67	0.37
Tonga	TON	6.65	1.27	6.32	1.21	12.34	2.14
Vietnam	VNM	5.35	2.70	5.90	2.87	0.43	0.20
EAP		3.14	0.35	4.11	0.44	3.02	0.26
RoW		-0.19	-0.03	0.24	0.07	-0.08	-0.02

Note: percent change compared to the baseline in total exports and GDP of participating countries.

4 Conclusion

This paper used new data on the content of trade agreements and a structural gravity general equilibrium model to quantitatively assess the economic impacts of deep trade agreements. Based on a clustering of 278 PTAs, comprising 906 provisions grouped in 18 policy areas, we have shown that a group of PTAs is associated with a much larger trade elasticity to PTAs. This confirms that using an average effect of PTAs disregarding the depth of trade agreements is misleading. We then simulated a series of full general equilibrium counterfactual situations for endowment economies, revealing the economic impacts of the intensive and extensive margins of PTAs. Illustrating the method with the example of countries in the Latin America and the Caribbean region, and with countries in the East Asian & Pacific region we showed that deepening existing PTAs is more promising for these countries than signing new ones.

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Appendix

A Appendix tables and figures

In a few cases we observe an overlapping at the country-pair by year level between bilateral and multilateral agreements, in the cases detailed below we prioritize multilateral agreements and drop the bilateral overlapping ones from the sample: South Asian Free Trade Agreement (SAFTA) and India-Bhutan; Eurasian Economic Community (EAEC) and Russian Federation - Belarus-Kazakhstan; Japan-Philippines/Brunei Darussalam/Indonesia and ASEAN - Japan; New Zealand - Malaysia and ASEAN - Australia - New Zealand.

Table A1: Agreements in the Deep and Medium cluster

Cluster #1, 28 PTAs	Cluster #2, 83 PTAs		
EC Treaty	Japan - Mexico	EFTA - Turkey	EU - Lebanon
ECOWAS	EFTA - Tunisia	EU - Central America	Singapore - Australia
EC (27) Enlargement	Thailand - New Zealand	Korea, Republic of - Turkey	EU - Chile
Chile - Japan	Korea, Republic of - Singapore	Malaysia - Australia	Korea, Republic of - Chile
EC (10) Enlargement	Japan - Malaysia	Costa Rica - Peru	CARICOM
Australia - New Zealand (ANZCERTA)	EU - Algeria	Mexico - Uruguay	EU - Egypt
EC (12) Enlargement	EFTA - Korea, Republic of	Costa Rica - Singapore	Thailand - Australia
EFTA - Serbia	EFTA - Lebanon	New Zealand - Chinese Taipei	
Andean Community (CAN)	EU - Albania	Mexico - Central America	
Peru - Mexico	Trans-Pacific Strategic Economic Partnership	EU - Moldova, Republic of	
EFTA - Ukraine	EFTA - Egypt	EU - Ukraine	
EU (28) Enlargement	CEFTA	EU - Georgia	
Eurasian Economic Union (EAEU)	Japan - Thailand	Iceland - China	
North American Free Trade Agreement (NAFTA)	EU - Montenegro	EFTA - Central America	
EC (15) Enlargement	Pakistan - China	Korea, Republic of - Australia	
European Economic Area (EEA)	EU - Bosnia and Herzegovina	EFTA - Bosnia and Herzegovina	
European Free Trade Association (EFTA) - 1971	EU - CARIFORUM States EPA	Japan - Australia	
European Free Trade Association (EFTA) - 1984	China - New Zealand	Canada - Korea, Republic of	
European Free Trade Association (EFTA) - 1993	Nicaragua - Chinese Taipei	Australia - China	
European Free Trade Association (EFTA) - 2017	Panama - Chinese Taipei	China - Korea, Republic of	
COMESA	Japan - Viet Nam	Japan - Mongolia	
Canada - Chile	ASEAN - Australia - New Zealand	Korea, Republic of - India	
Commonwealth of Independent States (CIS)	EU - Serbia	CPTPP	
EC (9) Enlargement	Colombia - Mexico	Gulf Cooperation Council (GCC)	
China - Macao, China	Hong Kong, China - New Zealand	EU - Turkey	
China - Hong Kong, China	EFTA - Albania	EU - Palestinian Authority	
EC (25) Enlargement	Turkey - Chile	EU - Tunisia	
EFTA - Chile	EFTA - Peru	EFTA - Morocco	
	EU - Korea, Republic of	EU - Mexico	
	Guatemala - Chinese Taipei	EU - Israel	
	Peru - Korea, Republic of	EU - Morocco	
	EFTA - Colombia	EU - South Africa	
	Japan - Peru	Chile - Mexico	
	China - Costa Rica	EFTA - Mexico	
	Panama - Peru	EU - North Macedonia	
	EFTA - Hong Kong, China	Japan - Singapore	
	EFTA - Montenegro	EU - Jordan	
	EU - Colombia and Peru	EFTA - Singapore	

Notes: the remaining 167 agreements in cluster # 3 are not listed. ANZCERTA, Closer Economic Relations Trade Agreement; COMESA, Common Market for Eastern and Southern Africa; ECOWAS, Economic Community of West African States; CARICOM, Caribbean Community and Common Market; SADC, Southern African Development Community; CEMAC Economic and Monetary Community of Central Africa; CPTPP Comprehensive and Progressive Agreement for Trans-Pacific Partnership.

Table A2: PPML: Gravity Estimations of the elasticity of trade to PTAs by Cluster, period 1980-2015

Dep Var: X_{ijt}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$PTA_{ij,t}$	0.627***	0.621***	0.271***	0.280***	0.253***				
	(0.058)	(0.072)	(0.051)	(0.050)	(0.053)				
$PTA^{K\#1}_{ij,t}$						0.412***	0.457***	0.384**	0.471***
						(0.106)	(0.141)	(0.153)	(0.138)
$PTA^{K\#2}_{ij,t}$						0.189***	0.210***	0.317***	0.192***
						(0.048)	(0.060)	(0.096)	(0.058)
$PTA^{K\#3}_{ij,t}$						0.164***	0.176***	0.208***	0.172***
						(0.055)	(0.066)	(0.054)	(0.065)
Transitory $PTAs_{ij,t}$		-0.023	0.078	0.099	0.097	0.173**	0.198*	0.148	0.201*
		(0.071)	(0.060)	(0.061)	(0.062)	(0.081)	(0.113)	(0.110)	(0.112)
INTL BRDR∗1980			-1.093***	-1.114***	-1.187***	-1.168***	-1.178***	-1.190***	-1.177***
			(0.047)	(0.047)	(0.048)	(0.050)	(0.082)	(0.081)	(0.082)
INTL BRDR∗1990			-0.645***	-0.643***	-0.673***	-0.673***	-0.682***	-0.681***	-0.682***
			(0.039)	(0.038)	(0.040)	(0.040)	(0.068)	(0.066)	(0.068)
INTL BRDR∗2000			-0.166***	-0.168***	-0.185***	-0.188***	-0.191***	-0.187***	-0.192***
			(0.024)	(0.023)	(0.022)	(0.022)	(0.040)	(0.041)	(0.040)
Period	1980-2015	1980-2015	1980-2015	1980-2015	1980-2015	1980-2015	1980-2015	1980-2015	1980-2015
Treatment for missing				Linear	Col (4) plus	Col (4) plus	Col (4) plus	Col (4) plus	Col (4) plus
Intra-National flows	UNIDO	UNIDO	UNIDO	Interpolation	Extrapolation	Extrapolation	Extrapolation	Extrapolation	Extrapolation
Cluster definition	Iterative	Iterative	Iterative	Iterative	Iterative	Iterative	Iterative	Non-Iterative	Reclassify
N. Countries (max)	114	114	114	131	153	153	153	153	153
N. Countries (end year)	87	87	87	91	153	153	153	153	153
Observations	99,607	99,607	99,607	111,542	153,864	153,864	153,864	153,864	153,864
FEs	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij	it, jt, ij

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 to column 9 both standard errors and point estimates are corrected using the Weidner & Zylkin (2019) procedure, implemented in Stata with *ppml_fe_bias*. In column 4 missing values in domestic sales are linearly interpolated; in column 5 to column 9 we extrapolate the remaining missing values using the evolution of a country total exports.