GVCs and the Endogenous Geography of RTAs

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Abstract

Geographical and economic characteristics help to predict Regional Trade Agreements (RTAs), and we here argue that Global Value Chains (GVCs) are one of these predictors. We estimate the time-varying probability that a country pair share a trade agreement, identify pairs who should sign an RTA and have not yet done so, and among these potential RTAs those mostly driven by the participation of the country pairs in GVCs. Using a General-Equilibrium model of an endowment economy, we construct counterfactuals where the geography of RTAs is redesigned according to our predictions and assess the trade and welfare consequences of phasing-in such pending RTAs. We last simulate the impact of a slowdown of GVCs on trade and welfare.

JEL classification: F13, F14, F15.

Keywords: Preferential trade agreements, Global Value Chains, Structural Gravity.

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Introduction

It has been understood since Baier & Bergstrand (2004) that countries self-select into Regional Trade Agreements (RTAs) according to both their individual and bilateral characteristics.[1] Being part of an economic union facilitates trade between Germany and France, but being two large, adjacent and economically-similar countries makes them natural partners anyway. On the other hand, the well-documented surge of new trade agreements in the 1990s extends beyond what we might consider as natural trading regions.

The international fragmentation of production through cross-country multilateral production linkages adds a new rationale for reducing trade frictions, as intermediate goods travel through multiple countries, often distant, before final assembly and consumption (Johnson & Noguera 2012). This paper aims to identify which country pairs should sign an RTA but have not yet done so, and which of these should sign due to the intensity of their involvement in GVCs. As such, we predict the presence of RTAs by including GVCs in the Baier & Bergstrand (2004) model and identify country pairs for which GVCs are a major determinant of the probability of being in an RTA. "GVC-driven" RTAs are defined according to a simple statistical criterion: the potential (but not yet signed) RTAs whose predicted probabilities of existence fall below some relevant threshold when the bilateral GVC income variable is winsorized at 95%.

Having identified such country pairs, the second aim is to rely on a General-Equilibrium model of an endowment economy to assess the trade and welfare consequences of signing such pending RTAs, with a focus on GVC-driven RTAs.[2] Last, the paper considers the consequences of a slowdown in GVCs on trade and welfare, for a given RTA geography.

There are two reasons why GVCs should help predict the occurrence of RTAs. First, even low tariffs are counter-productive when the domestic value-added content of foreign final goods, or the foreign value-added of domestic production, is large (Blanchard, Bown & Johnson 2016, Yi 2003, Limão 2016). As networks of value-added became denser and more complex over the 1995-2011 period (Amador & Cabral 2017), reducing the residual frictions between the countries involved in value chains became increasingly rewarding. Second, RTAs not only set most tariff duties to zero, they also facilitate trade more generally and reduce uncertainty (for instance about expropriation). With process fragmentation, complex contractual relationships between domestic producers and foreign providers require a stable and well-calibrated commercial environment (Antràs & Staiger 2012). Conversely, the presence of RTAs might well lead firms to establish complex contracts. Behind-the-border measures, such as regulatory divergence among trading partners, can be more

easily addressed in the regional rather than the multilateral negotiation arena, and such measures can be strategically manipulated when contractual relationships are prevalent. In a nutshell "*when domestic constituencies hold a direct economic stake in foreign export markets, their home government has less incentive to levy tariffs on imports*" (Blanchard 2015) (p. 91).

A first example of this complementarity between trade and "foreign involvement" in the broad sense is the causal link between US tariff preferences and offshoring by US multinational firms (Blanchard & Matschke 2015). There is also evidence from 14 countries that tariffs and temporary trade barriers are less prevalent in the presence of GVCs, which can be rationalized in a political-economy model (Blanchard et al. 2016). China is often targeted by the trade policies of importing countries, but is less so in the presence of intense GVCs and customized inputs, as shown by Ludema, Mayda, Yu & Yu (2018) for 27 importing countries plus the European Union. Finally, using a panel of 10 countries, 41 trading partners and 18 industries over 1995-2013, Bown, Erbahar & Zanardi (2019) show that GVC integration causally leads to a reduction in bilateral applied tariffs.

Starting from international Input-Output tables, the intensity of bilateral GVC linkages can be measured in a number of ways. In what follows we opt for a production perspective, and decompose the value added embodied in final goods starting from the production location and moving backward to all suppliers along the value chain, resulting in a full matrix of GVC income flows across industries and countries (Timmer, Los, Stehrer & Vries 2013). This decomposition allows us to allocate the income generated through the value chain in a way that is closely related to the literature on "task trade" (Grossman & Rossi-Hansberg 2008). As underlined by Johnson (2018), one additional advantage of the GVC income approach is the interpretation of *indirect* bilateral links: "*it measures bilateral foreign content in a way that allows for content to travel indirect routes (via third countries) from its source to where it is ultimately used in production. (...) To make both these ideas concrete, consider trying to measure Mexican content in US-produced cars, and suppose that the US uses imported engines from Mexico. (...) Mexican engines might include value-added content from third countries (e.g., steel from China)*"(p. 212). These indirect linkages will be exploited here: we argue that the intensity to which two countries are jointly *indirectly* involved in GVCs will increase their benefits from reducing their bilateral trade frictions and engaging in an RTA.[3]

We carefully consider the time dimension of the analysis. The country-pair characteristics used to predict RTAs are time-varying, and so therefore is the probability that a given country pair enter an agreement: economic geography changes over time, and the map of natural trading

regions should be re-drawn accordingly. We use data for the 1990-2014 period on 159 countries,[4] and observe from 1995 on whether each pair is covered at each date by an RTA.

We compare the observed RTAs to the probability threshold optimizing the joint prediction of signed and unsigned agreements, and derive a counterfactual RTA geography by signing predicted but unsigned agreements. To assess the trade and welfare consequences of signing unsigned agreements in General Equilibrium, we follow Anderson, Larch & Yotov (2018) and use a General Equilibrium Poisson Pseudo Maximum Likelihood (GEPPML) method to solve the system of equations associated with the model.[5]

Our first contribution is to provide empirical evidence that bilateral involvement in GVCs helps to predict the occurrence of RTAs. Our second contribution is to set out an empirical framework making it possible to quantify deviations from the RTA membership predicted on economic grounds, including indirect GVC links: 15 country-pairs, the trade between which accounted for 18% of World exports in 2014, should sign RTAs given the prevalence of their indirect GVC links. We evaluate the accuracy of our predictions for those 15 "GVC-driven" potential RTAs by contrasting them to the current negotiation status at the end of 2020. While the indirect intensity of GVC linkages helps to predict agreements, it is not necessarily the main determinant of signing an RTA. A good illustration is the fact that neither the EU and China, nor the US and China, nor China and India have signed an RTA (despite their high predicted probabilities). Nevertheless, most of the remaining GVC-driven RTAs predicted by the model have been validated by the presence of negotiations since 2014. Our third contribution is to provide an assessment of the economic impact of amending the observed RTA geography to fit the model predictions, to quantify the contribution of GVC-driven RTAs to this impact, and to assess the economic impact of a slowdown in GVCs. To our knowledge, we are the first to provide such an analysis, based on a structural-gravity model with General-Equilibrium effects while relying on the evidence of indirect GVC links.

To some extent, this analysis echoes the pioneering theoretical work of Antràs & Staiger (2012), who derive the Nash and internationally-efficient trade policies in the presence of traded inputs. Over the period considered, the increasing prevalence of GVCs has made it more difficult for governments to rely on simple general rules to handle trade-related issues, as the very principles of the GATT (non-discrimination, reciprocity) do not fit the needs of modern trade made up of goods-in-process. The more flexible RTA vehicle has helped to establish a GVC-friendly trading environment. Our exercise therefore points to the trade and welfare effects from the endogenous formation of RTAs.

The remainder of the paper is organized as follows. Section 1 sets out the empirical strategy used to predict the probability that country pairs sign regional trade agreements, based on economic characteristics including their participation in fragmented value chains. Section 2 proposes to quantify the welfare changes associated with this alternative RTA geography, relying on a structural gravity model. The last section concludes.

1 The existing and predicted RTA geography

The aim of this section is to establish a consistent empirical framework to predict which country pair is likely to share an RTA. One challenge in the prediction of RTAs is reverse causality. We add to this a second and more challenging issue: the international fragmentation of production.

Reverse causality is addressed by using five-year lags for the standard economic determinants of trade agreements. Five years seems to be a plausible time span to control for reverse causality, considering that the negotiations for the RTAs ratified over the 1988-2014 period lasted for 4.5 years on average (3.8 years at the median).[6]

The involvement of the country pair in GVCs is measured using the concept of value-added. The GVC income decomposition (Timmer et al. 2013) traces the origin of the value-added embedded in final goods and services, identifying the value-added contribution of each country that is involved in domestic production. Considering that value added is ultimately the compensation of production factors, this decomposition allows us to track and allocate the income generated by a given value chain to the different countries involved at the different stages of production.[7] In order to avoid the endogeneity of bilateral trade flows and bilateral GVC income, we only consider *indirect* linkages between countries, in line with Borin & Mancini (2019).

1.1 Predicting RTAs

This sub-section identifies how economic characteristics shape observed RTAs, considering all possible pairs of countries.[8] We ask whether exporter i and importer j are in the same RTA at time t, and then how their economic characteristics affect this probability, focusing on the indirect connection of i and j through the fragmentation of value chains. Joint participation in a global chain of production is indeed tightly linked to bilateral trade between the two countries, which raises a problem of the endogeneity of the distribution of economic activity on the probability of signing an RTA. We circumvent this problem by relying solely on *indirect* links, such as that

between the US and Mexico through China in the example in Johnson (2018), and introduce a five-year lag for the right-hand side variables. We do not discriminate RTAs by their depth (e.g. whether the agreement includes provisions over services or competition).

We proceed by estimating a probability model using data over the 1990-2014 period; the five-year lag for covariates implies that we will consider agreements that were signed between country pairs over the 1995-2014 period. The economic determinants that we include follow the work of Baier & Bergstrand (2004), Egger & Larch (2008) and Baier, Bergstrand & Mariutto (2014), and we add a control for the *indirect* involvement of the country pair in the fragmentation of value chains.

Combining these different elements, the baseline specification is as follows:

$$RTA_{ij,t} = \Gamma_{ij,t-5} \cdot \gamma + \overline{\Gamma_{ij}} \cdot \overline{\gamma} + \delta_t + \epsilon_{ij,t} \tag{1}$$

Our dependent variable is RTA_{ijt}, which takes the value of 1 if country i and country j are members of the same regional agreement at time t and zero otherwise.[9]

The vector Γ includes *indirect* bilateral GVC income $GVC^{indirect}_{ij,t-5}$, inspired by Borin & Mancini (2019) in addition to the main bilateral economic determinants of trade agreements as identified in previous work:[10] $Natural_{ij}$ is the log of the inverse of the distance between i and j; $Remote_{ij}$ measures the average log distance of countries i and j from all of the other countries in different continents; $GDP^{sum}_{ij,t-5}$ is the log of the sum of the countries' GDP (at constant 2011 national prices), reflecting their market size; $GDP^{sim}_{ij,t-5}$ is an index of the similarity of the size of the two markets; $DKL_{ij,t-5}$ is the absolute difference (in log) of capital stock per person employed, reflecting the difference in factor endowments between countries i and j; and $SQDKL_{ij,t-5}$ is the squared factor endowment. We also need to control for the involvement of each country in the i, j pair in RTAs with other countries, as signing another RTA reduces the benefit of existing signed RTAs, via third-country effects. We introduce two variables that tentatively capture these effects: $OthRTA_{i,t-5}$ and $OthRTA_{j,t-5}$. $OthRTA_{i,t-5}$ is an index of country i's agreements with all other countries (excluding j), measured as the (five-year lagged) stock of i's signed agreements; $OthRTA_{j,t-5}$ is defined analogously for country j.[11] The determinants suggested by monopolistic-type trade models should also be considered (size and similarity in size) in relation to the demand for variety (Helpman 1987). We also include $CRTA_{ij}$, a variable counting the number of common external trade agreements between country i and j in the pre-estimation period, in line with the domino-like spread of regionalism (Baldwin & Jaimovich 2012). This variable is meant to control

for selection into agreements and RTA interdependence.

$\overline{\Gamma_{ij}}$ includes the average of each covariate by country pairs in order to control for the possible correlation of time-variant variables with unobserved time-invariant heterogeneity (see Wooldridge 2010, Chapter 15). Last, δ_t represent a set of year fixed effects.

Based on the economic characteristics of each country pair, including the intensity of (indirect) production linkages, the model may *correctly* predict the probability of an RTA (or its absence), but it may also *incorrectly* predict the absence of existing agreements (or incorrectly predict the presence of absent agreements). We accordingly define four possible outcomes:

- A "True Positive" (TP thereafter) – the model predicts an RTA that actually exists;
- A "True Negative" (TN) – the model does not predict an RTA and no RTA has been signed;
- A "False Negative" (FN) – the model incorrectly predicts the absence of an existing agreement.
- A "False Positive" (FP) – the model incorrectly predicts the existence of an unsigned agreement.

We focus in the following on the False Positives.[12]

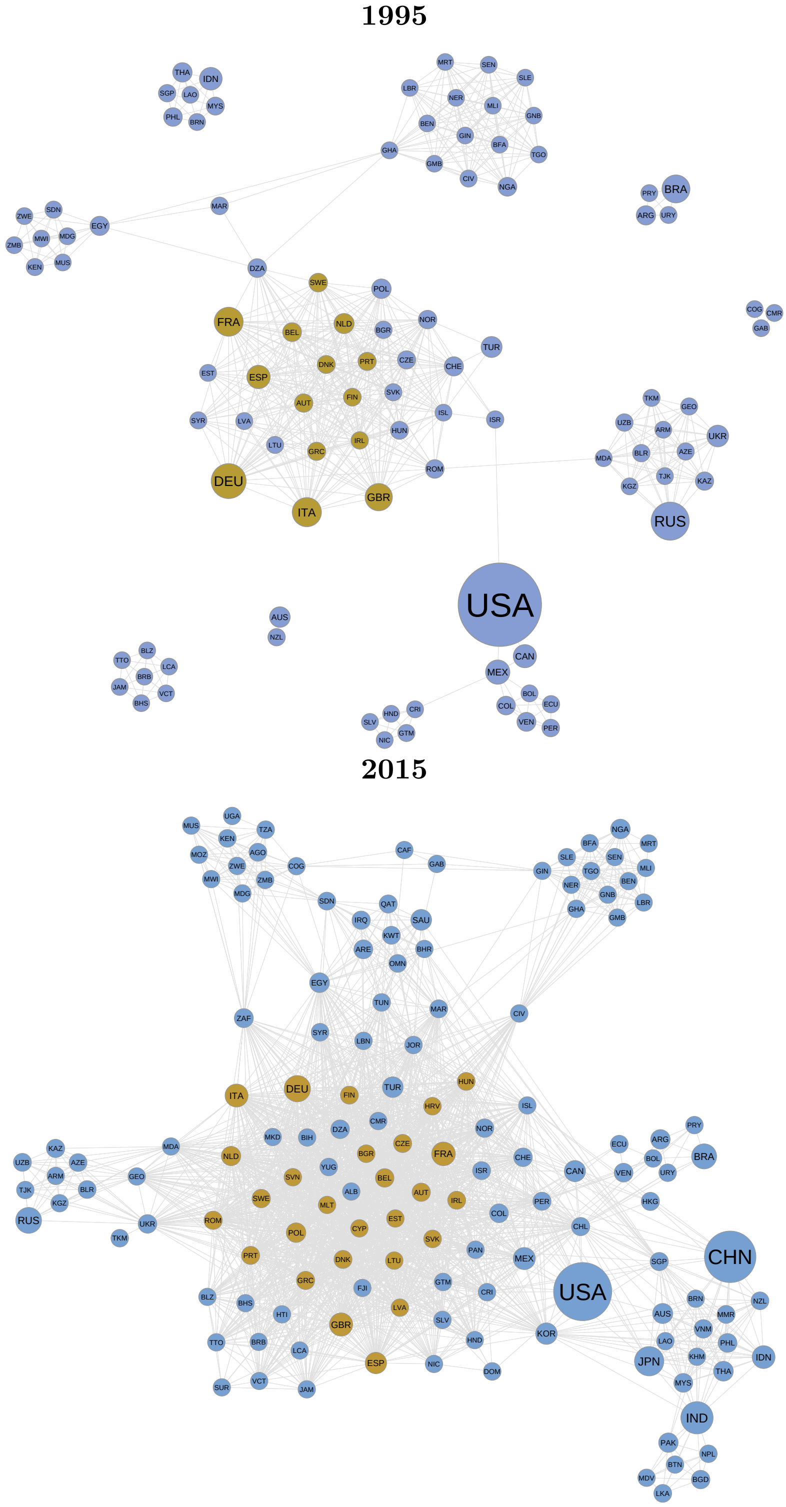
The distribution of the predictions is driven by the chosen probability cut-off. With a cut-off of 1, no RTAs are predicted, and conversely with a very small probability cut-off we predict that all RTAs will exist. The capacity to predict signed agreements increases almost linearly as the probability cut-off falls, whereas the ability to predict the absence of agreement is good even for very small probabilities. There is accordingly a trade-off between predicting correctly one type of outcome (signing) and the other (not signing). We evaluate model goodness-of-fit by considering the probability cut-off that provides the best percentage of correctly-predicted events (a country-pair being, or not, members at a given date of an RTA: RTA=1 and RTA=0). Following Baier et al. (2014), the optimal cut-off probability maximizes the percentages of true positives and true negatives.[13]

The identified mis-classified RTAs that are classified as FP from the probabilistic model will be used in a structural gravity system to evaluate the welfare changes associated with alternative sets of trade agreements in the next section.

1.2 Measuring GVCs

An important step is to correctly measure the involvement of country pairs in global production networks. Countries are becoming increasingly inter-connected, both directly and indirectly. Figure 1 depicts the trade-agreement network in 1995 (the top panel) and 2015 (the bottom panel). In both graphs a node represents a country, and two countries sharing a trade agreement are connected through an edge.[14] The European block (drawn in a lighter shade) was already at the core of the system in 1995. At the same time, despite sharing a bilateral agreement, a number of countries looked like "islands": either completely disconnected from the rest (see for example Argentina, Brazil, Paraguay and Uruguay in the North-East quadrant) or only lightly-integrated (Israel is the only link connecting the North-American block, i.e. the United States/Canada/Mexico, to continental Europe). By the end of the period, in 2015, the overall number of RTAs (the edges in the graph) had increased substantially. There are no longer any disconnected islands, and the overall system appears to be much more intricate. As a result, bilateral trade-cost shocks likely have larger General-Equilibrium effects.

Figure 1: The network of Regional Trade Agreements in force by year



Notes: The data on preferential trade agreements come from the CEPII gravity database: see Head & Mayer (2014). The network is drawn using *Gephi*. The size of the node reflects relative country GDP. European countries are depicted in a lighter shade. The number of (undirected) edges was 601 in 1995 and 2,199 in 2015.

When measuring bilateral involvement in GVCs, one potential concern is that bilateral trade and value-chain participation might not be orthogonal. We address this problem by considering i) *indirect* value-added income and ii) lagged involvement in value chains.

The involvement of country pairs in global production networks is calculated as the aggregate bilateral GVC income flow as a share of country GDP. It is important to underline that, being aggregated at the country level, this variable has no sectoral dimension although inter-industry relationships appear in the calculation of this variable.[15] At the country level, this measure captures the share of payments to domestic factors generated from foreign production, also known as forward foreign GVC integration. In other words, this variable measures the income that is generated from the supply chain connecting countries i and j through direct intermediate exports and via third countries. Following Johnson (2018), the GVC income decomposition at the country level for a given year t can be formalized as:

$$GVC_{ij} = \frac{V_i * (I - A)^{-1}_{ij} * F_j}{GDP_i} \tag{2}$$

Here V_i is a diagonal matrix of the value-added to output ratios and A_{ij} the technical-coefficient matrix, with terms a_{ij} showing the input share of country i used in the production of country j. The term $(I - A)^{-1}_{ij}$ is the Leontief inverse, capturing the direct and indirect production linkages between countries i and j. Last, F_j is a diagonal matrix of final demands. The general term in the resulting GVC_{ij} matrix shows the value added in country i (as a share of country total GDP) that is related to production in country j.

In order to limit endogeneity concerns, *we only consider indirect linkages in the GVC income flows.* Following Borin & Mancini (2019), for each country pair ij we isolate the indirect linkages by considering the Leontief inverse matrix generated *after setting the bilateral intermediate inputs flows between country i and j to zero.* In a three-country case the indirect GVC income flows between country-1 and country-2 are as follows:

$$GVC^{Indirect}_{12} = \frac{V_1 * \left(I - A^{\not{12}}\right)^{-1}_{12} * F_2}{GDP_1}$$

where:

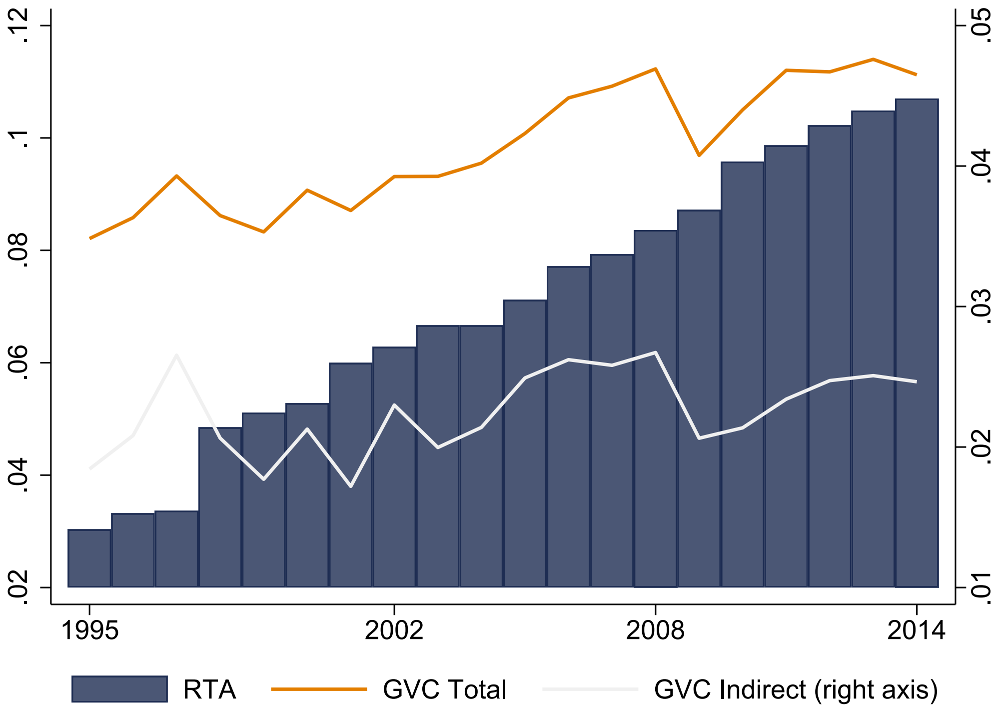
$$A^{\cancel{12}} = \begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix}$$

The matrix element $\mathrm{GVC}_{21}^{Indirect}$ is derived in a similar fashion by setting $A_{21} = 0$. As the GVC income decomposition depends on the location of production, $\mathrm{GVC}_{12}^{Indirect}$ (production location country-2) is different from $\mathrm{GVC}_{21}^{Indirect}$ (production location country-1) and we include the average of the two in the estimation. As a robustness check in Table ST3 in the Appendix, we consider alternative strategies to isolate the role of GVC deepening by *i)* splitting the second- and higher-order summands of the Leontief inverse,[16] and *ii)* applying Stone's additive decomposition to the Leontief inverse, isolating direct trade in intermediate goods from more complex value chains (including feedbacks).[17]

We calculate Equation 2 using multi-region input-output data from the EORA MRIO database.[18]

Figure 2 confirms that the international fragmentation of production - as measured by GVC income - has intensified significantly over the whole period, growing more rapidly between 2001 and 2007.[19] This pattern in total GVC income (the top curve in Figure 2) is confirmed (although slightly attenuated by eliminating bilateral relationships) in the bottom curve corresponding to the indirect GVC income variable that will be used hereafter in this paper. In both cases, there is an evident impact of the global financial crisis on the prevalence of GVCs. Over the same period, the number of country pairs covered by an active RTA (i.e. signed and ratified) more than tripled from 3 to 10.7 percent of all possible pairs. With this data and method in hand, we can now carry out a systematic analysis of the extent to which GVCs shape the geography of RTAs. We rely on a Logit estimation of the economic determinants that a country pair be in a common RTA.

Figure 2: The evolution of GVCs and RTAs (in-sample)



Notes: The solid lines show the (1995 GDP weighted) average share of domestic value added related to GVCs, considering first total and then only indirect linkages. The bars depict the share of countries covered by an active preferential trade agrement.

1.3 GVCs Shape the Geography of RTAs

Table 1 shows the marginal effects from the estimation (Logit regression) of the occurrence of RTAs. Column 1 uses an unweighted index of member countries' agreements with all other countries, while columns 2-4 rely on a trade-weighted index. In columns 3 and 4, GVC income is interacted with period dummies: 1995-2001, 2002-2007 and 2008-2014. All columns rely on indirect GVC income as the measure of bilateral production linkages. Our preferred specification (column 3) includes the full sample of countries. Column 4 excludes China as a robustness test. The overall sample covers $N(N-1)/2$ possible pairs for each year. European Member States are aggregated into a single entity. Following the European Union enlargements, the number of countries declines over the estimation sample from 145 in 1995 to 132 in 2014.

Our variable of interest is $GVC_{ij,t-5}$. As confirmed by both Likelihood Ratio and Bayesian Information Criterion tests, the inclusion of indirect GVC income in the regressors significantly improves model fit.[20] As expected, the marginal effect of GVC income on the propensity to sign an RTA is positive and significant in all specifications. *The intensity of GVCs helps to predict the occurrence of RTAs.* In our preferred specification in column (3), the impact of GVC income increases over time: the marginal effect triples between the first and last sub-period (a similar but milder increase is found when we exclude China from the sample in column 4). Figure 3 depicts the estimated marginal effects of the interaction terms between (indirect) GVC income and year fixed effects. This shows profound changes in international production patterns, with participation in global value chains having an increasingly-positive effect on the incentives to join an RTA.

The estimated parameters on the other controls are in line with those in the literature. For the estimated coefficient on $Natural_{ij}$, we see throughout Table 1 that proximate countries are more likely to sign trade agreements, being "natural trading partners". This is reinforced by the remoteness of the two trading partners from the rest of the world ($Remote_{ij}$). The number of *common* external trade agreements between countries i and j in the pre-estimation period, CRTA_{ij}, is strongly correlated with the likelihood of an agreement in the future. Large countries of similar size are also more prone to sign an agreement, as shown by the estimated parameter on $GDP^{sum}_{ij,t-5}$ and $GDP^{sim}_{ij,t-5}$. The comparative-advantage channel $DKL_{ij,t-5}$ contributes only marginally to predict a trade agreement between the two countries; the same remark holds for the stock of existing agreements by the partners i and j.

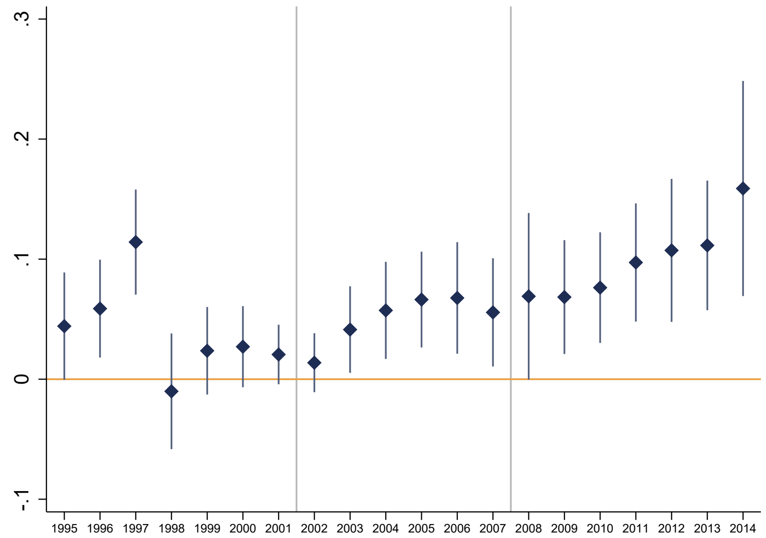
In line with Egger, Larch, Staub & Winkelmann (2011), who consider both economic and polit-

Table 1: Marginal effects of the economic determinants of RTAs

Dep Var: RTA_{ijt}	Logit (1)	(2)	(3)	(4)
$Natural_{ij}$	0.016	0.020	0.020	0.020
	(0.001)	(0.001)	(0.001)	(0.001)
$Remote_{ij}$	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)
$CRTA_{ij}$	0.025	0.030	0.030	0.030
	(0.004)	(0.004)	(0.004)	(0.004)
GDP^{sum}_{ijt-5}	0.002	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
GDP^{sim}_{ijt-5}	0.002	0.004	0.004	0.005
	(0.001)	(0.001)	(0.001)	(0.001)
DKL_{ijt-5}	-0.086	-0.003	-0.006	0.021
	(0.073)	(0.093)	(0.093)	(0.089)
$SQDKL_{ij,t-5}$	-0.002	-0.024	-0.023	-0.029
	(0.018)	(0.024)	(0.024)	(0.023)
$OthRTA_{i,t-5}$	0.000	0.009	0.007	0.003
	(0.000)	(0.006)	(0.006)	(0.006)
$OthRTA_{j,t-5}$	0.001	-0.006	-0.006	-0.005
	(0.000)	(0.006)	(0.006)	(0.006)
$GVC^{Indirect}_{ij,t-5}$	0.056	0.072		
	(0.015)	(0.018)		
$GVC^{Indirect,1995-01}_{ij,t-5}$			0.028	0.062
			(0.018)	(0.015)
$GVC^{Indirect,2002-07}_{ij,t-5}$			0.037	0.060
			(0.015)	(0.017)
$GVC^{Indirect,2008-14}_{ij,t-5}$			0.093	0.127
			(0.029)	(0.039)
IO Linkages:	Indirect	Indirect	Indirect	Indirect
Sample:	Full	Full	Full	Excl. CHN
OthRTA:				
Weighted $trade_{ij,t-5}$	No	Yes	Yes	Yes
Observations	193,162	193,162	193,162	190,395
Pseudo R^2	0.466	0.450	0.450	0.454
Log-Likelihood	-23048.8	-23744.9	-23731.6	-23272.6

Notes: Standard errors in parentheses are clustered by country-pair. $\overline{\Gamma_{ij}}$ and year fixed effects δ_t are included in all regressions but their estimated coefficients are not shown. Note that, to improve the readability of the table, the variables DKL_{ijt-5} , $SQDKL_{ij,t-5}$,$OthRTA_{i,t-5}$ and $OthRTA_{j,t-5}$ have been re-scaled so that the coefficients show the marginal effect of a 100% increase.

Figure 3: Indirect GVC coefficients by year (Logit model)



Note: This graph shows the marginal effects of the point estimates (along with the 90% confidence intervals) of the interaction terms between $GVC^{Indirect}_{ij,t-5}$ and the year fixed effects, controlling for the remaining covariates in the baseline model.

ical determinants in their analysis of regional agreements, Martin, Mayer & Thoenig (2012), who include economic and political factors in a model of RTA formation, and Baldwin & Jaimovich (2012), who include political and geopolitical determinants of the domino-like spread of regionalism, we test the robustness of our results to the inclusion of both time-varying and time-invariant political and institutional variables. We therefore further include as controls: the cumulative number of war-related casualties between i and j, common religions, common legal origins Pre- and Post-transition, a measure of country-year institutional quality, and the maximum of the number of days to start a business between i and j. The results in Appendix Table ST6 largely confirm our main findings, and the estimated parameter on indirect GVC income is barely affected by these additional controls.

Our baseline specification includes the country-pair average of the regressors in order to control for the possible correlation of time-variant variables with unobserved time-invariant heterogeneity. This strategy (the Chamberlain technique) has the advantage of allowing the inclusion of time-invariant regressors, such as those relating to geography, and retaining the full sample. Keeping the estimation sample is particularly important in our case, as it allows us to identify all of the miss-classified country pairs – e.g. False Positives. However, the Chamberlain approach may not control for unobserved time-invariant country pair heterogeneity, leading to potential omitted-variable bias.

As a robustness check, the Appendix presents the estimates from a conditional logit (Table

ST1) and a linear probability model with country pair fixed effects (Table ST2). In both cases there is a positive significant effect of $GVC_{ij,t-5}^{indirect}$ on RTAs. We also estimate the linear probability model using $GVC_{ij,t-5}^{total}$, which includes direct intermediate input flows, and find a positive and statistically-significant coefficient.[21]

1.4 The GVC-driven False Positive RTAs

Before turning to the General-Equilibrium analysis, we provide evidence of the contribution of the GVC to RTA geography in each period. To identify GVC-driven False Positives, we first winsorize the distribution of indirect GVC income at the 95th percentile in each year and re-calculate the expected probabilities using the baseline parameter estimates. The False Positives that disappear after winsorizing the GVC variable are the "GVC-driven" agreements: we quantify in General Equilibrium their contribution to the overall economic impact of phasing-in all FPs in Section 2.

Table 2 reports the number of FP observations for all countries in our sample (here labeled as "All"), and for China. Column 1 shows the number of country pairs in the sample for each sub-period, and column 2 the number of country pairs having signed an RTA at the end of each period. The number of FPs in column 3 corresponds to the overall number of country pairs that should ratify an RTA in each period, based on the model's prediction. In column 4, FP_{GVC}^{all} refers to the number of countries that should ratify an RTA mostly *because* of their joint indirect GVC linkages: when winsorizing the distribution of indirect GVC income at the 95th percentile, these country pairs among the FPs in column 3 now disappear. These are the "GVC-driven" FPs. Columns 3 and 4 accordingly correspond to the number of FPs and GVC-driven FPs plotted by country in the top and bottom panels of Figure 4 respectively. Last, columns 5 and 6 repeat the same exercise focusing on country pairs involving China.

Table 2 shows that, out of the 4,278 country pairs, 448 were in an RTA in 2014 and 676 were incorrectly predicted to be in an RTA, with the prediction for 15 of the latter reflecting their joint involvement in GVCs. The last row of Table 2 shows that trade between the latter 15 country pairs amounts to 17.6% of World trade, and 42% of the value of World trade corresponding to the overall False Positives.

Table 2: Number of country pairs with an RTA, False Positives & GVC-induced False Positives, by period. All countries and China.

Period	No. Pairs (1)	RTA = 1 (2)	FP^{All} (3)	FP^{All}_{GVC} (4)	FP^{China} (5)	FP^{China}_{GVC} (6)
			Country Pairs			
1995-01	4,851	279	390	15	5	1
2002-07	4,278	332	568	13	3	2
2008-14	4,278	448	676	15	6	3
			World Export Shares			
2014		0.4	0.422	0.176	0.181	0.124

Notes: FP = "False Positive" (i.e. predicted $RTA = 1$ but observed $RTA = 0$). The table is based on the GE sample (following EU enlargements, the number of symmetric pairs ranges from $4,851 = (98 * 97 * 0.5) + 98$ in 1995 to $4,278 = (92 * 91 * 0.5) + 92$ in 2014). The probability cut-off that maximizes the percentages of true positives and true negatives is Pr> 0.064.

It is useful to focus on the country pairs for which we incorrectly predict an RTA in 2014 mostly due to the prevalence of their joint indirect GVC participation. Were this prediction to be correct, these pairs should have started negotiations since 2014, which we can observe. We carry out this ex post validation in Table 3. The 15 country pairs appear in the first column of Table 3 and the information on their negotiations in November 2020 in the second column.

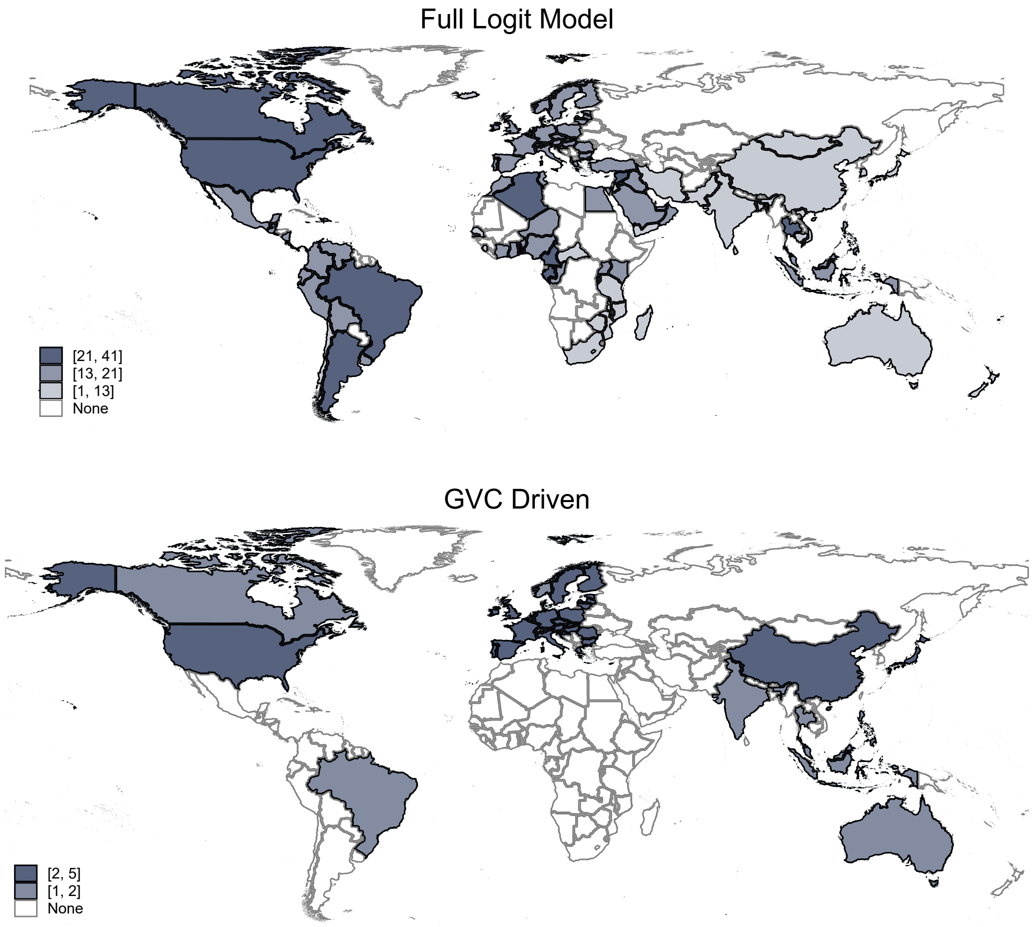
Table 3: List of GVC driven FPs, period 2008-2014

Country Pairs	Status as of November 2020
CAN-MYS	Part of CPTPP. Malaysia however has not yet ratified
CHE-IDN	Indonesia-EFTA CEPA signed December 2018
CHN-IND	APTA, Partial Scope Agreement
CHN-USA	.
EU-AUS	Discussion started in 2018
EU-CHN	.
EU-PHL	EU-ASEAN discussions resumed in 2017
IDN-NOR	CEPA, Indonesia-EFTA signed December 2018
IND-EU	Discussion started in 2007, stopped in 2013
JPN-EU	In force since February 2019
JPN-HKG	.
NOR-BRA	EFTA-MERCOSUR, signed August 2019
SGP-CAN	Part of CPTPP
USA-JPN	USA - Japan Trade Agreement in force since January 2020
USA-THA	.

Notes: The table lists in the first column the 15 country-pairs that should have had a signed RTA in 2014 (according to the prediction of the model) as a result of their joint involvement in GVCs, referred to in the text as "GVC-driven" False Positives. The status of negotiations as of November 2020 is summarized in the second column and described in the body of the text.

Contrary to our prediction, China and the US entered an unprecedented trade war in 2018, which ended in the "Phase-one Deal" in February 2020 consisting of managed trade.[22] Another country pair for which our model incorrectly predicts a GVC-driven RTA is China-EU: the current talks are limited to a "High-Level Trade and Economic Dialogue", which took place for the 8^{th} time in July 2020. China joined the Asian Asia-Pacific Trade Agreement (APTA) in April 2001, previously called the Bangkok Agreement when launched in 1975 with the participation of India. According to the WTO website, this preferential tariff arrangement is however defined as a "Partial Scope Agreement and Economic Integration Agreement". Participating countries apply tariff and non-tariff concessions (a maximum of a 50 percent margin of preference) in favor of the goods originating in all other participating countries based on their respective National List of Concessions covering only partially the tariff lines. The USA and Thailand started negotiations in 2004, but did not reach an agreement; negotiations have not yet resumed. However, Thailand set up a committee in July 2020 to consider the opportunity of joining the Comprehensive and

Figure 4: Number of False Positives by country (2008-2014)



Notes: The upper panel shows the FPs or natural RTAs count by country. The overall number of FPs in the period 2008-2014 is 676 (as reported in column 3 of Table 2). In the lower panel we show only the 15 GVC driven RTAs: CAN-MYS, CHE-IDN, CHN-IND, CHN-USA, EU-AUS, EU-CHN, EU-PHL, IDN-NOR, IND-EU, JPN-EU, JPN-HKG, NOR-BRA, SGP-CAN, USA-JPN, and USA-THA (see column 4 of Table 2).

Progressive Agreement for Trans-Pacific Partnership (CPTPP) signed in December 2018. The US withdrew from the Trans-Pacific Partnership (TPP) negotiations in 2017, the ancestor of the CPTPP, which may be reconsidered by a new US Administration. For all of the other country pairs, the predicted GVC-driven RTA has either been signed or is under negotiation. Canada and Malaysia are part of the CPTPP, although not yet in force between the two countries as Malaysia needs to ratify the agreement. The CPTPP is currently only effective between Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam. Switzerland and Indonesia are linked by the Comprehensive Economic Partnership Agreement (CEPA) signed between the European Free Trade Association (EFTA) and Indonesia in December 2018. Norway is also linked to Indonesia as a member of the EFTA. Australia and the EU started negotiations in 2018. The 8^{th} round of negotiations took place in October 2020. Discussions between the EU and the Association of

SouthEast Asian Nations (ASEAN), suspended in 2009, resumed in 2017, including the Philippines. Negotiations between the EU and India started in 2007, but were abandoned in 2013. The EU declared being committed to strengthening economic links with India, and the two parties remain in contact. The EU-Japan Economic Partnership Agreement came into force in February 2019. The ASEAN-Japan Comprehensive Economic Partnership Agreement signed in February 2019 entered into force in June 2020; although Hong Kong also has an agreement with ASEAN, Japan and Hong Kong have not yet signed a bilateral RTA, only a bilateral Investment Promotion and Protection Agreement. The agreement between EFTA and Mercosur was signed in August 2019, and thus involves Brazil and Norway. Singapore and Canada have been members of the CPTPP mentioned above since December 2018. The USA and Japan signed a trade agreement in the areas of market access for "certain agriculture and industrial goods", as well as digital trade, in October 2019. The agreement, which is not yet an RTA stricto sensu entered into force in January 2020.

2 The General-Equilibrium Effects of an Alternative RTA Geography

We argue in this paper that the indirect intensity of GVCs helps to predict the occurrence of RTAs, as the GVC provide a rationale for entering into preferential agreements. To give a sense of the relevance of this mechanism in terms of trade and welfare, we carry out a number of counterfactual General-Equilibrium exercises.

We quantify the trade and welfare impacts of a change in the overall structure of trade costs via a reduced-form approach, and consider that trade costs depend on the aggregate intensity of GVCs by country-pair, on the top of RTAs, time-invariant country-pair characteristics and a border effect that varies by period. The drawback of this aggregate approach is that the model does not allow changes in trade patterns to feed back into RTA formation. As trade costs are reduced by the endogenous signature of RTAs, our ultimate goal is to give a sense of the welfare gains associated with this change in the overall structure of trade costs. We do so using a one-sector General-Equilibrium gravity model.[23]

We change the vector of agreements between country pairs by "signing" agreements that were wrongly predicted to exist (the "False Positives") between any country pair i and j. We carry out this exercise for all FPs, and quantify: i) the contribution of the subset of GVC-driven FPs to this result, and ii) the contribution of the subset of GVC-driven FPs involving China. We hold the set of correctly-predicted agreements constant. Bilateral trade between each country pair will react to the signing of an agreement; this is the partial effect of an RTA, based on the actual impact of being in an RTA that is estimated in a first step. This partial RTA effect is identified using a gravity setting controlling for the indirect GVC links defined as a dummy for the bilateral indirect GVC income flow being above the 95th percentile of the distribution in the last year of the period considered (see Equation 6).

Third-country effects, or more generally so-called "General-Equilibrium effects", also have to be taken on board. Multilateral Resistance Terms (MRT thereafter) can be considered as General-Equilibrium trade-cost indices (Anderson & Van Wincoop 2003). These are the terms Π_i and P_j in Equation (4). The inward MRT P_j will account for the impact on consumers at destination and the outward MRT Π_i that on producers in the origin country. Signing a new RTA has a direct effect on X_{ij} holding the MRT terms constant (this is the partial effect), and an indirect effect through the change in the inward and outward MRTs (these are the conditional General-Equilibrium effects). Last, the effects on the price of the variety exported by the representative

producer and expenditure in the exporting country reflect the General-Equilibrium effects for an endowment economy (Head & Mayer 2014).

2.1 The Calculation of the General-Equilibrium Baseline and Counterfactual

The series of partial- and General-Equilibrium effects described above can be set out more precisely using the standard gravity system described in Equations 3 to 5, with the usual notation: t_{ij} for 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 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 Equation 3, holding the MRTs Π_i and P_j constant. However, MRTs are not constant, as changing the trade costs between any i and j affects the overall structure of relative trade costs and prices between i and j, as well as with third countries. The indirect effect on i and j can accordingly be derived from Equation 4, which is the solution of the conditional General-Equilibrium effects. When an RTA between i and j enters into force, this lowers the MRTs for this country pair but increases them for third countries. Ultimately, 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 5). We accordingly derive the General Equilibrium for this endowment economy.[24]

$$\text{Partial Equilibrium}\begin{cases} X_{ij} = & (\frac{t_{ij}}{\Pi_i P_j})^{1-\sigma}\frac{Y_i E_j}{Y} \end{cases} \tag{3}$$

$$\text{Conditional GE}\begin{cases} \Pi_i^{1-\sigma} = & \sum_j(\frac{t_{ij}}{P_j})^{1-\sigma}\frac{E_j}{Y} \\ P_j^{1-\sigma} = & \sum_i(\frac{t_{ij}}{\Pi_i})^{1-\sigma}\frac{Y_i}{Y} \end{cases} \tag{4}$$

$$\text{GE}\begin{cases} p_i = & \frac{(Y_i/Y)^{\frac{1}{1-\sigma}}}{\alpha_i \Pi_i} \\ E_i = & = \phi_i Y_i = \phi_i Q_i p_i \end{cases} \tag{5}$$

In order to recover the MRTs from the non-linear system described above we can take advantage of the properties of PPML with country fixed effects (Feenstra 2015). Silva & Tenreyro (2006) suggest using a PPML estimator to address the issues of heteroscedasticity and zero trade

flows. This often makes PPML the preferred estimator to recover partial-equilibrium effects from Equation 3. Moreover, we know from Fally (2015) that the PPML first-order conditions for the fixed effects enforce the market-clearing conditions from the model described in Equations 4 to 5, making this a useful additional option to recover General-Equilibrium effects.[25]

This approach yields a baseline corresponding to the actual set of RTAs and the associated trade costs. This is the observed RTA geography. Given our definition of GVC-driven RTAs, the indirect GVC-participation measure is introduced in the trade-cost vector as a dummy for the bilateral indirect GVC income flow being above the 95th percentile of the distribution in the last year of the period considered (e.g. 2014). We shock this geography by "signing" the agreements that are predicted to exist but do not, with a focus on "GVC-driven" potential RTAs and then potential RTAs involving China. We alternatively simulate a slowdown of GVCs with no impact on the geography of RTAs. We solve the system of equations for each counterfactual scenario independently, and derive General-Equilibrium indices from which we calculate welfare levels, and hence welfare changes relative to the baseline for each country.

Table 4 describes the shocks to the trade-cost vector in our simulations, taking the last period as an example. We have 4,278 country-pairs in 2014. In column 1 of Table 4, the 676 (622+54) FP country pairs with no RTA over the 2008-14 period are those for which the average probability of signing an RTA over the period is above the threshold: these were already identified in column 3 of Table 2.[26] In our first counterfactual exercise, phasing in all FPs switches the RTA dummy to one for the 676 country-pairs in 2014, with no retroaction on GVC income. Our results should thus be considered as a short-term or lower bounds of the trade and welfare impacts, before any adjustment in global production. This exercise will then be repeated for the subset of 661 FPs excluding GVC-driven FPs, and last excluding the three GVC-driven FPs involving China. This sequence of counterfactuals provides a quantification of the contribution of GVC-driven agreements (and in the latter those involving China) to the overall trade and welfare impacts of phasing in all FPs. Turning to our "GVC slowdown counterfactual", we find that 79 of the 448 country-pairs with an RTA in force are above the 95th percentile of the distribution of indirect GVC income in 2014. In the same percentiles of the distribution, we find 235 country pairs out of the 3,830 with no RTA. In total, these are the 314 country-pairs for which we will reduce the intensity of indirect-GVC income in the "GVC-slowdown counterfactual", by switching the dummy $GVC_{ijt}^{95^{pc}}$ to zero, keeping the geography of RTAs as given.

We follow the four-step procedure in Yotov, Piermartini, Monteiro & Larch (2017): a) solve the baseline gravity Equation (6) to recover β and μ_{ij}; b) define the counterfactual scenario; c) solve

Table 4: Design of the scenarios, 2008-14

Period	Baseline	RTA = 0 (1)	RTA = 1 (2)	Total (3)
2014	GVC_{ijt}^{95pc} =0	3595	369	3964
2008-14	*of which FP*	622	.	
2014	GVC_{ijt}^{95pc} =1	235	79	314
2008-14	*of which FP*	54	.	
2014	Total	3830	448	4278

Notes: FP = "False Positive" (i.e. average $pr(RTA) > 0.064$ and the observed $RTA = 0$ over the 2008-2014 period). This table is based on the GE sample in 2014, i.e. $4,278 = (92*91*0.5)+92$ symmetric country-pairs.

the counterfactual gravity system; and d) construct the relevant General-Equilibrium indices.

We first need to estimate bilateral trade costs and the partial effect of an RTA (*step a*). We start by estimating a structural gravity model, using PPML with panel data, including both intra-national and inter-national trade flows covering 1990, 1995, 2001, 2007 and 2014.[27] The dummy $INTL\ BRDR_{ij}$ takes the value of one for international trade flows. We interact this dummy with years indexed by T. Exporter-time and importer-time fixed effects control for time-varying MRTs, while a bilateral fixed effect controls for the unobserved characteristics of the country pair that are constant over time. The estimated equation is as follows:

$$X_{ij,t} = exp\left(\beta_1 RTA_{ij,t} + \beta_2 GVC_{ij,t}^{95pc} + \sum_{T=1990}^{2007} \beta_T INTL\ BRDR_{ij} * T + \pi_{i,t} + \chi_{j,t} + \mu_{ij}\right) + \epsilon_{ij,t} \quad (6)$$

where $X_{ij,t}$ are the export flows from country i to country j, π_i and χ_j the exporter and importer fixed effects, μ_{ij} the country-pair fixed effects (capturing the time-invariant determinants of trade costs, such as the logarithm of distance, common border, common language and colonial ties), $RTA_{ij,t}$ the signing of a new regional trade agreement between country i and j, and $GVC_{ij,t}^{95pc}$ the GVC participation dummy.

We solve the model using the "estibration" procedure developed by Anderson et al. (2018).[28] The outcome of the General-Equilibrium comparative static analysis is identical to the "exact hat" algebra introduced by Dekle, Eaton & Kortum (2007).[29]

Table 5 lists the structural gravity estimates for the key components of trade costs that will be shocked in the General Equilibrium analysis. Column 1 shows the estimated partial effect of

an RTA; the point estimate is relatively large, implying that bilateral trade increased on average by 62% after the entry into force of an RTA.[30] In column 2 we include a full set of interactions between the international border dummy and the year fixed effects to make sure that the RTA coefficient is not just picking up globalization forces (Bergstrand, Larch & Yotov 2015). As expected, the point estimate drops significantly, at 0.146. In column 3 we amend the structural gravity equation of column 1 by modeling GVC linkages as part of trade costs, without the RTA variable. In column 4 we include the RTA dummy along with the international border interactions: the point estimate on GVC is very little affected. Finally, in column 5, we control for the possible correlation between GVCs and bilateral trade by controlling for the lagged log trade value, with the estimated coefficients on RTA_{ijt} and GVC^{95pc}_{ijt} being only marginally affected.[31]

Table 5: PPML: Gravity Estimations of the direct RTA and GVC effect

Dep Var: X_{ijt}	(1)	(2)	(3)	(4)	(5)
$\ln(1 + X_{ijt-1})$					0.371
					(0.027)
RTA_{ijt}	0.533	0.146		0.150	0.112
	(0.083)	(0.066)		(0.061)	(0.051)
GVC^{95pc}_{ijt}			0.238	0.262	0.202
			(0.054)	(0.043)	(0.039)
INTL BRDR∗1990		-1.209		-1.207	
		(0.071)		(0.070)	
INTL BRDR∗1995		-0.747		-0.766	-0.308
		(0.059)		(0.057)	(0.065)
INTL BRDR∗2001		-0.495		-0.493	-0.230
		(0.052)		(0.052)	(0.048)
INTL BRDR∗2007		-0.110		-0.123	0.041
		(0.039)		(0.038)	(0.044)
No. Countries (max)	98	98	98	98	98
Observations	44,504	44,504	44,504	44,504	35,076
FEs	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. The standard errors in parentheses are clustered by country-pair. The estimation covers 1990, 1995, 2001, 2007 and 2014. Note that 1,236 observations are dropped because they belong to groups with all zeros. Following EU enlargements, the number of observations ranges from $9,604 = 98*98$ in 1990, 1995 and 2001 to $8,464 = 92*92$ in 2007 and 2014.

Using the estimates of β_1 β_2 and β^T, along with the bilateral fixed effects μ_{ij} from column 4 of Table 5, we derive a matrix of bilateral trade costs for the baseline scenario (BLN):

$$\widehat{t_{ij,t}^{1-\sigma}} = exp(\widehat{\mu_{ij}} + \widehat{\beta}_1 RTA_{ij,t} + \widehat{\beta}_2 GVC_{ij,t}^{95pc} + \widehat{\beta_T} INTL\ BRDR_{ij} * T) \times (X_{ij,t}/\widehat{X_{ij,t}}) \quad if\ X_{ij,t} > 0$$
$$\widehat{t_{ij,t}^{1-\sigma}} = exp(\widehat{\mu_{ij}} + \widehat{\beta}_1 RTA_{ij,t} + \widehat{\beta}_2 GVC_{ij,t}^{95pc} + \widehat{\beta_T} INTL\ BRDR_{ij} * T) \quad if\ X_{ij,t} = 0$$

where $(X_{ij,t}/\widehat{X_{ij,t}})$ is the ratio of observed to predicted trade from Equation 6. The "estibrated" $\widehat{t_{ij,t}^{1-\sigma}}$, combined with the gravity system (3) - (5), yields the values of the key components in the General-Equilibrium analysis, such as the consumer-price index and the inward and outward MRTs.[32]

We now turn to the definition of the counterfactual scenarios (*step b*) mentioned above. The General-Equilibrium effects on trade (e.g. the change in the weighted average of total exports relative to the baseline at the end of each period for the treated countries) and welfare (analogously the change in real GDP) for this set of exercises appear in Tables 6 and 7. Column 2 of Table 6 refers to the subset of GVC-driven FPs in the last period, and column 3 to those involving China. Table 7 then lists the bilateral export and welfare changes for the 15 individual country pairs in column 2 of Table 6. In each scenario, we first have to solve the counterfactual (CFL) gravity model by imposing the corresponding vector of alternative trade policies or GVC intensities (*step c*). Considering the signing of all FPs, the estimated equation becomes:

$$X_{ij,t} = exp(\overline{\beta_1} RTA_{ij,t}^{FP,All} + \overline{\beta_2} GVC_{ij,t}^{95pc} + \overline{\beta_T} INTL\ BRDR_{ij} * T + \pi_{i,t}^{CFL} + \chi_{j,t}^{CFL} + \overline{\mu_{ij}}) + \epsilon_{ij,t} \quad (7)$$

where the coefficients $\overline{\beta}$ and $\overline{\mu_{ij}}$ have been constrained to their baseline values, whereas $\text{RTA}_{ij,t}^{FP,All}$ is the vector of trade policies corresponding to the counterfactual scenario where we sign absent but predicted RTAs.

As was the case for the baseline, the estimates from Equation 7 produce the counterfactual values for the MRTs, $\widehat{\pi_{i,t}^{CFL}}$ and $\widehat{\chi_{j,t}^{CFL}}$. These are the building blocks of the iterative procedure used to solve for the General-Equilibrium effects of the simulated trade policy ($RTA_{ij,t}^{FP,All}$) for this endowment economy. The General-Equilibrium effects include the adjustments of factory-gate prices (implied by the market-clearing condition in Equation (5)) and the endogenous values of income, expenditure and trade.[33]

We can now quantify the General-Equilibrium effect of the simulated trade policy as the percentage difference between the baseline (BLN) and the counterfactual scenarios (*step d*).[34]

The changes in factory-gate prices between CFL and BLN are simply:

$$\Delta p_{i,t}^{CFL} = \frac{p_{i,t}^{CFL}}{p_{i,t}} = \left(\frac{exp(\widehat{\pi}_{i,t}^{CFL})/E_{R,t}^{CFL}}{exp(\widehat{\pi}_{i,t})/E_{R,t}} \right)^{\frac{1}{1-\sigma}}$$

whereas the endogenous change in the value of income (or expenditure) in the CFL compared to the BLN is:

$$Y_{i,t}^{CFL} = \frac{p_{i,t}^{CFL}}{p_{i,t}} \cdot Y_{i,t}$$

Last, the change in welfare in the *GE* counterfactual scenario can be calculated as the change in real GDP:

$$\widehat{W}_i = \frac{Y_{i,t}^{GE}/P_{i,t}^{GE}}{Y_{i,t}^{BLN}/P_{i,t}^{BLN}}$$

The elasticity of substitution between varieties from different countries plays a crucial role in the estimation of both factory-gate prices and welfare: in the empirical results presented below we adopt the conservative value of $\sigma = 5$.[35]

2.2 Welfare changes in numbers

This section shows the results for the General-Equilibrium impacts of our counterfactuals. We are first interested in the aggregate effect on exports and real GDP in 2001, 2007 and 2014. These years are chosen as the date of the shock to the model. For each counterfactual we take a comparative-static approach (e.g., the percentage change in real GDP in 2014 when all of the predicted FPs for the subperiod 2008-2014 enter into force in 2014, see the last row of column 1 in Table 6). The percentage changes in exports and real GDP are weighted averages of the country-level changes in the treated countries. In column 2 of Table 6 we show the contribution of the GVC-driven FPs to the results in column 1, and column 3 shows the contribution of the GVC-driven FPs involving China. For the sake of comparison, the weights are kept constant in columns 1 to 3. The last column of Table 6 shows the aggregate results for a slowdown in GVCs as defined above. The changes in exports and welfare of the untreated countries are not presented in the table for space reasons, although the usual trade-diversion effects are found. For instance, considering the 2002-2007 period, signing all the FPs reduces the total exports of non-participating countries by 0.86%, with a 0.1% toll on GDP.[36]

Total exports of countries signing all the potential RTAs (i.e. FPs) would increase on average

by 3.05% to 4.23%, and their welfare by 0.23% to 0.39% (column 1 of Table 6). The "GVC-driven" potential RTAs make a large contribution to these figures. In the first period, GVC-driven RTAs account for 70% of the change in exports and 65% of the welfare change. In the last period, these contributions fall to 46% for exports and 40% for welfare, suggesting a retrenchment of opportunities related to the fragmentation of value chains. On the other hand, the contribution of GVC-driven FPs involving China rises over time: quasi absent in the first period, China becomes a major contributor at the end (with 69% of the contribution of GVC-driven FPs) as a result of the centrality of this country in the networks of GVCs.

Table 7 describes the General-Equilibrium impact on *bilateral* exports of the countries directly affected by the "GVC-driven" counterfactual (columns 1 and 2), and columns 3 and 4 the welfare impacts for the same country-pairs. The outcome in columns 1 and 2 is driven by the estimated elasticity of trade to RTA, the economic size of the partner in the pair, and the complex set of trade costs vis-à-vis all trading partners for each country in the pair. Ultimately, the trade impact ranges from 12% to 20%. The simulated asymmetry of welfare impacts within country pairs is driven by the difference in the economic size of the partners, for which USA-Thailand (last row) is a good example.

Last, we quantify in column 5 of Table 6 the economic impact of a slowdown of GVCs, for a given geography of RTAs, at the end of each period. This mimics greater trade frictions such as uncertainty or additional border controls. The impact on exports is sizeable, with an 8% to 9% drop, and a fall in GDP of around one percent.

Table 6: The Weighted Average General-Equilibrium effects of RTA or GVC shocks (comparative statics): Percentage deviation from baseline.

			FP		GVC
		All	All GVC-Driven	China GVC-Driven	Slowdown
Counterfactual	Comparative Statics	(1)	(2)	(3)	(4)
1995-2001	Δ Export$_{2001}$	3.05	2.12	0.02	-9.17
2002-2007	Δ Export$_{2007}$	3.87	1.74	0.88	-8.73
2008-2014	Δ Export$_{2014}$	4.26	2.01	1.42	-7.97
1995-2001	Δ GDP$_{2001}$	0.23	0.15	0.00	-0.83
2002-2007	Δ GDP$_{2007}$	0.40	0.15	0.07	-1.16
2008-2014	Δ GDP$_{2014}$	0.39	0.16	0.10	-0.92

Notes: The subscript indicates the year of the observed trade flow. We assume $\sigma = 5$. The reference country used in the normalization is South Africa.

Table 7: General-Equilibrium effects of a GVC shock (comparative statics): Percentage deviation from baseline, by country pair.

Country Pairs	Export		GDP	
Cty_a - Cty_b	$\Delta_{a,b}$	$\Delta_{b,a}$	Δ_a	Δ_b
CAN - MYS	16.16	15.96	0.01	0.03
CHE - IDN	16.04	16.12	0.01	0.02
CHN - IND	13.70	17.68	0.01	0.15
CHN - USA	11.63	19.70	0.06	0.18
EU - AUS	13.03	17.89	0.02	0.21
EU - CHN	17.80	12.93	0.32	0.08
EU - PHL	14.73	14.68	0.01	0.70
IDN - NOR	16.12	16.10	0.01	0.01
IND - EU	14.96	16.52	0.18	0.04
JPN - EU	15.40	16.02	0.14	0.08
JPN - HKG	14.37	16.57	0.03	0.31
NOR - BRA	16.08	16.07	0.03	0.00
SGP - CAN	16.06	16.06	0.03	0.01
USA - JPN	17.47	14.10	0.07	0.16
USA - THA	15.81	14.43	0.01	0.52

Note: This table lists the GE effects for the 15 country-pairs that should have had a signed RTA in 2014 (according to the model's prediction) as a result of their joint involvement in GVCs, referred to in the text as "GVC-driven" False Positives.

3 Conclusion

This paper has argued that the fragmentation of value chains helps to predict the geography of regional trade agreements. There are a number of reasons: tariffs are more counter-productive in the presence of foreign (domestic) value-added content in exported (imported) products; residual trade frictions are more penalising; and contractual relationships between domestic producers and foreign providers require a stable institutional environment. As a consequence, the degree to which two countries are jointly indirectly involved in GVCs should increase their benefits of engaging in an RTA.

We calculated indirect bilateral GVC income, which was introduced in our prediction of RTA occurrence among country-pairs and in our trade-cost function. Using a structural gravity General-Equilibrium model, we simulated a series of counterfactuals featuring either a different geography of trade costs or a retrenchment of the fragmentation of international value chains.

Three main results emerge. First, a series of (potential) RTAs become endogenously more desirable as GVCs increase in intensity. Even though the number of GVC-driven potential RTAs is small in comparison to the total number of potential RTAs that our model predicts, the trade between the country pairs in these GVC-driven RTAs represents a sizeable share of World trade. Second, phasing-in such "GVC-driven" unsigned RTAs contributes significantly to the export and welfare impacts of signing all incorrectly-predicted RTAs. Third, a slowdown of GVCs is associated with sizeable impacts on World trade and welfare.

This paper has not exhausted the research agenda: the model does not allow changes in trade patterns after the signature of new agreements to feed back into RTA formation. Our results should thus be considered as short-term and providing lower bounds of the impacts of the newly-signed RTAs, before any adjustment of the global production structure. The counterfactual exploring the consequences of a GVC slowdown keeps RTA geography as given. We also leave the introduction of sectoral GVC income and the use of a multi-sector General-Equilibrium trade model for future research: GVC linkages are here contemplated at the aggregate level for each country-pair, consistent with a General-Equilibrium analysis based on a one-sector model. This extension would permit changes in trade patterns to feed back into changes in GVCs.

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Notes

[1]In WTO parlance, RTAs are stricto sensu defined as reciprocal trade agreements between two (or more) countries. Free-trade agreements and Customs Unions are different types of RTAs. There is great variance in the depth of these agreements, which may cover questions beyond trade in goods. RTAs are different from Preferential Trade Agreements (PTAs), which correspond to unilateral trade-preference schemes (e.g. the Generalized System of Preferences). In the following, we adopt this definition and restrict our analysis to RTAs as defined by the WTO. We use the CEPII database, which includes RTA data from the WTO published up to 2015.

[2]Egger et al. (2011) also provide a theory-consistent approach to solve for the conditional general-equilibrium effects of RTAs.

[3]Egger, Egger & Greenaway (2008) is a first attempt to introduce multinational and intra-industry trade as determinants of selection into regional trade agreements. They only consider the fragmentation of value chains as a reflection of the intra-industry trade in intermediate goods within industries.

[4]Our sample comprises 138 countries that were members of the GATT/WTO by the end of 2014 and 21 non-member countries.

[5]As shown by Fally (2015), fixed effects are the empirical counterparts of the multilateral resistance terms in a structural gravity equation, when this is estimated by Poisson Pseudo Maximum Likelihood. This relies on the property of the PPML first-order conditions for the fixed effects in enforcing the market-clearing conditions in the model. Changes in multilateral resistance terms can then be derived from changes in the fixed effects, changes in exports and changes in consumption in order to evaluate the welfare change in each country. Using a benchmark exercise of abolishing the border effects for manufactured products, Anderson et al. (2018) demonstrate that the resulting changes are in line with those from the solution of the non-linear gravity system.

[6]As recently shown by Tarlea (2018).

[7]Taking the example from (Timmer et al. 2013): "Demand for German cars will in the first instance raise the output (*and income*) of the German car industry. But production in this industry relies on car parts and components that are produced elsewhere, such as engines, braking systems, car bodies, paint, seat upholstery or window screens, but also energy, and various business services such as logistics, transport, marketing and financial services. These intermediate goods and services need to be produced as well, thus raising output (*and income*) in the industries delivering these, say the German business services industry, the Czech braking systems industry and the Indian textile industry" (Italics added).

[8]As signing RTAs is an exclusive competence of the European Union (EU), the EU as a whole – instead of individual Member States – negotiates and legislates on such trade matters according to Article 207 of the Treaty on the Functioning of the European Union. For this reason, we aggregate Member States into a single entity in our calculations of natural RTAs below.

[9]As in Baier & Bergstrand (2004) and Egger & Larch (2008), the RTA_{ij} outcome can be interpreted as the difference in unobserved utility between the two outcomes: membership vs. non-membership.

[10]A detailed description of the variables appears in Appendix 4.1.

[11]In our preferred specification, the $OthRTA$ are weighted using past trade flows (lagged five years); we also show results using unweighted measures for robustness.

[12]More specifically, we calculate the average threshold probability per sub-period (e.g. 2008-14) in our sample of countries and the predicted probability in each year for each country pair. We then compare the simple country-pair average of the predicted probabilities over the period to this threshold. If the country pair had, or enforced, an RTA at any date during the period, and if the average predicted probability is over the threshold, the country pair is classified as a TP for the period considered. Without an RTA, it is an FP.

[13]As pointed out in Baier et al. (2014), being signed up to an RTA is actually relatively rare, so that the intuitive threshold at 0.5 would imply that the not very informative TNs are mostly behind the predictive power of the model.

[14]The position of the countries on the map is determined using a force-directed algorithm. This algorithm acts like balanced-spring system, as if countries were linked via springs: the countries that are connected tend to stay close together, while countries that are not connected are further apart.

[15]Using a ratio bypasses the problem of units of measurement and avoids the choice of a deflator. Although the EU GVC income of EU Member States is ultimately aggregated to carry out the estimations and prediction of RTAs, we retain the country dimension within the EU for the initial calculation of GVC income. This choice was motivated by the imperfect integration of Member States' national economies, despite the completion of the Single European Market. The border effects identified by Head & Mayer (2000) remain prevalent inside the Single Market, even though they have been declining. Using our data, a within-sample estimation of the border effect over the period considered controlling for time-varying multilateral resistance terms, tell us that Member States were still trading 4.1 times more domestically than with other Member States in 2014, down from figures of 6.0 in 2007, 7.1 in 2001 and 8.7 in 1990.

[16]In constructing the GVC income variable, we subtract the value of the direct linkages, A_{ij}, from $(I - A)^{-1}_{ij}$. Following Bosker & Westbrock (2018), this implies that we focus only on the *network-diffusion* channel of trade-cost shocks.

[17]For a detailed derivation of the Stone decomposition, see Miller & Blair (2009).

[18]The EORA database is the most-complete source of information on country production structures and input-output (IO) tables, covering 189 countries (plus a Rest of the World aggregate) and 26 industries over the 1990-2015 period. For further information see Lenzen, Kanemoto, Moran & Geschke (2012) and Lenzen, Moran, Kanemoto & Geschke (2013). For a recent application of EORA to quantify the welfare effects of trade liberalization, see Caliendo, Feenstra, Romalis & Taylor (2015).

[19]Note that the average increase in GVC income (weighted by GDP) over the 1995-2007 period is 2.71 percentage points, in line with the 2.84 percentage-point increase found by Reshef & Santoni (2019) using the restricted WIOD sample.

[20]The Likelihood-Ratio test produces a χ^2 of 59.8, and the BIC a difference of 35.4, providing strong support for the inclusion of GVC income in the model.

[21]Note that $GVC^{total}_{ij,t-5} = GVC^{indirect}_{ij,t-5} + GVC^{bilateral\,trade}_{ij,t-5}$. The detailed results appear in column 6 of Table ST2 in the Appendix.

[22]We use this abbreviation for "Economic and Trade Agreement Between the United States of America and the People's Republic Of China: Phase One".

[23]General-Equilibrium gravity models have been used extensively to carry out counterfactual analyses of changes in trade costs: Anderson & Yotov (2010) revisit the border effect for Canada; Behrens, Mion, Murata & Südekum (2014) simulate a scenario where all trade barriers associated with the US-Canada border are removed; Egger & Larch (2011) assess the economic impacts of the Europe Agreements between incumbent Member States and the 10 new entrants from Central and Eastern Europe; Heid & Larch (2016) add a labor market featuring search and matching; Martin et al. (2012) investigate the role of past-conflict propensity in predicting RTAS; and Mayer, Vicard & Zignago (2018) propose a reappraisal of the cost of non-Europe.

[24]α_i is the usual preference parameter in the CES equation.

[25]This procedure allows us to recover the MRTs, up to a scalar. To avoid collinearity, one fixed effect has to be dropped as the reference country. All of the other fixed effects are then interpreted relative to the dropped country (this country has an MRT of one).

[26]Note that, out of the 676 FP country pairs over the 2008-2014 period, 54 were above the 95th percentile of the distribution of indirect GVC income in 2014, whereas 622 were below the 95th percentile in 2014. Concerning the "GVC-driven" FPs, out of the 15 country pairs in Table 3, 9 were above the 95th percentile of indirect GVC income distribution in 2014 and 6 below.

[27]To proceed, we require data on output and expenditure, as the correct benchmark for trade integration is the domestic economy (Yotov 2012). The data on intra- and inter-national trade come from the CEPII TradeProd database, described in de Sousa, Mayer & Zignago (2012), and UNIDO INDSTAT4 2018. We fill in intra-national flows using linear interpolation between non-missing data, as in Baier, Yotov & Zylkin (2016).

[28] Alternatively, a calibration can be used to solve the model using the odds-ratio method, Head & Ries (2001), the tetrads method, Head, Mayer & Ries (2010), and the three-countries method, Caliendo & Parro (2015). For the "estibration" method see also Yotov et al. (2017). This approach combines trade-cost estimation (using PPML) and calibration (through the error term in Equation 6).

[29]This procedure builds on the unique additive property of the PPML estimator (set out in Arvis & Shepherd (2013) and Fally (2015)) ensuring that the estimated importer and exporter fixed effects directly match their

theoretical counterparts, $exp(\widehat{\pi_{i,t}}) = \frac{Y_{i,t}}{\widehat{\Pi^{1-\sigma}_{i,t}}} \cdot E_{R,t}$, where $\widehat{\pi_{i,t}}$ is the estimated exporter fixed effect, $\widehat{\Pi^{1-\sigma}_{i,t}}$ the value of the outward MRT, and R the reference country for the normalization (i.e. Brazil). $E_{R,t}$ is hence the expenditure in this reference country. The same property holds for $exp(\widehat{\chi_{j,t}})$. Moreover, the PPML procedure does not need to assume values for the CES shares, such as the preference parameter α_i. See Anderson et al. (2018) for additional details. Note that, since we include intra-national trade flows, $Y_{i,t} = \sum_j X_{ij,t}$ and $E_{j,t} = \sum_i X_{ij,t}$.

[30] $[exp^{0.533} - 1] * 100 = 62$

[31] In Table ST5 we show the General-Equilibrium estimates using RTA and GVC elasticities from the specification including lagged (log) trade values.

[32] Note that although both the baseline and counterfactual solutions are calculated for individual cross-sections (2001, 2007 and 2014), the underlying values of $\widehat{\beta}$ and $\widehat{\mu_{ij}}$ are calculated over the whole period, and as such are time-invariant. As 2.7% of the estimated $\widehat{\mu_{ij}}$ are not identified, we replace missing trade costs with predictions from the standard gravity regression using the logarithm of distance, common border, common language and colonial ties as the explanatory variables.

[33] The endogenous changes in the values of income and expenditure generate a further adjustment in MRTs that, in turn, is translated into a new matrix of bilateral trade flows, $X^{CFL}_{ij,t}$. The estimation of Equation (7) is carried out iteratively with the endogenous bilateral trade flows $X^{CFL}_{ij,t}$ until the change in factory-gate prices converges to zero. The final set of fixed effects is used to construct the GE indices for factory-gate prices, MRTs, income, expenditure and trade.

[34] Using the notation $\widehat{IND}$ for our variables of interest, exports or real GDP, this is easily calculated as:

$$\Delta\widehat{IND_i}\% = \frac{\widehat{IND}_i^{GE} - \widehat{IND}_i^{BLN}}{\widehat{IND}_i^{BLN}} \times 100$$

[35] In their collection of 435 elasticities present in 32 papers using gravity with MRTs, Head & Mayer (2014) find a median elasticity of 5.0. Fontagné, Guimbard & Orefice (2019) obtain an average elasticity of 5.5 using HS6 data. In the Appendix we also present results assuming that $\sigma = 7$.

[36] We do not comment on the economic impact on untreated countries in the last period, as all countries in our sample are concerned by at least one FP RTA to be signed in this period.

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4 Appendix

4.1 Variable construction and robustness checks

Real GDP at constant 2011 national prices in milions of 2011US$ (gdp), capital stock (K) and employment (L) come from the Penn World Tables 9.0 (variables: rgdpna, cn, emp; for more details see Feenstra, Inklaar & Timmer (2015)), the great-circle distance between countries from CEPII (see Mayer & Zignago 2011) and multi-region input-output tables from the EORA MRIO database. The economic variables in the estimation of Equation (1) are calculated as follows:

$$
\begin{aligned}
Natural_{ij} &= log(\frac{1}{dist_{ij}}) \\
Remote_{ij} &= (0.5\{log[\sum_{k\neq j} Dist_{ik}/n-1] + log[\sum_{k\neq i} Dist_{jk}/n-1]\}) \\
CRTA_{ij} &= R^2_{i,j} \\
GDP^{sum}_{ijt} &= log(gdp_{it}) + log(gdp_{jt}) \\
GDP^{sim}_{ijt} &= log(1-[gdp_{it}/(gdp_{it}+gdp_{jt})]^2 - [gdp_{jt}/(gdp_{it}+gdp_{jt})]^2) \\
DKL_{ijt} &= |log(K_{it}/L_{it}) - log(K_{it}/L_{it})| \\
OthRTA_{it} &= \sum_{k\neq j}^{N} RTA_{ikt} \\
OthRTA_{jt} &= \sum_{k\neq i}^{N} RTA_{kjt} \\
GVC^{income}_{ijt} &= 0.5 * \left[\frac{GVC^{i->j}_{ijt}}{GDP_{it}} + \frac{+GVC^{j->i}_{ijt}}{GDP_{jt}}\right]
\end{aligned}
$$

Here $R_{i,j}$ in $CRTA_{ij}$ is the $i \times j$ matrix of RTAs in the pre-estimation period.

Figure 5 shows some preliminary evidence on the positive association between value-added trade and RTAs, confirming that the bulk of GVC (indirect) income flows occurs between countries with a preferential trade agreement in place. The average $\text{GVC}^{Indirect}_{ij,t-5}$ flow among preferential trade partners is significantly higher than that between country pairs with no preferential trade agreement.

In column 1 of Table ST1, we report the estimated coefficients (not the marginal effects as

in the main text) from the baseline logit estimates for reference: the model includes all of the controls in column 2 Table 1. The conditional logit model is presented in column 2: due to the functional forms, only time-varying controls are included. The total number of observations shrinks significantly when including only "switching" country-pairs: i.e. country-pairs for which the dependent variable changes over the estimation period. For completeness, columns 3 and 4 list the results from the baseline logit and probit models on the sub-sample of switching pairs (with both time-invariant and time-varying controls). As shown in the table, the estimated coefficients on $\text{GVC}_{ij,t-5}^{Indirect}$ are positive and significant (although only at the 15% level in column 3: $p - value = 0.134$) across the models, suggesting that time-invariant unobserved heterogeneity does not represent a major threat to the baseline model.

Table ST2 shows the estimates from a linear-probability model that sequentially includes country-pair fixed effects ij (column 1); origin-year and destination-year fixed effects, it and jt (column 2); and the full set of fixed effects, ij, it and jt (column 3). Not surprisingly, most of the variation in the model (82.8%) is captured by the country-pair fixed effects. In columns 4 and 5 we add to the full fixed effect model the $\text{GVC}_{ij,t-5}^{Indirect}$ variable alone (column 4) and the remaining $ij, t-5$ controls (column 5). Finally, in column 6 we replace the indirect GVC income variable with $GVC_{ij,t-5}^{total}$, which includes direct exports of intermediate inputs, and find a positive and statistically-significant coefficient.[37]. The results in columns 4 to 6 largely confirm the positive significant effect of GVCs on the likelihood of signing an RTA, as predicted in the baseline logit model.

Table ST1: Conditional-Logit estimates

Dep Var: RTA_{ijt}	Logit (1)	Conditional Logit (2)	Logit (3)	Probit (4)
$\text{GVC}_{ij,t-5}^{Indirect}$	6.617	17.299	8.955	5.578
	(1.558)	(6.311)	(5.825)	(3.211)
Sample	Full	Switchers only	Switchers only	Switchers only
Controls	All	Time Variant	All	All
Observations	193,162	10,190	10,190	10,190

Notes: Standard errors in parentheses are clustered by country-pair. Year fixed effects δ_t are included in all regressions but their estimated coefficients are not shown.

Table ST2: The Linear-Probability model for RTAs

Dep Var:				$RTA^{ij,t}$		
	(1)	(2)	(3)	(4)	(5)	(6)
$GVC^{Total}_{ij,t-5}$						0.228
						(0.082)
$GVC^{Indirect}_{ij,t-5}$				0.506	0.486	
				(0.181)	(0.180)	
Additional Controls:					GDP^{sim}_{ijt}, DKL_{ijt}, $SQDKLL_{ijt}$	GDP^{sim}_{ijt}, DKL_{ijt}, $SQDKLL_{ijt}$
FEs	ij	it , jt	ij, it , jt	ij, it , jt	ij, it , jt	ij, it , jt
Observations	193,162	193,122	193,122	193,122	193,122	193,122
R^2	0.828	0.076	0.850	0.850	0.850	0.850

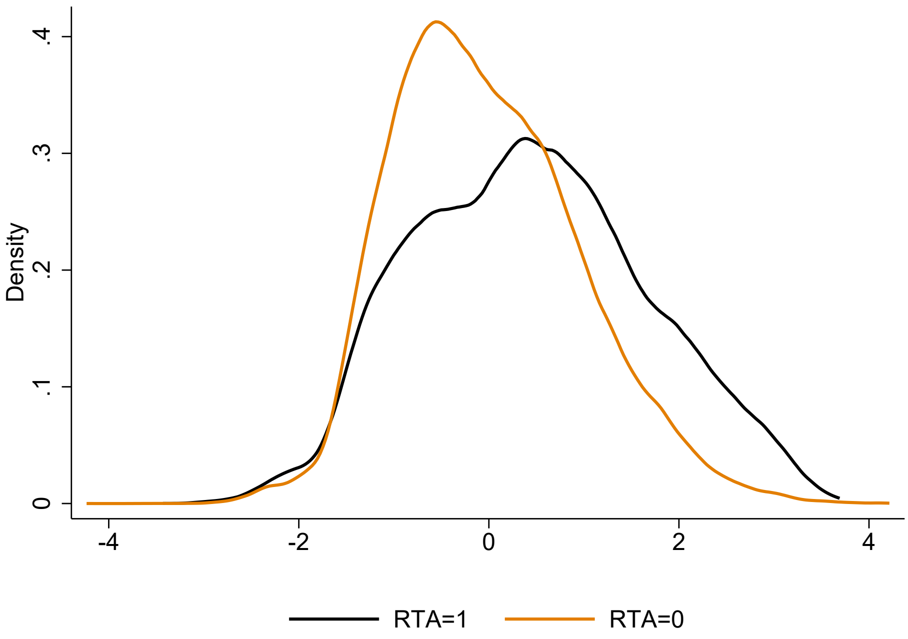
Note: Standard errors in parentheses are clustered by country-pair.

Table ST3: Robustness to different measures of GVC integration

Dep Var:	Baseline	Complex GVCs Stone Decomp	Higher-Order Leontief	Trade Stone Decomp	First-Order Leontief
RTA_{ijt}	(1)	(2)	(3)	(4)	(5)
$GVC^{Indirect}_{ij,t-5}$	0.072	0.070	0.032	0.018	0.035
	(0.018)	(0.018)	(0.014)	(0.011)	(0.020)
Observations	193,162	193,162	193,162	193,162	193,162
Pseudo R^2	0.450	0.450	0.453	0.454	0.454
Log-Likelihood	-23744.9	-23743.9	-23607.8	-23565.3	-23566.1

Notes: Standard errors in parentheses are clustered by country-pair. Γ_{ij}, $\overline{\Gamma_{ij}}$ and year fixed effects δ_t are included in all regressions but their estimated coefficients are not shown.

Figure 5: The distribution of indirect GVC income flows



Notes: The two curves reflect the distribution of (indirect) $log(GVC^{Indirect})$ for country pairs with a preferential trade agreement ($RTA = 1$), versus those without a trade agreement ($RTA = 0$). Before calculating the density distribution, the values of $log(GVC^{Indirect})$ are standardized to have zero mean and a standard deviation of 1. Note that the observations are pooled over the full sample period: 1995-2014. The data on preferential trade agreements come from the CEPII gravity database: see Head & Mayer (2014). The EORA Multi Regional Input Output database is used to calculate indirect GVC income.

4.2 Estimated welfare with a trade elasticity of $\sigma = 7$

Table ST4: The Weighted Average General-Equilibrium effects of an RTA or GVC shock (comparative statics): Percentage deviation from baseline.

		FP			GVC
		All	All GVC-Driven	China GVC-Driven	Slowdown
Counterfactual	Comparative Statics	(1)	(2)	(3)	(4)
1995-2001	Δ Export_{2001}	3.04	2.13	0.02	-9.87
2002-2007	Δ Export_{2007}	3.73	1.61	0.80	-9.49
2008-2014	Δ Export_{2014}	4.12	1.91	1.35	-8.34
1995-2001	Δ GDP_{2001}	0.15	0.10	0.00	-0.55
2002-2007	Δ GDP_{2007}	0.27	0.11	0.05	-0.76
2008-2014	Δ GDP_{2014}	0.27	0.11	0.08	-0.62

Notes: The subscript indicates the year of the observed trade flow. We assume $\sigma = 7$. The reference country used in the normalization is South Africa.

4.3 Estimated welfare controlling for lagged trade ($\sigma = 5$)

Table ST5: The Weighted Average General-Equilibrium effects of an RTA or GVC shock (comparative statics): Percentage deviation from baseline.

		FP			GVC
		All	All GVC-Driven	China GVC-Driven	Slowdown
Counterfactual	Comparative Statics	(1)	(2)	(3)	(4)
1995-2001	Δ Export_{2001}	2.23	1.53	0.02	-7.13
2002-2007	Δ Export_{2007}	2.78	1.15	0.56	-6.77
2008-2014	Δ Export_{2014}	3.04	1.38	0.96	-6.17
1995-2001	Δ GDP_{2001}	0.16	0.10	0.00	-0.62
2002-2007	Δ GDP_{2007}	0.29	0.11	0.05	-0.87
2008-2014	Δ GDP_{2014}	0.29	0.12	0.08	-0.69

Notes: The subscript indicates the year of the observed trade flow. We assume $\sigma = 5$. The reference country used in the normalization is South Africa.

4.4 The Role of Political variables

In order to shed light on the role of the political determinants in RTA predicted probabilities, we augment the baseline model with a series of political variables. These are the cumulated number of war-related *Casualties* between the two countries (source: Correlates of War: Dyadic Militarized Interstate Dispute Data, Version 3.10, `https://correlatesofwar.org`), a measure of institutional quality by country and year (*PolityIV*: See Marshall, Ted Robert & Jaggers (2016)), and a series of bilateral historical and political factors, such as common religions, common legal origins Pre- and Post-transition (including a series of dummies for the legal system: FR, GR, SC, SO and UK) and the maximum number of days and procedures needed to start a business between the two countries (source: Head et al. (2010)). Table ST6 confirms that the estimated coefficients are little affected by the inclusion of political variables.

The estimated probabilities are strongly correlated (above 96%) between the baseline (column 1) and augmented models (column 4).

Table ST6: Marginal effects of the economic determinants of RTAs, including Political Variables

Dep Var:	Logit			
RTA_{ijt}	(1)	(2)	(3)	(4)
$Natural_{ij}$	0.020	0.022	0.017	0.016
	(0.001)	(0.002)	(0.001)	(0.001)
$Remote_{ij}$	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)
$CRTA_{ij}$	0.030	0.031	0.024	0.021
	(0.004)	(0.006)	(0.005)	(0.004)
$GDP^{sum}_{ij,t-5}$	0.001	0.000	0.000	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
$GDP^{sim}_{ij,t-5}$	0.004	0.005	0.004	0.003
	(0.001)	(0.001)	(0.001)	(0.001)
$DKL_{ij,t-5}$	-0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
$SQDKL_{ij,t-5}$	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$OthRTA_{i,t-5}$	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$OthRTA_{j,t-5}$	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$GVC^{Indirect}_{ij,t-5}$	0.072	0.081	0.069	0.069
	(0.018)	(0.023)	(0.025)	(0.020)
Polity $IV^{Min:ij}_{ij,t}$			-0.000	-0.000
			(0.000)	(0.000)
Start $Business^{Max:ij}_{ij}$			-0.001	-0.001
			(0.001)	(0.001)
Common Legal $origins^{BeforeTransition}_{ij}$			0.013	0.015
			(0.002)	(0.002)
Common Legal $origins^{AfterTransition}_{ij}$			-0.009	-0.009
			(0.002)	(0.002)
Common $Religion_{ij}$			0.005	0.006
			(0.002)	(0.002)
$Casualties^{COW}_{ij}$			-0.000	0.000
			(0.000)	(0.000)
Legal Origins Dummy	No	No	No	Yes
Observations	193,162	162,596	162,596	162,596
Pseudo R2	0.450	0.444	0.463	0.472
Log-Likelihood	-23744.9	-20833.1	-20110.8	-19780.2

Notes: Standard errors in parentheses are clustered by country-pair. $\overline{\Gamma_{ij}}$ and the fixed effects δ_T are included in all regressions but their estimated coefficients are not shown.