Modeling heterogeneous direct and third-country effects of the trade policy network

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Abstract

This paper presents a structural Melitz-type gravity model with firm heterogeneity featuring heterogeneous trade cost elasticities to estimate modular effects of trade agreements. We provide a structural underpinning for heterogeneous third-country—trade diversion and reverse diversion—effects. The correct estimation strategy when using approximated multilateral resistances in panels is shown. We analyze the components of the indirect effects of agreements, and two simulations highlight the quantitative importance of indirect effects. Third-country effects from the network of agreements in place can be economically significant. Governments should consider third-country effects when analyzing potential strategic integration scenarios.

Keywords: Economic integration agreement, trade diversion, third-country effects, multilateral resistances, heterogeneity.

JEL-codes: F15, F14, F17, F13, C23.

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1 Introduction

The increasing number of international agreements, their varying content scope, and the diverse number of members involved weave a complex web of trade linkages. It is well established that international trade liberalizations have positive aggregate trade, welfare and development effects.[1] Recent research explores how the direct effects of international agreements vary across countries and agreements and which channels define this variation. It is less understood, however, how indirect, third-country effects of the complex network of trade agreements vary and their macroeconomic implications.

This paper studies the heterogeneous direct and third-country effects of EIAs. It presents a theoretical framework to estimate heterogeneous modular effects from trade costs. Modular effects encompass direct and multilateral-resistance (third-country) effects and account for the trade impact of trade barriers holding output and expenditures constant (Anderson, 2011, Head and Mayer, 2014). Our framework expands the Melitz-type gravity model with firm heterogeneity and heterogeneous trade cost elasticities by Baier et al. (2018). We obtain the structural gravity model and derive an expression of the approximated multilateral resistances, which provides a structural underpinning for third-country—trade diversion and reverse diversion or external trade creation—effects.

The model is applied to the analysis of the effects of Economic Integration Aggreements (EIAs). We augment the empirical model to include interactions of the EIA indicator and demographic variables, which are proxies for trade costs and the effects of trade liberalizations through productivity. The inclusion of these demographic indicators is based on evidence from urban economics. The model is estimated for a large panel dataset, and the correct strategy to obtain unbiased estimates when using approximated multilateral resistances in panels is shown. The general-equilibrium solution is obtained and the total effects can be decomposed into direct, third-country effects.

Our estimates reveal not only important heterogeneous bilateral effects but also that third-country effects derived from the intricate web of EIAs currently in place are heterogeneous, can be econom-

[1] See e.g. Anderson and Van Wincoop (2003), Eaton and Kortum (2002), Melitz (2003) and Costinot and Rodríguez-Clare (2014).

ically significant and become more important as the EIA network expands. A simulated experiment contributes to the understanding of the gains of trade liberalizations and shows the increasing role of third-country effects in the context of a growing number multilateral trade agreements that characterize the recent decades and the importance of quantifying third-country effects of EIAs. Governments should take into account third-country effects when analyzing potential strategic integration scenarios, specially when their external dimension is closely related to highly integrated areas and regions fostering economic integration.

This paper contributes to several branches of literature. First, it relates to recent research on heterogeneous effects of trade agreements. Novy (2013) documents substantial heterogeneity in trade costs broadly defined across country pairs. Baier et al. (2018) extend a standard Melitz model and show that the elasticity of trade flows associated with trade liberalizations is heterogeneous and endogenous to levels of fixed and variables costs. They estimate pair-specific trade elasticities, captured by interactions between an indicator for EIA and geographic, institutional, and cultural gravity variables.[2] Given the structural underpinning of the estimated heterogeneous elasticities, Baier et al. (2018) incorporate them in ex ante simulations and show the effect of accounting for heterogeneity of trade elasticities on general-equilibrium inference about the welfare effects of EIA trade liberalizations. Baier et al. (2019) emphasize the relevance of pair's characteristics (within agreement variability), which they estimate that produces 2/3 of the variation of the effects of Free Trade Agreements (FTA) , whereas the other 1/3 of the variation is attributed to variation across FTAs. They also conclude that FTA effects increase with ex-ante trade frictions of country pairs (captured by pair fixed effects) and that the FTA effects on a country decrease with decreasing market power over terms of trade, with prior existence of trade agreements in place, and with increasing geographical distance.

Our analysis builds on Baier et al. (2018) and expands the empirical model in two ways. First, we include interactions that capture variable and fixed costs related to urban density. Urban density

[2] Baier et al. (2018) provide empirical support for heterogeneous trade elasticities at the extensive and the intensive margins, as well as of total trade. Our research focuses on modeling third-country effects without distinguishing between third-country effects at the extensive or intensive margins. The extension of our framework to determine heterogeneous third-country effects at the extensive and intensive margins is straightforward.

determines several drivers of trade flows such as network distribution and transport costs, and their interaction with the firm's productivity. Second, we extend the model to provide insights on third-country effects—trade diversion and reverse trade diversion.

Therefore, our research also relates to recent studies on the trade creation and diversion effects of trade agreements.[3] These studies augment the gravity model with variables capturing third-country effects of membership to an agreement. However, the introduction of these variables in the gravity model, as well as their definition, lacks a structural underpinning within the gravity model. Hence, the definition of the trade diversion variables used differs between studies,[4] and a problem of collinearity between the proxies for third-country effects and the directional-time fixed effects capturing multilateral resistances arises—trade diversion variables cannot be estimated together with directional-time fixed effects and are defined such that multicollinearity with directional-time fixed effects is avoided.

Evidence from studies analyzing trade diversion is mixed. Carrere (2006) estimates some trade diversion effects on the importer side, whereas Magee (2008) finds limited evidence for trade diversion of average regional trade agreements and Freund and Ornelas (2010) conclude that trade diversion is not a major concern for most regional agreements. The estimated trade diversion effects are substantial on the importer side in Dai et al. (2014) and comparable to those in Cheong et al. (2015b). Also, trade agreement effects are smaller when a country is a member of preexisting agreements (Cheong et al., 2015a, and Sorgho, 2016) and marginal diversion effects are expected to be smaller as more trade agreements are in place (Magee, 2017). Furthermore, trade agreements can imply non-discriminatory liberalizations or harmonization of standards, which can have positive effects on third countries—namely, reverse trade diversion or external trade creation (Baldwin,

[3] The analysis of trade creation and diversion of trade agreements dates back to the seminal articles by Viner and fundamentally to Viner (1950) and includes a large number of references. We focus on the most recent research, mainly in the framework of panel data.

[4] Without aiming at providing an exhaustive literature review, Carrere (2006) uses agreement-specific dummies representing trade diversion from exporter and importer's side. Magee (2008) uses the count of the number of agreements of observed trading partners with third countries for a generic trade agreement and specific agreements. Cheong et al. (2015b) modify Magee's (2008) count to avoid multicollinearity with the directional-time fixed effects. Dai et al. (2014) distinguish between diversion affecting importer and exporter's sides. Matoo et al. (2022) define the relative preference margin and the average depth of trade agreements on the importer side, and both measures are defined such that they can be included together with the importer-time fixed effect.

2011). In this regard, Matoo et al. (2022) account for the depth of PTAs and distinguish between tariffs and discriminatory and non-discriminatory provisions. They find that non-discriminatory provisions have a reversed diversion effect, whereas tariff preferences and preferential provisions have a diversion effect. The diverting effects of tariffs depend on the depth of the agreement of the importer, such that deep agreements moderate the diverting effect of tariff preferences, which is even reverted for deeper agreements.

We add to prior research on trade diversion by providing a structural underpinning to both trade diversion and reversed trade diversion in terms of the components of approximated multilateral resistances. Trade diversion emerges from the structural gravity model and multilateral resistances capture third-country effects of trade cost changes and absorb trade diversion effects of agreements. Thus, our measures for trade diversion are derived from the multilateral resistances. Moreover, third-country trade diversion and creation effects in our framework depend on fixed and variable costs, which are pair-specific, and can be lagged.

Third, our derivation of third-country effects is based on a linear approximation of the multilateral resistances, such that they are fully consistent with the structural definitions of output and expenditures (Fally, 2015) and can be identified when using fixed effects in the estimation. Baier and Bergstrand (2009, 2010) propose first-order Taylor approximations of multilateral resistances in the context of cross sections and show that they yield parameter estimates close to the unbiased fixed-effects estimator. Later research uses approximated multilateral resistances in panel data (Egger and Nelson, 2011, Francois and Manchin, 2013) and in gravity models with self-selection (Behar and Nelson, 2014). Egger and Pfaffermayr (2023) show that Baier and Bergstrand's (2009) approximation uses observed sales and expenditures that are not consistent with the approximation point. As a consequence, the approximation error is exacerbated and the linear model does not approximate the nonlinear model in the approximation point. Moreover, estimates using the approximated multilateral resistances are biased. They propose a linear approximation based on a weighted projection matrix, such that these sources of bias are corrected. Additionally, their approximation allows to specify the approximation point at the observed one. We show that first-order Taylor approximations using structurally-consistent output and expenditures and observed point as an approximation point are a specific case of the linear approximation proposed by Egger and Pfaffermayr (2023), and that our estimation approach using directional-time fixed effects is free from the bias induced by using incorrect approximations of the multilateral resistances in the estimation step. Fally (2015) shows that when the data generating process is the structural gravity model, directional-time fixed effects in PPML identify the multilateral resistances. By contrast, we note that when drivers of trade flows other than those predicted by the theoretical model are present, directional-time fixed effects are required to obtain unbiased estimates in panels, and the approximation of the multilateral resistances identifies mathematically third-country effects conditioned on the structural model.

Fourth, there is much evidence that trade liberalizations have gradual effects on trade flows.[5] Lagged effects of agreements can be rationalized by phase-in, price pass-through, and spatial effects of EIAs (Baier and Bergstrand, 2007, Besedes et al., 2020). Our research adds to this evidence by identifying lagged bilateral effects and multilateral-resistance terms capturing indirect effects of EIAs that are pair specific. Delayed agreement effects are associated with specific variable and fixed cost changes and are captured by the lagged EIA interactions. Lagged heterogeneous third-country effects of EIAs appearing in the multilateral resistances are consistent with lagged trade diversion and reversed diversion effects, which can result from gradual phase-in of agreements, delayed price pass-through, and gradual market expansion of firms as a consequence of decreasing trade costs from agreements potentially combined with sequential exporting and learning (Albornoz et al., 2012, 2021, Morales et al., 2019).

The structure of the paper is as follows. The next section presents the theoretical framework and the empirical model. Section A presents the data sources. Section 3 analyzes the econometric results. In Section 4, we introduce two simulated experiments to study the modular effects of EIAs. Section 5 concludes.

[5] See e.g. Baier and Bergstrand (2007), Olivero and Yotov (2012), Baier et al. (2019), Besedes et al. (2020), Khan and Khederlarian (2021).

2 Methodology

Our purpose is to estimate direct, indirect, modular and general-equilibrium effects of trade policies in a heterogeneous firms model with pair-specific trade costs. We first derive a structural gravity specification (see Anderson and Yotov, 2010, Fally, 2015, for a definition) from Baier et al. (2018, ; BBC) and linearize the multilateral resistances. This model can be estimated using PPML and allows for the estimation of the modular trade impact of trade barriers holding output and expenditures constant. After that, we show how to perform general equilibrium analysis conditioned on the estimated parameters. A full description of the methodology can be found in Appendix E.

2.1 Derivation of the structural gravity

The groundwork for our study is the gravity model of Baier et al. (2018, ; BBC), a Melitz-type model of trade with heterogeneous firms in spirit of Chaney (2008) and Redding (2011), which incorporates in an additive form policy and natural fixed costs, as well as endogenous export fixed costs as in Krautheim (2012) and obtains pair-specific trade elasticities depending on the level of trade costs. The model in BBC can be summarized by three equations. The first equation characterizes trade flows from exporter i to importer j as

$$X_{ij} = \left[(\alpha_i L_i)\left(\varphi_{ij}^{*}\right)^{-\gamma}\right]\left[\left(\frac{\sigma\gamma}{\gamma-(\sigma-1)}\right) w_j \left(A_{ij} + M_{ij}^{-\eta}\right)\right] \tag{1}$$

L_i is the labor force (population) in country i, w_j is the wage in country j, and $A_{ij} = (A_{ij}^{P} + A_{ij}^{N})$ is the sum of policy and non-policy (exogenous) fixed costs. M_{ij} is the (equilibrium) mass of firms selling from i to j capturing endogenous costs, and φ_{ij}^{*} is the zero-profit-condition productivity cutoff for firms selling from i to j. γ is the shape parameter governing heterogeneity in the Pareto distribution of the firms' productivity, and $\sigma > 1$ is the elasticity of substitution of consumption across product varieties in the set of varieties Ω_j. α_i is an i-specific parameter depending on γ, σ and the exogenous fixed entry costs faced by firms in country i. The second equation is the zero-profit condition characterizing the equilibrium cutoff productivity level φ_{ij}^{*}:

$$\left(\frac{w_i \tau_{ij}}{\rho P_j}\right)^{1-\sigma} \frac{E_j}{\sigma} \left(\varphi_{ij}^*\right)^{\sigma-1} = w_j \left(A_{ij} + M_{ij}^{-\eta}\right) \quad , \tag{2}$$

where τ_{ij} are ad valorem iceberg variable trade costs ($\tau_{ij} \geq 1$), E_j is aggregate expenditure of country j, $\rho = (\sigma - 1)/\sigma$ represents firms' markup, $\eta \in (0,1)$ is the elasticity of fixed costs with respect to the mass of firms in i selling to j, and P_j is the equilibrium price index:

$$P_j^{1-\sigma} = \sum_{i=1}^{N} M_{ij} \left(\varphi_{ij}^*\right)^{-\gamma} \left(\frac{w_i \tau_{ij}}{\rho}\right)^{1-\sigma} \left(\frac{\gamma}{\gamma - (\sigma - 1)}\right) \left(\varphi_{ij}^*\right)^{\sigma-1} \tag{3}$$

Adding market clearing and trade balance conditions, the structural gravity model is

$$X_{ij} = \frac{Y_i E_j}{Y^w} \left[\frac{t_{ij}}{\theta_j \Pi_i}\right]^{-\gamma} \tag{4}$$

$$\theta_j^{-\gamma} = \sum_{i'=1}^{N} \left[\frac{s_{i'}}{\Pi_{i'}^{-\gamma}}\right] t_{i'j}^{-\gamma} \tag{5}$$

$$\Pi_i^{-\gamma} = \sum_{j'=1}^{N} \left[\frac{s_{j'}}{\theta_{j'}^{-\gamma}}\right] t_{ij'}^{-\gamma} \quad , \tag{6}$$

where Y_i, and Y^w are output of exporter i and world output. θ_j and Π_i are the multilateral resistance terms, where i', j' refer to exporters and importers in the sample, and s_i' and s_j' are the weights of countries i' and j' in world output. t_{ij} is a catch-up variable capturing all trade costs, $t_{ij} = \tau_{ij} \left(F_{ij}\right)^{1/(\sigma-1)-1/\gamma}$, and F_{ij} collects fixed costs ($A_{ij} + M_{ij}^{-\eta}$). The system formed by (4)–(6) has the form of the traditional structural gravity model and is suitable for linearization of the multilateral resistances in spirit of Baier and Bergstrand (2009) and Egger and Pfaffermayr (2023). In particular, we apply a linearization based on a scale projection matrix as recently proposed by Egger and Pfaffermayr (2023).[6] In Appendix E we show that this linearization produces expressions for the

[6] We are thankful Peter Egger for suggesting using linearization based on a scaled projection matrix and sharing their paper.

multilateral resistances analogous to those in Baier and Bergstrand (2009) but around observed trade costs and with theory-consistent weights. That is:

$$\ln \theta_j = -\left[\sum_{i'=1}^{N} s_{i'} \ln t_{i'j} - \sum_{i'=1}^{N} s_{i'} \ln t_{i'1}\right] \tag{7}$$

$$\ln \Pi_i = -\left[\sum_{j'=1}^{N} s_{j'} \ln t_{ij'} + \sum_{i'=1}^{N} s_{i'} \ln t_{i'1} - \sum_{i'=1}^{N}\sum_{j'=1}^{N} s_{i'} s_{j'} \ln t_{i'j'}\right] \tag{8}$$

for $i, j = 2, \ldots, N$, with normalization $\theta_1 = 1$, and where $s_{i'}$ and $s_{j'}$ are theory-consistent weights of output of country i' and expenditures of country j', respectively, on world output and expenditure.

The structural gravity equation (4) can be cast in a form suitable for estimation using Poisson Pseudo-Maximum Likelihood (PPML, Silva and Tenreyro (2006)) such as

$$E\left[X_{ij}\right] = \exp\left\{\ln Y_i + \ln Y_j - \ln Y^w - \gamma \ln \tilde{t}_{ij}\right\} \quad , \tag{9}$$

$$\ln \tilde{t}_{ij} = \ln t_{ij} - \left[\sum_{i'=1}^{N} \left(s_{i'} \ln t_{i'j}\right) + \sum_{j'=1}^{N} \left(s_{j'} \ln t_{ij'}\right) - \sum_{i'=1}^{N}\sum_{j'=1}^{N} \left(s_{i'} s_{j'} \ln t_{i'j'}\right)\right] \quad , \tag{10}$$

where $\tilde{t}_{ij}$ captures the modular effects of trade barriers, such that variable and fixed trade costs in t_{ij} enter both as bilateral trade costs affecting the observation ij, first term in equation 10), and as third-country trade effects associated with the approximated multilateral resistances (terms within square brackets).

The terms within the square brackets have a compelling mathematical form. The third term is the logarithm of the weighted geometric average of the trade costs across all pairs in the world, with weights equal to the product of the shares of the countries in the pair i, j with respect to world output and income, respectively. The first and second terms within the square brackets are the weighted geometric average of the trade costs of all potential partners of the importer j and of the exporter i, respectively, weighted by the partners' share of world output and income, respectively. These terms can also be expressed in terms of the weights associated with the pairs in the summations. The first (second) term is the weighted geometric average of the trade costs of all potential partners of the importer j (exporter i), with weights equal to the product of the output (income) shares of the countries in the pairs relative to world output (income), scaled by the ratio of world output (income) relative to the output of exporter i (income of importer j), a proxy for how large the potential market demanding (supplying) goods from exporter i (to importer j) is.[7] Therefore, the modular effect of trade barriers on trade between two partners depends on the bilateral trade barriers (the first term within brackets) relative to the average of trade barriers of the trade partners with their trading partners scaled by the size of the potential market faced by the importer and the exporter (the first and second terms within brackets, respectively), adjusted by a globalization trend including trade barriers between third countries and captured by the average trade barriers worldwide (the third term within brackets).

2.2 Empirical specification and estimation strategy

For the empirical specification it is convenient to substitute the variable t_{ij} capturing variable and fixed trade costs with a set of observables (see also BBC):

$$t_{ij} = \exp\left[\sum_{k=1}^{K} \beta_k z_{ij}^k EIA_{ij}\right] \tag{11}$$

EIA_{ij} is an indicator variable equal to one when there is an economic integration agreement in place between exporter i and importer j. z_{ij}^1 is vector of ones, such that the first term in the sum only depends on the EIA_{ij}. $z_{ij}^k\ \forall z > 1$ are related to observable variables, which represent geographical, cultural, institutional, historial and demographic factors determining variable and fixed trade costs. When such variable is an indicator variable, z_{ij}^k is equal to the variable, while when it is not an indicator variable, $z_{ij}^k = Z_{ij}^k - \mu^k$ refers to the variable demeaned by its corresponding

[7] The (approximated) multilateral resistance terms are related to trade diversion measures proposed by the literature. See Appendix E for comparisons.

cross-sectional mean. Equation (10) can be decomposed in a sum of analogous expressions for each of the components of t_{ij} in equation (11). Therefore, the empirical model is:

$$X_{ijt} = \exp\left[\sum_l \sum_k \delta_{kl} MTE_{ijl}^k\right] \exp\{\eta_{it} + \eta_{jt} + \eta_{ij}\} \exp\{u_{ijt}\} \quad , \tag{12}$$

where l is an index that allows to incorporate contemporaneous and lagged effects of EIAs $l = \{t-10, t-5, t\}$.

The modular trade effects (MTE_{ijl}^k) refer to the modular trade effect of the EIA and the interaction of EIA with the variable z_{ijl}^k and are captured in each period as

$$MTE_{ijl}^k = z_{ijl}^k EIA_{ijl} - \left[\sum_{i'=1}^N \left(s_{i't} z_{i'jl}^k EIA_{i'jl}\right) + \sum_{j'=1}^N \left(s_{j't} z_{ij'l}^k EIA_{ij'l}\right) - \sum_{i'=1}^N \sum_{j'=1}^N \left(s_{i't} s_{j't} z_{i'j'l}^k EIA_{i'j'l}\right)\right] \quad , \tag{13}$$

In equation (12), the parameters associated with the terms capturing modular trade effects, MTE_{ijl}^k, are $\delta_{kl} = \gamma\beta^{kl}$, where $\beta^{1t} = 1$, such that $\delta_{1t} = \gamma$. η_{it}, η_{jt} and η_{ij} are exporter-time-, importer-time- and pair-fixed effects, which capture unobserved heterogeneity, u_{ijt} is the perturbation. The inclusion of $it-$ and $jt-$FEs renders unbiased estimates robust to the selection of the country weights in the terms associated with third-country effects (see also Baier and Bergstrand, 2009, 2010, Egger and Pfaffermayr, 2023). Although the MTE variables defined in equation (13) include third-country effects which vary on dimensions it and jt and thus are collinear with and absorbed by the $it-$ and jt-fixed effects, the parameter restrictions from the theoretical model—i.e. that the coefficients associated with third-country effects are equal to the EIA coefficients—identify the third-country effects through the identified bilateral EIA effect even when directional-time fixed effects are included. The identification of the effects of EIAs is facilitated by measuring them relative to intra-national trade (Yotov, 2012, Borchert and Yotov, 2017), which is not subject to bilateral EIA effects.

Our model incorporates delayed effects of agreements associated with specific variable and fixed cost changes, which are captured by the lagged EIA interactions. There is much evidence that trade liberalizations have gradual effects on trade flows.[8] Lagged effects of agreements can be rationalized by phase-in, price pass-through, and spatial effects of EIAs (Baier and Bergstrand, 2007, Besedes et al., 2020). The phase-in hypothesis (Baier and Bergstrand, 2007) notes that EIAs typically remove a substantial parts of trade costs gradually. Tariff phase-outs are typically implemented following stages defined in a schedule, and although some non-tariff barriers may be removed immediately as the agreement enters into force, other non-tariff barriers such as technical measures and standards may stay for longer periods until harmonization is achieved. Additionally, the delayed effect of the gradual phase-out of trade costs may be amplified when firms anticipate trade cost changes and smooth their purchases until trade costs are effectively reduced (Khan and Khederlarian, 2021). The price pass-through hypothesis (Baier and Bergstrand, 2007) postulates that tariff changes pass through to prices gradually over time, delaying the effects of the agreement on trade flows. The third explanation hinges upon potential spatial effects of EIAs (Besedes et al., 2020). As the implementation of the agreement removes trade barriers, exporting firms increase their profits and can face new costs associated with geographic expansion within the same region and gradually increase trade flows.

Furthermore, lagged heterogeneous effects of EIAs are consistent with lagged third-country, trade diversion and reversed diversion, effects appearing in the approximated multilateral resistances. These lagged diversion effects can be triggered by gradual phase-in of agreements, delayed price pass-through, and gradual market expansion of firms as a consequence of decreasing trade costs from agreements potentially combined with sequential exporting and learning (Albornoz et al., 2012, 2021, Morales et al., 2019).

[8] See e.g. Baier and Bergstrand (2007), Olivero and Yotov (2012), Baier et al. (2019), Besedes et al. (2020), Khan and Khederlarian (2021).

2.3 Observable proxies for variable and fixed trade costs

The interactions of the observable variables with the EIA indicator introduce heterogeneity in the effects of EIAs at the pair level, such that the modular trade effects associated with bilateral and third-country trade barriers are heterogeneous pairwise depending on the proxies for variable and fixed trade costs (see also Baier et al., 2018). Following Baier et al. (2018), we include proxies for distance, adjacency, common language, religion similarity, common legal origin, and common colonial history, but we expand this set by also including urban population and urban population in major cities, and dummies for the EU and NAFTA. Distance (in logarithm) and adjacency are proxies for natural non-policy variable trade costs. Distance has an expected negative effect on both the extensive and intensive margins of trade and thus, an expected negative total effect. By contrast, adjacency has a positive effect on the intensive margin, as neighbor countries experience lower freight costs, but a negative effect on the extensive margin, when a negative relationship between border and the probability of trading is expected due to larger natural fixed costs (Helpman et al., 2008, HMR, and Egger et al., 2011). Therefore, the total effect of adjacency is a priori ambiguous.

Common legal origins and common colonial histories are proxies for institutional similarities. Institutional similarities are expected to have no impact on the intensive margin and an ambiguous effect on the extensive margin due to two forces. On the one hand, a lower level of policy costs raises the share of endogenous export fixed costs in total exports fixed costs, which increases the variable-trade-cost and fixed-export-cost elasticities. On the other hand, a lower level of institutional costs also lowers the relative importance of policy vs. non-policy fixed export costs, diminishing the policy fixed export costs EIA elasticity. That is, when two countries already have a common legal origin or a common colonial history, the potential of an EIA to reduce policy fixed export costs and thus the gains from liberalization are lower.

Religion and language capture bilateral cultural similarities, which are expected to decrease bilateral non-policy fixed trade costs and have a positive impact on the extensive margin and no impact on the intensive margin of trade (Baier et al., 2018). Accordingly, their total effects on bilateral trade are expected to be positive. However, the presence of a common language may relate to common legal and institutional origin. The introduction of a language in colonies is historically connected to the introduction of new values, rules and administration, and the new language serves as a way to establish the new rules and institutions and to facilitate their functioning. In this vein, Hall and Jones (1999) suggest that Western Europe helped establishing institutional and legal structures, like property rights, into their colonies through the expansion of their influence and language. If countries share a common tongue as a result of their past colonial ties, language could reflect these institutional similarities. When language is related to legal and institutional links, its effect can reflect the effect of common legal origin and be negative. Therefore, in contrast to Baier et al. (2018), we regard the effect of common language as a priori ambiguous.

We also extend the model to include distribution and network effects associated with urban density. Firms benefit from urban density through increasing economies of scale and decreasing transportation costs but there are also costs associated with urban agglomeration (see Duranton and Puga, 2020, for a review survey). Urban density provides firms with the potential to realize economies of scale and decreasing costs associated with a more dense production and distribution network. Urban areas can reduce exporting costs at the origin and offer better distribution networks at the destination. This can be particularly relevant for firms' production within global supply chains. However, urban agglomeration also brings costs associated with higher rents and wages, which induce firms locating outside urban areas, decrease their potential to realize economies of scale and increase costs associated with transport and distribution.

We expand the set of interactions and incorporate two demographic variables associated with urban density to capture distribution and network effects. Urban population share captures decreasing costs from increasing urban density in a territory, and the share of population in major cities is used as a proxy for agglomeration costs.[9] Exporting firms benefit from diminishing transport and distribution costs at both the origin and the destination and thus we define the proxies for urban

[9] The inclusion of pair fixed effects in our specifications brings the reading of our proxies closer to urban density, the theoretical counterpart.

density as the interaction between origin and the destination. These transport and distribution costs can be variable and fixed.[10]

Moreover, urban density can correlate with the distribution of firms' productivity. Firms in urban areas may show larger productivity for several reasons (Duranton and Puga, 2020). Increases in productivity translate in a larger mass of exporting firms, which expands the network effect emphasized in Krautheim (2012), in turn magnifying the effect of trade liberalizations.[11] However, excessive urban concentration has negative effects on productivity growth (Henderson, 2003), implying the opposite effect on the mass of exporting firms, reverting the network effect and lessening the effects of trade liberalizations. Because the relationship between firms' productivity and our proxies for urban density effects has the same sign as the relationship between trade costs associated with urban density, the theoretical effects of our proxies can be predicted unambiguously. Therefore, our proxies for urban density identify the trade effects of both distribution costs and productivity threshold changes associated with trade liberalizations. Urban population share and the agglomeration proxy are expected to increase and decrease, respectively, the effects associated with trade liberalizations.

Several mechanisms may channel endogeneity between trade and proxies related to urban concentration. Trade can affect the rate of growth of GDP, which in turn has effects on urban concentration (e.g. Williamson, 1965, Ades and Glaeser, 1995, Davis and Henderson, 2003). Additionally, several factors link trade liberalization to urban density (see e.g. Monfort and Nicolini, 2000, Bruelhart et al., 2004, Crozet and Koenig, 2004), but other forces can attenuate this channel (Krugman and Livas Elizondo, 1996, Behrens et al., 2007). The empirical literature reaches mixed conclusions concerning the relation between trade liberalization and urban concentration (see the survey by Bruelhart, 2011 and Karayalcin and Yilmazkuday, 2015). Yet, if trade levels can affect the process of trade liberalization, they can also affect urban concentration. The presence of directional-time

[10] In principle, local trade costs applying to both imported and domestic goods—i.e. entering prices as a markup at the destination dimension—do not change relative prices to buyers and trade patterns in the gravity context (Anderson and van Wincoop, 2004). Since the variables related to urban density are defined at the pair level, they are not subject to this issue. Additionally, the proxies for costs associated with urban density appear interacted with the EIA indicator, which is pair specific.

[11] Specifically, the increasing network effect resulting from the larger mass of exporting firms magnifies the ad valorem tariff-rate elasticity of the extensive margin. Such a network effect does not make the elasticity endogenous, however.

fixed effects controls for the effect of trade on urban concentration through growth of GDP, while the inclusion of pair fixed effects controls for the endogeneity working through trade liberalization by accounting for invariant pair-specific factors that are the source of the endogeneity between trade and EIAs (Baier and Bergstrand, 2007). The dynamics of these variables are mostly affected by history, long-term demographic patterns and urban policies and are exogenous to trade flows.

Finally, we include dummies for membership to the EU and the NAFTA. There are several reasons for it. Many country pairs belonging to these agreements are historically deeply integrated before the start of our sample or started integrating before the 1970s (e.g. early agreements between some EU core countries and sectoral agreements between US–Canada) or in the first years of our sample. Also, the scope of these two agreements is large when compared with other agreements. For more details please see Appendix A.

3 Regression results

We analyze the results from the estimation of the gravity model with heterogeneous effects of EIAs, quantify the relative size of third-country effects, and study the empirical relevance of third-country effects through two simulations. The regression analysis is based on several specifications run to achieve unbiased evidence and minimize efficiency issues from multicollinearity of the interaction terms. Table 1 provides results for the main specifications. In column 1 and 2, we compare specifications with approximated multilateral resistances with and without directional-time fixed effects, only including contemporaneous effects. Column 3 shows the benchmark specification, which adds lagged effects and directional-time fixed effects, and where insignificant variables are removed.

Several findings can be extracted. First, including directional-time fixed effects is required to control for unobserved heterogeneity at the country-time dimension despite the use of approximated multilateral resistances in the regression. While including directional-time fixed effects renders unbiased parameters' estimates in panels, previous research in the context of cross sections suggests that a specification including approximated multilateral resistances may not require the inclusion of country-time fixed effects. Baier and Bergstrand (2009) show supporting empirical evidence for this in a cross section, and Fally (2015) presents theoretical evidence suggesting that under PPML estimation the directional-time fixed effects map into output, expenditures and the multilateral resistances. The comparison of specifications including and excluding directional-time fixed effects (columns 1 and 2 in Table 1) reveals that the coefficients associated with EIAs are biased under exclusion of directional-time fixed effects. The bias is large for the baseline EIA effect, which is four times larger under exclusion of directional-time fixed effects, and the point estimates of the interaction of urban population share change sign, while other interactions change significance.

The explanation for the bias when excluding directional-time fixed effects relies on the fact that under misspecification of the structural model, directional-time fixed effects in PPML do not map perfectly into output, expenditures, and multilateral resistances. That is, when factors other than those in the theoretical framework drive international trade flows at the country-time dimension, the directional-time fixed effects account for their effects and are not fully explained by output, expenditures and the multilateral resistances. This is confirmed by the significant coefficients associated with other factors in a second-stage regression of the fixed effects on a set of variables, time and pair fixed effects (see Honoré and Kesina, 2017), where we offset the multilateral resistances by taking advantage that the estimate of the first stage identifies the parameters associated with both the direct and third-country effects under the theoretical structure (see Table 11 in Appendix C for results).[12]

Accordingly, the correct empirical strategy includes directional-time fixed effects and takes advantage of the identification of the parameters associated with both direct and third-country effects of EIAs. Under the structural restrictions to the parameters, the effects induced by multilateral resistances are fully identified and can be easily retrieved. Moreover, the inclusion of directional-time fixed effects

[12] In the first three columns, only the multilateral resistance terms are offset, while in columns 4 to 6 also the GDPs are offset. In the last 6 columns, the same offsets are implemented but output and expenditures are defined structurally as the sum of trade flows following Fally (2015) and imposing unit elasticity. In all these specifications, several variables are significant, confirming that the directional-time fixed effects are not fully explained by output, expenditures and multilateral resistances. Plenty of empirical evidence supports the inclusion of other determinants in ad-hoc gravity regressions. For example, Francois and Manchin (2013) include factors related to physical capital and infrastructure in an ad-hoc gravity regression. We restrict our estimations to a set of variables sufficiently large to avoid large misspecification issues while keeping broad country coverage, which is of relevance for our simulations in Section 4.

eliminates concerns about the endogeneity of GDP appearing in the weights of the multilateral resistance terms and makes the estimation robust to the definition of GDP.[13]

Second, the regression results show a baseline EIA effect that is positive but confirm the heterogeneity in EIA's partial effects. The baseline EIA effect, captured by the MTE coefficient, is positive and significant across specifications.[14] For the benchmark specification (column 3), the contemporaneous baseline effect of an EIA is 0.127 and significant, such that the baseline EIA partial effect increases trade flows contemporaneously about 13.5 percent. Although it is not directly comparable to average effects estimated in other research, it is slightly larger than the PPML estimates of the average EIA effect in Baier et al. (2018) and the contemporaneous coefficient of average FTAs estimated by Baier et al. (2019) in a model without pair-specific FTA effects. The lagged baseline EIA effect is 0.040 and increases considerably the point estimate of the average EIA.[15] The total baseline partial effect of an EIA becomes 18.2 percent. Our estimates appear to be smaller than Baier et al.'s (2019) average effect, but a comparison is not straightforward, because Baier et al. do not include pair-specific effects in this specification and add dummies for globalization. [16] Also, a key difference is that Baier et al. estimate larger lagged than contemporaneous effects, whereas our estimates point to a larger contemporaneous effect.[17] However, the EIA effects are to a large extent channeled through the pair-specific interactions.

[13] Baier and Bergstrand (2009, 2010) and Egger and Nelson (2011) propose using the inverse of the number of countries (1/N) to avoid endogeneity between GDP-based shares and trade flows. Anderson and Yotov (2010) and Fally (2015) favor using structural output and expenditures based on the sum of trade flows to keep consistency with the theoretical model. As the fixed effects absorb the multilateral resistances, the parameter estimates are robust to the definition of the weights; that is, they do not depend on whether weights are the inverse of the number of countries or based on structural output and expenditures. Thus, it is unnecessary to use ad-hoc uniform weights, and the elasticities associated with the multilateral resistances are fully identified by the direct effects of EIAs under theoretical restrictions.

[14] The baseline EIA effect corresponds to an EIA for which the interactions using indicator variables are evaluated at zero and the interactions for continuous variables are evaluated at the cross-sectional mean. Thus, it is not an average effect. See Table 8 for more details.

[15] Although the lagged baseline EIA effect is not significant, it is jointly significant with the contemporaneous effect and improves the model estimate. Removing it increases the contemporaneous parameter by a similar magnitude but decreases the model's likelihood.

[16] In spirit of Bergstrand et al. (2015a), we add international trade border dummies yearly to isolate whether there have been general technological developments that facilitate trade capturing globalization trends. These dummies tend to be insignificant and decrease over time showing that there has been a declining in border costs over the years (see Table 13 in Appendix C.

[17] In general, PPML panel estimates tend to be smaller than OLS panel estimates (see also Anderson and Yotov, 2010), and the baseline EIA effects found are smaller than OLS estimates found in panels (see Baier et al., 2018, Baier and Bergstrand, 2007, Bergstrand et al., 2015a) but close to Novy (2013).

The significant interactions support the existence of heterogeneous effects depending on trade cost levels and imply pair-specific channels that supplement the baseline EIA effect, increasing or decreasing the EIA effects at the pair level. Column 3 in Table 1 presents the interactions included in the benchmark specification. In general, the signs of the interaction effects match the theory discussed.[18] The two proxies for distribution costs, urban population share and agglomeration, reflect the expected effects. Urban population share increases EIA effects, showing that as population establish in urban areas, trade costs related to distribution decrease. Lower distribution costs imply larger gains from trade liberalizations. However, the proxy for urban agglomeration decreases the effects of EIAs. As population is agglomerated in cities, this reduction in distribution costs is surpassed by increasing costs from agglomeration, such as high rent and wage costs, causing firms to locate in the outskirts of the cities and increasing distribution costs. The larger distribution costs imply smaller gains from joining an EIA.

For the rest of interactions, already present in Baier et al. (2018), the results are mostly consistent with their findings. The effects of EIAs decrease with distance, adjacency and common language, and increase with common religion. By contrast, proxies for fixed trade costs related to common institutional frameworks, such as common legal origin and common colony, are not significant, and their inclusion in the model does not alter the other coefficients. Their effects seem to be captured by common language, which shows correlations of 0.5 with each of them, consistent with the idea that common language is associated with the existence of common legal and institutional origins, and a negative coefficient, suggesting that institutional similarities relate to lower policy fixed costs and tend to decrease the gains from trade liberalizations.

[18] Table 9 in Appendix C shows a full-set specification including all the interactions. The results from this equation are qualitatively similar to those from the benchmark specification. However, because of multicollinearity, some of the interactions are not significant.

	1stage FE	1st approx ij t FE	1stage lags
MTE_n_t	0.130**	0.473***	0.180***
	(0.054)	(0.048)	(0.047)
MTE_n_t * ln DIST	-0.085**	-0.057**	-0.036
	(0.041)	(0.025)	(0.038)
MTE_n_t * ADJ	-0.219*	-0.060	-0.294**
	(0.126)	(0.080)	(0.123)
MTE_n_t * LANG	-0.254***	-0.431***	-0.131*
	(0.080)	(0.069)	(0.069)
MTE_n_t * RELIG	0.375***	0.602***	0.233**
	(0.101)	(0.079)	(0.099)
MTE_n_t * LEGAL	0.030	-0.009	
	(0.064)	(0.055)	
MTE_n_t * COLONY	-0.027	-0.144*	
	(0.100)	(0.085)	
MTE_n_t * URBAN	0.303*	-0.581***	
	(0.182)	(0.166)	
MTE_n_t * AGGLOMERATION	-0.401**	-0.367**	-0.413***
	(0.159)	(0.144)	(0.159)
urban share	-11.395***	5.254***	-10.522***
	(1.952)	(0.215)	(1.799)
agglomeration	-1.304***	2.094***	-1.497***
	(0.452)	(0.195)	(0.439)
MTE_EU_n_t			0.195***
			(0.033)
MTE_NAFTA_n_t			0.334*
			(0.176)
MTE_lag5_n_t			0.028
			(0.027)
MTE_lag5_n_t * ln DIST			-0.048**
			(0.024)
MTE_lag5_n_t * LANG			-0.159***
			(0.046)
MTE_lag5_n_t * RELIG			0.183**
			(0.079)
MTE_EU_lag5_n_t			0.082***
			(0.025)
Exporter-Year	Yes		Yes
Importer-Year	Yes		Yes
Country-Pair	Yes	Yes	Yes
Year		Yes	
N	265181.000	265181.000	265181.000

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 1: Trade gravity model: PPML main specifications

Note: Standard errors in parentheses: * $p < .10$, ** $p < .05$, *** $p < .01$. The specifications with three-way fixed effects use the bias correction proposed by Weidner and Zylkin (2021). In the selected benchmark specification in column 3, distance and lagged baseline EIA are not significant. Tests for joint significance of the contemporaneous and lagged effects do not reject jointly significant effects with p-values 0.0027 and 0.0091 for distance and baseline EIA, respectively, and we included them both contemporaneously and lagged. See Table 9 in Appendix C for the results of alternative specifications.

Moreover, there are significant pair-specific lagged effects of EIAs.[19] In the benchmark specification, urban population share, urban agglomeration and adjacency enter only contemporaneously. The absence of lagged effects from urban population share and agglomeration suggests that they identify fixed and variable costs related to distribution and transport costs but do not capture network effects associated with learning. By contrast, distance, common language and religion enter both contemporaneously and lagged. Overall, the size of the interaction effects in Baier et al. (2018) using PPML is relatively close to our estimates. However, our estimates point to an additional channel related to distribution costs captured by proxies for urban density and to a different timing of the interaction effects reflecting the gradual implementation or lagged effects of EIAs.

To better illustrate the resulting heterogeneity in EIA effects, it is convenient to analyze the bilateral partial effects of EIAs, which are defined as:

$$\frac{dX_{ijt}}{dEIA_{ijt}} = \left(\gamma + \sum_k \delta_k z_{ijt}^k\right)[1 - s_i - s_j + s_i s_j] \tag{14}$$

In equation (14), the direct partial effects are $\left(\gamma + \sum_k \delta_k z_{ijt}^k\right)$, while the term $\left(\gamma + \sum_k \delta_k z_{ijt}^k\right)[-s_i - s_j + s_i s_j]$ captures the indirect effects on the observed pair implementing of an EIA channeled through the multilateral resistances. Trivially, the direct effects are larger than the indirect effects as long as $|-s_i - s_j + s_i s_j| < 1$.[20] Figure 1 displays the distributions of the direct, indirect, and total partial effects associated with EIAs at the pair level. The sample includes many zero trade flows and pairs without an EIA and thus, each plot contains three distributions, namely for all pairs (red), pairs with positive trade flows (green), and for pairs with positive flows and EIA (blue). The plots highlight the following findings.

Conventional wisdom attributes to EIAs a positive bilateral partial effect and a negative, small indirect effect through multilateral resistances. The densities of estimated pair-specific partial

[19] Lagged effects of trade agreements are included in prior research. See, e.g. Baier and Bergstrand (2007), Bergstrand et al. (2015b), and for pair-varying effects, see Baier et al. (2019).

[20] Equation (14) resembles the expressions for comparative statics in Behar and Nelson (2014). Two key differences exist, however. Our expressions do not distinguish extensive and intensive margins, but imply pair-specific comparative statics depending on the partners weights s_i and s_j, and on the interaction terms z_{ijt}^k. Although we show them aggregated across all interactions, disaggregated measures can be calculated.

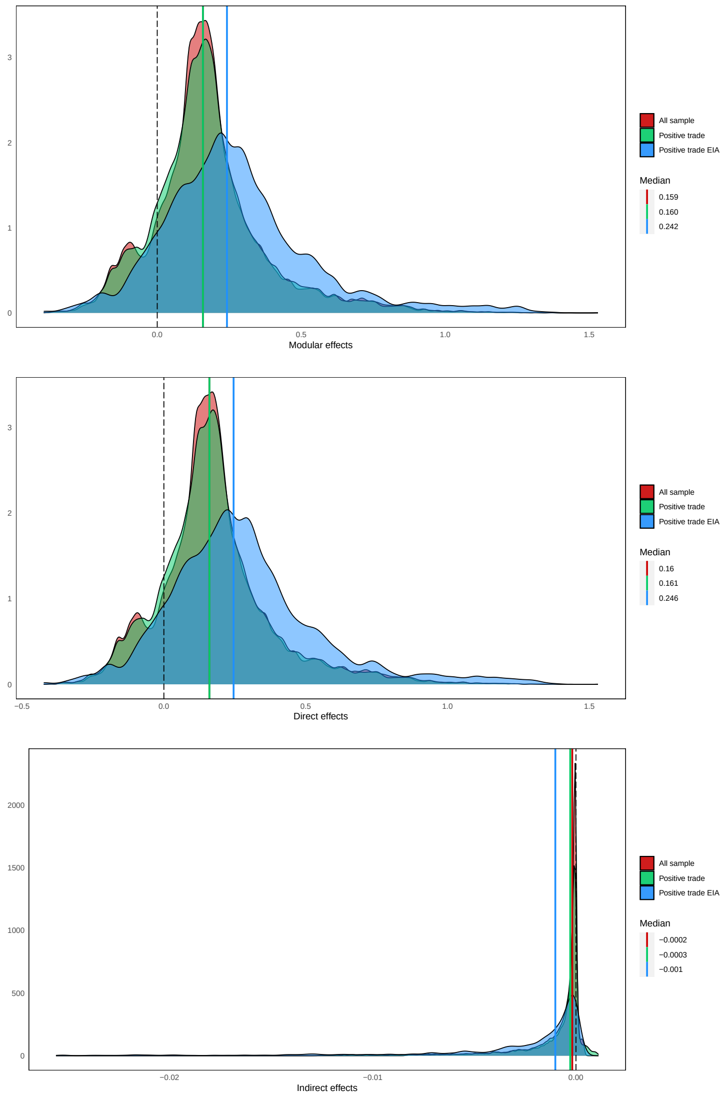

Figure 1: Total, Direct and Indirect partial effects
Note: The figure on top collects the total effects, the middles one the direct and the one at the bottom the indirect. The three densities in each plot reflect three distributions including more or less observations. First, All sample represents all the effects retrieved for all country pairs. Positive trade collects the effects only for those countries with positive trade while Positive trade EIA shows the effects for those countries with positive trade flows and an economic integration agreement.

effects show that the share of observations conflicting with conventional wisdom is reduced as we change our focus from all observations, including those with zero trade flows and no EIA, to only considering observations with positive trade and an EIA in place, which identify the EIA effects in the sample. The direct partial effects are rather heterogeneous and, although they are in general positive, 27 percent of the partial effects are negative when considering the whole set of observations. This percentage decreases to just 10 percent when only observations with positive trade flows and an EIA in place are considered. The indirect partial effects are mostly negative—71 percent for the whole sample and 91 percent when only considering observations with positive trade flows and an EIA in place. Indirect partial effects are small relative to direct partial effects. Consequently, the shape of the distributions of total partial effects are similar to those of direct effects, and the shares of observations with negative total partial effects is also 27 percent when considering the whole set of observations and 10 percent when considering only those observations with positive trade flows and an EIA in place. The size of the conflicting observations (negative direct effects and positive indirect effects) is relatively small when considering the support of the distributions. This highlights the importance of sample splitting to differentiate the relevant pair groups and to isolate impacts when studying heterogeneous EIA effects.

Finally, our estimates emphasize the importance of lagged effects of EIAs. Figure 2 shows the distribution of total, contemporaneous and lagged partial effects of EIAs. The distribution of 5-year lagged effects is more concentrated than that of contemporaneous effects, and although they are smaller, they explain a large share of the modular effects. Because of the positive correlation between contemporaneous and lagged effects, the distribution of total partial effects is more dispersed and presents a longer upper tail.

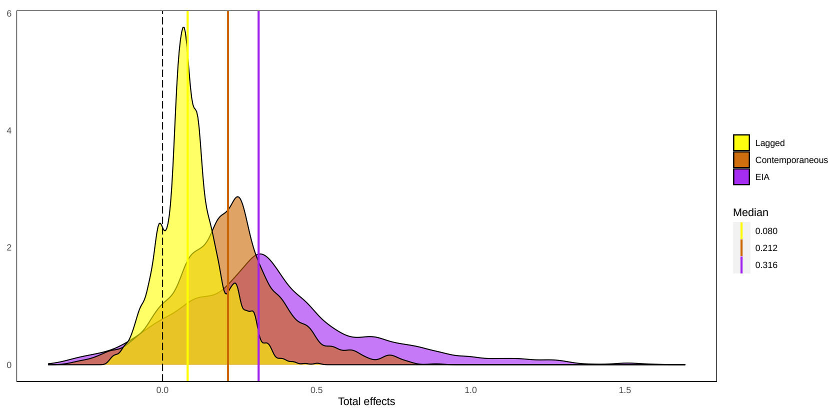

Figure 2: Total, contemporaneous and lagged partial effects
Lagged effects are more concentrated but represent a considerable part of the variation.

Notwithstanding the above, bilateral partial effects in equation (14) do not exhaust all the indirect effects of a pair's EIA membership. As long as any of the partners of an EIA shares EIA partnerships with third countries, there emerge indirect effects to those EIA partnerships with third countries, as shown by the first and second terms in brackets in equation (10). Furthermore, indirect effects emerge to all trade partnerships worldwide, as the third term in brackets in equation (10) suggests. This complex network of effects can be better represented through a set of simulations.

4 Ex-post estimation of the gains from globalization

The recent decades have witnessed an intense process of international trade liberalization characterized by two features: the proliferation of trade agreements and the multilateral character of these agreements. Our model emphasizes the heterogeneous multilateral effects of trade agreements and can be used for the analysis of their direct effects and of the indirect effects generated within and outside trade agreements. We evaluate the direct, indirect, and modular trade effects of this process of trade liberalization from 1970 to 2017.

Prior research analyzes the general-equilibrium effects of globalization. Costinot and Rodríguez-Clare (2014) simulate the costs from autarky across countries and predict real income increases between 1.5 and 8.1 percent, with an average of 4.4 percent. Anderson et al. (2018) simulate a border removal for all countries, obtaining exports increases ranging from 6.67 to 230 percent, with an average effect of 63 percent, and changes in real gross domestic product ranging from 0 to 10.31 percent with a moderate average effect of 2.63 percent. These experiments are defined in cross-sectional settings with samples of about 40 countries and a rest of the world aggregate. Our experiment extends previous analysis with respect to the number of countries (190 countries) and the period covered. It also expands previous settings by adding heterogeneous EIA effects conditioned on the regression estimates from Section 3, which include interactions capturing the dependence of EIA effects on pair-specific trade costs levels and lagged effects.

We estimate the long-term trade changes of joint membership to an EIA in each period in the sample conditioned on the model parameters estimated and accumulating contemporaneous and 5-year lagged heterogeneous EIA effects.[21] Table 2 displays the average trade effects for those country pairs with a trade agreement across years and pairs, differentiating between direct, indirect, and modular effects. On average, EIAs signed from 1970 to 2017 have a direct effect of increasing trade by 37 percent while they divert it by 11 percent, leading to a modular effect of about 18 percent. These estimates are larger than the 21 percent obtained by performing the same simulation using our sample but conditioning on the coefficients estimated by Baier et al. (2018), and of the same magnitude as the average partial effect of 34 percent reported by Baier et al. (2019). Accordingly, assuming a tariff elasticity of 4, our model estimates an average 9.7 percent decline in trade barriers, which is very close to the 7 percent estimated by Baier et al. (2019).

Average effects accross years	mean	percentile	AVE tariff decrease
Direct	37.04	90	9.70
Indirect	-11.36	41	-2.80
Modular	18.04	77	4.61
BBC direct	20.68	81	5.31

Table 2: Summary Statistics of EIA effects for pairs with EIA
The number of pairs with EIA is 14,124 out of a total sample of 326,567 observations. Direct stands for the direct effect, TCEs stands for the third-country effects, Modular stands for modular effects. The column percentile presents the percentile at which we find the first positive effect. BBC stands for results from the simulation conditioned on the coefficient estimates of Baier et al. (2018).

The model predicts positive direct bilateral effects of EIAs for 90 percent of the pairs and positive modular trade effects for 77 percent of the pairs. These estimates are larger than the 80 percent of positive direct trade effects calculated using our sample and the parameter estimates of Baier et al. (2018). These figures are also much larger than that reported by other research using heterogeneous effects models such as Baier et al. (2019), report positive general-equilibrium effects for 57 percent of the sample, and Kohl (2014), who only find positive effects for 27 percent of pairs.[22]

[21] Because we do not model the probability of going from zero to positive trade, this particular aspect of the extensive margin of trade is not accounted for. In this sense, the estimates shown are conservative.

[22] It should be noted that the measurement definitions do not match directly, as we report modular effects, while Baier et al. (2019) and Kohl (2014) report general-equilibrium effects, the difference being the income effects. Although these income effects may be large when they accumulate across pairs (see also Anderson et al., 2018). Baier et al. (2019) and Kohl (2014) uses a relatively small sample of countries, such that the accumulation of income effects may not affect these shares dramatically.

Standard trade models with firm heterogeneity predict a positive trade effect of trade liberalization through two channels. The first one operates through a market expansion and has a positive effect on trade. The second one operates through increased competition inducing inter-firm reallocation of production and has a positive effect on exports carried out by the more competitive firms but a negative effect on exports of those firms that are less competitive. However, the econometric model incorporating pair-specific effects allows for positive and negative direct bilateral effects of trade liberalizations. Negative direct effects of EIAs may be related to sectoral re-allocations and are consistent with multilateral gains from joining a multilateral agreement that compensates for the negative effects of trade with a specific partner. These factors may explain the small share of negative trade direct effects (11 percent) found at the pair level.

Indirect effects are on average about -11 percent, implying average trade diversion. Yet, there are positive, generally small, indirect effects for 41 percent of the pairs, highlighting that trade agreements can generate third-country trade creation. In the standard model with firm heterogeneity, the interplay of market expansion and increased competition related to decreased trade costs associated with third countries provides an explanation for trade diversion. By contrast, the pair-specific heterogeneity resulting from the interaction terms of our model allows for negative and positive third-country effects and provides a structural underpinning to the third-country trade diversion and creation effects noted by Magee (2008) and Baldwin (2011). Again, sectoral re-allocations may underlie reversed trade diversion (third-country trade creation), but at least three other mechanisms can explain third-country trade creation effects, especially in the context of multilateral trade agreements, where multilateral (third-country) considerations can be of particular interest when negotiating the agreement.

The first mechanism relates to the presence of vertical specialization and global value chains (GVCs). The reduction of trade costs between two members of a GVC can have spillover effects throughout the whole GVC. The second mechanism refers to the reduction of non-discriminatory measures (see Baldwin, 2011, Matoo et al., 2022). If the trade cost reduction is associated with a non-discriminatory measure (e.g. non-tariff barriers like standards), third countries may benefit from these trade cost reductions, resulting in third-country trade creation. The third mechanism relates to gains from the multi-destination character of exporting firms. Exporting firms tend to enter foreign markets that share similarities with their previous export destinations because entry costs in new markets are smaller for firms that previously exported to similar countries Morales et al. (2019).

A clear picture of the relevance of indirect effects over 1997–2017 is provided by the ratio of indirect to direct effects for country pairs with an agreement. This ratio shows the size of third-country effects that a country pair faces relative to the direct effects of their EIA partnership. Figure 3 presents the evolution of the distribution of the ratio of indirect to direct effects for country pairs with an agreement for 1972, 1997, and 2017.[23] Two main findings emerge. First, the ratio is negative when indirect and direct effects have different signs, being positive otherwise. In 2017, 54 percent of the observations shows positive direct and negative indirect effects (trade diversion), as predicted by standard theory; 36 percent has a positive direct effect and positive indirect effects (third-country trade creation); 6 percent of the observations shows negative direct and positive indirect effects; and 2 percent exhibits both direct and indirect effects negative.

Second, the distribution tends to move to the right for more recent periods, reflecting the increasing third-country effects as a result of the proliferation of multilateral EIAs in the last two decades. For a given country pair, the ratio increases as more EIAs become active and their third-country effects on the pair accumulate. The median of the distribution of the ratio increases from -5 percent in 1972 to -20 percent in 1992, minimum of the sample, and to 18 percent in 2017, showing that indirect effects increase as more EIAs enter into force. This shows that on average the ratio has started to decrease with the last round of liberalizations since the 1992 that contain deeper trade agreements. Global value chains and vertical specialization might also explain the decreases in negative effects for third countries and that some agreements do create reverse trade diversion as proposed by Mattoo et al. (2022). Additionally, as more EIAs are active, the dispersion of the distribution of the ratio increases, because of the heterogeneity of the EIA effects resulting from the pair-specific interaction terms in the empirical model, and the distribution shows a larger lower tail.

[23] For a detailed picture of the evolution across all years in the sample, see the boxplots in Figure 4 in Appendix D.1.

Overall, the proliferation of EIAs strengthens the relevance of third-country effects relative to the direct effects of EIAs.

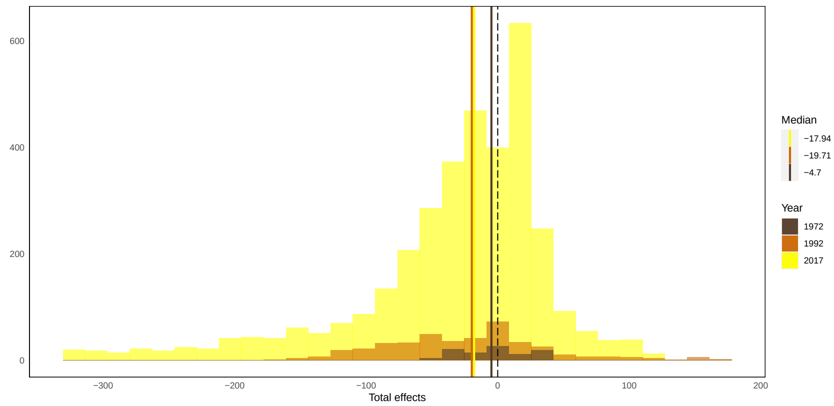

Figure 3: Ratio of indirect to direct effects for 1972, 1997 and 2017
Note: The histograms cover the central 94 percent of the distribution in each year to avoid outliers.
The importance of indirect effects has grown over the years. Strategic cooperation is key for countries' trade development.

Trade effects are conditional on pairs' level of economic development (see Table 3). On average, high-income country pairs benefit more through the direct effects of trade agreements and recieve negative third-country effects (trade diversion). Whereas low-income country pairs, on the contrary, benefit less from direct economic gains but receive positive effects from third countries (reverse trade diversion or external trade creation). This is in contrast to Anderson et al. (2018)'s findings where a complete removal of international borders would benefit more large developed countries.

To investigate this further, we perform a simple regression where the (logged) pairwise predicted direct effects on GDP, and on GDP per capita (GDPpc) and population. We obtain positive correlations for GDP and GDPpc and negative effects for population (see Table 15 in Appendix D). Anderson et al. (2018)'s negative correlation which is identified via a cross-sectional forty country sample might be capturing two different effects. The first one is a size effect, such that larger countries in terms of population experience lower increases in trade after a reduction of trade barriers. The second one refers to the level of development, such that the more developed countries, being more competitive and showing larger consumption per capita potential, experience larger benefits after a reduction of trade barriers. GDP per capita collects the level of development while population collects the size or scale of a country.[24] We find support for these hypothesis in Francois and Manchin (2013) point out that higher infrastructure and institutional quality is correlated with development levels and trade flows. This is also consistent with our theoretical model, where the lower the fixed and variable costs, the higher trade costs reductions. Although BBC argue in these terms based on their model, they find negative correlation between predicted trade flows and GDP per capita significant at the 10% level. The difference with our results can come from our extended panel until 2017, the use of PPML, the inclusion of internal trade, the additional variables reflecting distribution costs, the phase-in effects and especially the treatment for EU and NAFTA agreements that is not performed in previous analysis.

	Globalization		High-High pairs		Low-Low pairs	
Average effects across years	mean	percentile	mean	percentile	mean	percentile
Direct	37.04	91	44.05	93	10.17	69
TCE	-11.36	45	-15.47	33	7.17	99
Modular	18.04	74	18.41	72	18.02	79

Table 3: Summary Statistics of agreement effects over 1970-2017 for pairs with an agreement
Direct stands for the direct effect, TCEs stands for the third-country effects, Modular stands for modular effects. The column percentile presents the percentile at which we find the first positive effect. The classification in high and low income country pairs is from the World Bank based on GDP per capital. High-High stands for country pairs which both belong to high or upper middle income. Low-Low both belong to low or lower middle income countries. To see the effects from high-low and low-high are around 19% for the direct effects, -2% for TCE, and the Modular is around 17% see Table 14 in Appendix C.

EU and NAFTA agreements have been extensively studied (Frankel et al., 1997, Caliendo and Parro, 2015, Caliendo et al., 2021, Head and Mayer, 2021, Baldwin and Wyplosz, 2022, Santamaría et al., 2023) and due to their historically deeper integration even before our sample starts we also treat them specifically. They represent an interesting case study to see the effects of particular agreements. Therefore, we restrict the simulation to the effects generated by those agreements only. EU generates larger effects (82 percent) than the average effects for trade agreements and 99% of country pairs

[24] The negative relationship between GDP per capita and population is supported by the Solow growth model. Savings and population drive economic growth, and rapid population growth leads to a smaller amount of capital per worker. Additionally, increases in population with relatively low growth of capital stock, as it tends to happen in low-development economies, gives rise to diminishing returns.

receive a positive direct effect (see Table 4) . Similarly, the higher integration among country pairs come at a cost for third-countries which receive large negative third-country effects.

EU trade effects until the single market range from 16% to 60% depending on sample and year in the previously mentioned papers. While in one of the most recent studies on the EU single market from 1995 to 2015, Wolfmayr et al. (2019), finds additional trade-weighted average effects of this agreement of 9% but highly skewed towards accession countries after 2004 which receive 48% of the increase while EU15 experience 6.6%. Therefore our direct effects are larger but once we account for TCE's, effects are in line with the literature.

	EU		EU acc EU-acc		EU-acc-EU 15		NAFTA	
Average effects across years	mean	percentile	mean	percentile	mean	percentile	mean	percentile
Direct	89.85	99	94.19	99	67.08	99	30.89	99
TCE	-34.06	7	-21.18	0	-33.11	6	-9.32	31
Modular	25.20	70	52.54	93	7.69	55	19.36	68

Table 4: Summary Statistics of all EU agreements, EU enlargement and its effects on EU15 and NAFTA
Note: Direct stands for the direct effect, Indirect stands for the TCEs, Modular stands for modular effects. The column percentile presents the percentile at which we find the first positive effect. EU reflects the effects generated and received by all EU countries, while EU-acc EU-acc which stands for EU accession represents the effects generated and received by the EU enlargement after 2004 by those pairs while EU-acc EU 15 represents the effects received by the EU15 countries as result of the enlargement. NAFTA reflects the effects received and generated by the USA, Mexico, and Canada agreement.

Analyzing the effects of the European enlargement after 2004[25], we observe that accession countries experience higher increases than the average of the EU while there are no positive TCEs on other members. Looking at the fifth and sixth columns we see that positive direct effects of the enlargement on EU15 are found for around 67% and negative redirection of trade between EU15 countries towards accession countries. In line with previous analysis Baldwin et al. (1997), Egger and Larch (2011).

Additionally, the effects of the US, Canada, and Mexico agreement (NAFTA) are positive for all the countries every year but the size is slightly smaller of that of high income countries but in line to the estimates of Caliendo and Parro (2015). Although these countries were highly integrated

[25] Up to 2004, the EU consisted of 15 countries (Germany, France, Italy, The Netherlands, Belgium, Luxembourg, Denmark, Ireland, United Kingdom, Greece, Spain, Portugal, Austria, Finland, and Sweden) and in that year 10 countries join the common market: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia, and Slovenia, Bulgaria, Romania and Croatia.

before, this free trade agreement is shallower regarding the number of provisions and coverage of the agreement than the EU single market.

Overall, on average, the trade policy implication is that as high income countries benefit more through the direct effects of trade agreements and experience higher TCEs which result in larger incentives to join trade agreements than low-income countries which benefit more via the third country effects than via direct effects.

5 Conclusions

This paper estimates heterogeneous modular effects from EIAs for a large cross-country panel over 1972–2017. We derive structural expressions for heterogeneous modular effects from EIAs within the Baier et al.'s (2018) gravity model with Melitz firm heterogeneity. We augment the empirical model to include interactions of the EIA indicator and demographic variables related to urban density, which are proxies for distribution and transport costs, effects of trade liberalizations through productivity, and lagged effects from EIAs. The approximated multilateral resistances derived provide a structural underpinning for third-country trade diversion and reverse diversion or creation effects, as well as lagged third-country effects.

The regression results confirm the existing heterogeneity of third-country effects of EIAs. Three simulated experiments, on the gains of trade liberalizations and on the effects of the EU and its enlargements after 2004 and on the effects of NAFTA, show the increasing importance of third-country effects in the recent decades, in a context of growing number multilateral trade agreements.

The trade effects of EIAs depend on the level of variable and fixed trade costs. These costs are captured by several proxies. In particular, EIA effects increase with religion commonality and urban population share, whereas they decrease with distance, natural borders captured by adjacency, legal and institutional commonalities captured by common language, and urban agglomeration. Moreover, there are economically significant lagged heterogeneous EIA effects.

The process of international trade liberalization carried out from 1972–2017 has economically significant trade effects. On average, the direct effects of trade liberalizations imply a trade increase of 37 percent, but modular trade effects are smaller (18 percent) as a result of trade diversion. Although the indirect partial effects of EIAs are small relative to direct partial effects, as more EIAs enter into force and the number of members to EIAs increases, third-country effects of EIAs accumulate and become more heterogeneous. From the end of the 1990s, the median size of third-country relative to direct effects of EIAs is about 15 percent.

On average, high-income countries benefit more through the direct effects of trade agreements and are subject to trade diversion, this is particularly the case for EU members. By contrast, low-income countries benefit less from direct effects of EIAs and experience reverse trade diversion or external trade creation. Because of its depth, the EU and its recent enlargements induce higher trade gains for its members than the average of EIAs, while its geographical scope also implies larger trade diversion towards EU members.

All in all, the effects of trade agreements are rather heterogeneous across country pairs and conditioned on trade cost levels. Furthermore, the large number of existing multilateral trade agreements and the members involved lead to heterogeneous, often substantial, third-country effects. This increases the strategic role of third-country effects from trade agreements. Therefore, countries should assess the potential indirect effects they may face from current integration processes, especially when they involve main trading partners and neighbors and when they imply deep integration, and define their trade policy strategies taking such information into account.

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A Data sources

A.1 Variables' description

Our data comprises information for 192 countries over the period 1970–2017.[26] For estimation, we take 5-year intervals starting from the most recent year, although the results are robust to 3- and 4-year interval, all years as recommended by Egger et al. (2022) and if we cut the sample until 2010 to compare to BBC (see Appendix C, Table 12).

The data required for the analysis comes from several sources. International trade flows is sourced from the gravity database from CEPII's database (Conte et al., 2021). We add internal trade observations to ensure consistency with gravity theory (Yotov, 2012, Yotov et al., 2016), to better identify third-country effects as EIAs may be diverting trade from domestic to international sales biasing downward our estimates (Dai et al., 2014) and to improve the identification of trade costs related to distance, adjacency and EIA (Yotov, 2012, Borchert and Yotov, 2017). We extend Yotov et al. (2016) approach who calculate internal trade as apparent consumption subtracting from gross domestic product (GDP) exports of goods to additionally substract exports of services also.[27] GDP and exports of good and services data come from UNCTAD which provides the widest possible country and time coverage for 221 countries.[28]

EIA data is sourced from Bergstrand database in order to keep consistency with BBC. In this database, the are six types of economic relations: One-way Preferential Trade Agreement ("OWPTA")- concessions given by developed nations to developing countries; Two-way preferential trade agreement

[26] See at the end of this Appendix in subsection A.2 for the full country list.

[27] In Table 10 in Appendix C, it can be seen that there is virtually no difference between these two approaches. When we subtract exports of goods and services there are 56 observations for which the exports of goods and services are bigger than the GDP. This occurs for particular years of the following countries: United Arab Emirates, Bahrain, Djibouti, China-Hong Kong SAR, Ireland, Iraq, Luxembourg, China-Macao SAR, Maldives, Malta, Malaysia, Singapore, San Marino, Turkmenistan, Vietnam. This is because of the dependence of these economies on exports which are calculated as gross exports while the intermediates are calculated as value added. These observations are set to missing.

[28] For particular countries data transformations are needed previously to merge them with EIA data from Bergstrand which have only one series for certain countries whereas in UNCTAD these countries are splitted into different series up to a certain year. This occurs for Germany up to 1989; For Yemen until 1989 is divided between Yemen Arab Republic and Yemen Democratic republic that we sum; For Ethiopia up to 1991; For Indonesia until the civil unrest in 2002 that led to the resignation of the president. In the opposite case, for Sudan and South Sudan even though they are two independent countries after 2011 we unify them into the same series and we drop South Sudan from the series.

(“TWPTA”)- Preferential terms to members vs. non-members; Customs union (“CU”) when trade barriers are eliminated (or substantially so) among members and treat non-members similarly; Common market when additionally to CU there is also free movement of labor/capital; Economic union (“EC”) when additionally to EC there is also monetary, fiscal policy coordination and further harmonization of taxes/regulation/monetary system. In the analysis, it is further simplified in a binary variable that includes as an EIA all Free Trade Agreements, Customs Unions, Common market and Economic union.[29]

A number of variables are interacted with the EIA indicator to proxy for specific fixed and variable costs related to EIAs. First, a set of gravity variables—the log of distance, an indicator for adjacency, common language, common legal origin, common colonial history, and an index for common religion. All these variables come from the gravity database from CEPII’s database (Conte et al., 2021). However, the original data for these variables comes from their previous GeoDist dataset which collected information from several sources (see Mayer and Zignago (2011) for more details). Distance is calculated as the simplest measure of geodesic distance which uses latitudes and longitudes of the most important cities/agglomerations (in terms of population). In most cases, the main city is the capital of the country. This variable also incorporates internal distances based on areas.[30] Data on the historical origin of a country’s legal system (comleg pretrans) and the share of religion by country (catholics, muslims, protestants, orthodox) are taken from La Porta et al. (1999) and Porta et al. (2008). Afterwards, these continuous variables are demeaned by subtracting the cross-sectional mean while the dummies are just multiplied by themselves in order to leave always a group in the intercept that can be directly identified (see Table 5).

Second, two demographic variables are used to capture the effects of urban density associated with trade costs and the firm productivity distribution. The first variable, urban share, is the geometric mean of the urban population shares corresponding to the origin and the destination in period t. The use of the geometric mean instead of the mere interaction between shares is justified because the transformation renders the distribution of the variable symmetric and less prone to overrepresent

[29] Check for further details at: https://sites.nd.edu/jeffrey-bergstrand/database-on-economic-integration-agreements/

[30] Internal distance for country i, $d_{ii} = .67\sqrt{\frac{area}{\pi}}$ is often used as a measure of average distance between producers and consumers in a country, see Head and Mayer (2002) for more details.

pairs with larger values. The second variable, the agglomeration proxy, is the interaction of the shares of population living in cities with more than 300.000 inhabitants. In this case, we do not transform it by using the geometric mean, because the transformation induces more dispersion between values at the mode of zero and the otherwise bell-shaped symmetric distribution over positive values. Since both urban share and agglomeration vary at the dimension ijt they not only enter the specification through the interaction with the EIA indicator, in which case they are demeaned, but also in levels.

Third, we include two additional dummies to collect the effects that two particular agreements have induced, particularly the European Union (EU) and North American free trade agreements (NAFTA). These dummies are included to capture the fact that these countries were already integrated before joining the agreement and share previous sectoral agreements which would lead to higher effects of these agreements.

Fourth, we include as robustness, another variable that collects if a country pair belonged to the general agreement on tariffs and trade (GATT) and belongs nowadays to the world trade organization (WTO). This variable controls for globalization effects that come via the creation of these agreements to isolate all these effects and capture via the trade agreement only the differential effects of bilateral or multilateral trade agreements after controlling for these agreements.

For robustness, several variables are used in the second stage regression. From the Penn World Tables (PWT), three variables are retrieved: Human capital indexes to account for differences in human capital based on the number of year; Capital stock and total factor productivity (TFP) which is defined as the relative level of output divided by the relative level of inputs. This TFP has no unit and to make it comparable we multiplied it by TFP at Constant National Prices for United States which is retrieved from Federal reserve economic data (FRED) to account for the relative distribution with respect to USA; Level of democracy is retrieved from the quality of governance database; Population from CEPII; Gross domestic product in levels from UNCTAD to keep consistency with the exports of goods and services substracted from GDP from UNCTAD; Gross domestic product per capita obtained dividing gdp from UNCTAD between population from CEPII; Belonging to the WTO equals 1 if the country belong to the WTO from CEPII.

Finally, we compare our results with those from Baier et al. (2018) (thereafter BBC data) using their publicly available data which contains information from 1965 to 2010 for 183 countries including trade flows, control variables and the economic integration agreement information. BBC follow Hummels and Klenow (2005) to decompose trade flows between the extensive and intensive margins forcing all internal trade variables to become missing.

Variables in the model				
EIA	Dummy	Equal one if countries have an FTA, CU, CM, ECU	Bergstrand*	Not demeaned
Distance	Continuous, log	Distance between most populated city of each country (km)	CEPII	Demeaned
Adjacency	Dummy	Equal to 1 if countries are adjacent	CEPII	Not demeaned
Common language	Dummy	Equal 1 if countries share common official or primary language	CEPII	Not demeaned
Common religion	Index religions groups	Religious proximity index	CEPII	Demeaned
Common legal origins	Dummy	Equal 1 if countries share common legal origins before 1991	CEPII	Not demeaned
Common colony	Dummy	Dummy equal 1 if countries share a common colonizer post 1945 bilateral	CEPII	Not demeaned
Urban share	Percentage	$(\sqrt{(Urban\ share\ importer\ * urban\ share\ exporter)})/100$	United nations. Population division	Demeaned
Agglomeration	Percentage	$(majcitdens\_isoex * majcitdens\_isoim)/10000$	United nations. Population division	Demeaned
EU (European Union)	Dummy	Equal one if countries belong to the EU in that particular year	Bergstrand	Not demeaned
NAFTA (US-Canada-Mexico)	Dummy	Equal one if countries belong to the NAFTA agreement	Own calculation	Not demeaned
Trade flows				
International trade	Thousands		CEPII	
Internal trade	Millions	GDP- exports of goods and services	UNCTAD	
Variables second stage				
Human capital	Logarithm		PWT	
Capital Stock	Logarithm	Capital stock at current	PWT	
Total factors productivity	Logarithm	We multiply PWT productivity in levels times the TFP from the STATES	PWT/ FRED	
Level of democracy	Levels, values from 0 to 10	Freedom House/ Imputed polity		
Population	Thousands		CEPII	
Belonging to the WTO	Dummy equal 1 if the country belongs to the WTO		CEPII	
GDP	Thousands		UNCTAD	
GDP per capita	Thousands		UNCTAD	

Table 5: Variables definition

Note: *Bergstrand database: https://sites.nd.edu/jeffrey-bergstrand/database-on-economic-integration-agreements/

A.2 List of Countries:

Afghanistan, Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Aruba, Australia, Austria, Azerbaijan, Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda, Bhutan, Bolivia (Plurinational State of Bolivia), Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Canada, Cayman Islands, Central African Republic, Chad, Chile, China, China Hong Kong SAR, China Macao SAR, Taiwan Province of China, Colombia, Comoros, Congo, Democratic Republic of the Congo, Costa Rica, Croatia, Cuba, Cyprus, Czechia, Ivory cost, Denmark, Djibouti, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Estonia, Eswatini, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Georgia, Germany, Ghana, Greece, Greenland, Grenada, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran (Islamic Republic of Iran), Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kiribati, Korea, Republic of, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Mexico, Micronesia (Federated States of Micronesia), Moldova (Republic of Moldova), Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Caledonia, New Zealand, Nicaragua, Niger, Nigeria, North Macedonia, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Rwanda, Saint Kitts and Nevis, Saint Lucia , Saint Vincent and the Grenadines, Samoa, San Marino, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Singapore, Slovakia, Slovenia, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Sweden, Switzerland, Syrian Arab Republic, Tajikistan, Tanzania (United Republic of Tanzania), Thailand, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, Union of Soviet Socialist Republics, United Arab Emirates, United Kingdom, United States of America, Uruguay, Uzbekistan, Vanuatu, Venezuela (Bolivarian Rep. of Venezuela), Viet Nam, Yemen (Yemen Democratic/Yemen Arab Republic), Zambia, Zimbabwe.

B Appendix Comparison to BBC results

This section tests how the incorporation of our third-country effects, internal trade and PPML estimation method changes Baier et al. (2018) (BBC) results. The comparison shows similar coefficients for the first stage regressions confirming that BBC results do not suffer bias from omitting third-country effects (TCE) as they have included importer-year, exporter-year and pair fixed effects. However, differences appear with our results, due to the fact that our benchmark is estimated using PPML.

As an initial step, we want to address how our new Modular Trade Effects (MTE) proxy for variable natural trade costs (distance and adjacency), non-policy fixed exports costs (distance, adjacency, language and religion), and policy fixed exports costs (legal and colony) compared to those from BBC. To perform the analysis we have to use three databases to construct Table 6. First, we use their main database that is obtained applying the Hummels and Klenow (2005) (HK) decomposition between the intensive and extensive trade margins. We replicate BBC linear benchmark in column 1 and introduce our variables including third-country effects in column 2 showing that there are only small differences in the second or third decimal. Second, in columns 3 and 4, we include internal trade into another dataset provided by the authors that does not have the HK decomposition.[31] The differences are also small decreasing the economic integration agreement (EIA) coefficient but increasing the interactions. Particularly, the adjacency interaction becomes significantly negative showing that internal trade is needed to properly identify the impact pointing to a preference for internal goods. Third, in column 5, we replicate their benchmark results for PPML and compute our results with this database in column 6. It can be observed that as normally occurs with this estimation method the coefficients are smaller but almost identical to BBC.

In columns 7 and 8, we use the second dataset and estimate a PPML model with internal trade observing the same signs as BBC also in this setting. The main difference with respect to the linear case is that the language interaction is negative and significant which means that sharing a common language decreases the marginal effect of a trade agreement which might point to lower scope of

[31] We restrict the sample to 1970-2010 because of missing internal trade data previous to that year.

trade agreements. As commented before, having a common language and a common religion seem to have an opposing effect.If two countries have only a common religion the impact of the EIA is even bigger because they might share some more clear characteristics than what the official language shows. The official common language may be capturing past imposed colonial relationships which do not connect cultures as well as the common religion similarity. Common legal origins and common colony are not significant and also not jointly significant but including them or not does not alter other coefficients. As pointed out by BBC it might be that if two countries already have similar institutional factors, the gains from a trade agreement to reduce policy fixed export costs might have already being exhausted.

Overall, BBC interactions are not significantly different from the Modular Trade Effects (MTE) specifications including importer-time, exporter-time and country pair fixed effects.[32] Therefore, they show no bias as the fixed effects were absorbing the third-country effects. These TCE have been approximated by the multilateral resistances (MRs) following Baier and Bergstrand (2009) who argue that the specification with MRs or fixed effects gives identical coefficients. However, as we have a panel setting with internal trade we keep them to avoid unobserved heterogeneity not controlled for and to keep consistency with BBC strategy.

In the OLS setting we can see that the interaction for distance is significant although in reversed signs (column 1). This might point to some non-linearities that this model is not able to capture. While in the PPML setting which is the preferred one, all coefficients are significant except the colony one. We can see that adjacency is now positive when internal and external observations are in the same variable probably due to the opposing impact of one another. While distance, language and religion maintain the first stage signs and common legal origins is now negative and significant.

[32] In this case the interactions where weighted by the number of countries (1/N). When the interactions are weighted by GDP the same results are found.

	1) EIA-OLS	2) MTE-OLS	3) EIA-OLS	4) MTE-OLS	5) EIA-PPML	6) MTE-PPML	7) EIA-PPML	8) MTE-PPML
	Non-internal	Non-Internal	With internal	With internal	Non-internal	Non-Internal	With internal	With internal
t * EIA	0.286***	0.283***	0.261***	0.257***	0.096**	0.093**	0.092**	0.092**
	(0.036)	(0.036)	(0.053)	(0.053)	(0.041)	(0.041)	(0.041)	(0.041)
t * DIST	-0.229***	-0.231***	-0.239***	-0.241***	-0.107**	-0.106**	-0.097**	-0.097**
	(0.031)	(0.031)	(0.040)	(0.041)	(0.042)	(0.042)	(0.042)	(0.042)
t * ADJ	0.034	0.036	-0.348***	-0.330***	-0.267***	-0.263***	-0.257***	-0.257***
	(0.089)	(0.090)	(0.108)	(0.112)	(0.092)	(0.091)	(0.091)	(0.091)
t * LANG	0.201***	0.207***	0.308***	0.231**	-0.417***	-0.420***	-0.423***	-0.422***
	(0.068)	(0.068)	(0.088)	(0.091)	(0.087)	(0.086)	(0.086)	(0.086)
t * RELIG	0.245***	0.245***	0.300***	0.285***	0.471***	0.480***	0.468***	0.471***
	(0.067)	(0.068)	(0.084)	(0.088)	(0.103)	(0.103)	(0.103)	(0.103)
t * LEGAL	-0.111**	-0.121**	-0.138**	-0.114	0.115	0.120	0.117	0.119
	(0.054)	(0.055)	(0.070)	(0.072)	(0.078)	(0.078)	(0.078)	(0.078)
t * COLONY	-0.205*	-0.202	-0.555***	-0.546***	0.050	0.051	0.066	0.065
	(0.122)	(0.125)	(0.132)	(0.133)	(0.115)	(0.115)	(0.114)	(0.115)
N	66940.000	65651.000	153937.000	140310.000	232335.000	210914.000	228491.000	210222.000
p-value test EIA and interactions	0.000		0.000		0.000		0.000	
p-value MTE_ext and interactions		0.000		0.000		0.000		0.000
p-value MTE_ext only interactions		0.000		0.000		0.000		0.000
p-value MTE_ext sum plus interactions		0.865		0.000		0.002		0.004
F test MTE_ext sum only interactions		0.048		0.000		0.000		0.000

Table 6: Other Specifications

Note: Standard errors in parentheses: * $p < .10$, ** $p < .05$, *** $p < .01$. All tables include importer-time, exporter-time and pair fixed effects and cluster standard error at the pair level. The dependent variable is the logarithm of trade flows for OLS columns (1 to 4) and trade flows in levels for PPML columns (5 to 9). The independent variables for EIA-columns reflect only trade costs as in BBC including only the EIA part while in MTE-columns include the direct and third-country effects. Columns 1 (benchmark for BBC) and 2 are computed using BBC dataset with HK decomposition from 1965 to 2017. Columns 3 and 4 use another dataset provided by BBC but without the decomposition and our internal trade data 1970 to 2010 as there is no internal trade data previous to that year.Column 5 (benchmark for BBC) and 6 use BBC dataset without HK decomposition from 1965 to 2010. Column 7 and 8 use the dataset without HK decomposition with our internal trade from 1970 t 2010. All p-value tests refer to the p-value of a joint significance F-test. The first one applies only to BBC model to test if all EIA coefficients are different from zero. The second one tests if all MTE coefficients are equal to zero. The third tests if all MTE coefficients are equal to zero. The fourth one tests if the sum of all MTE interactions is equal to zero. The fifth one tests if only the MTE interactions are equal to zero.

Panel A: OLS Without internal trade						
	Coef.	Std.Err.	t	P>t	[95%Conf.	Interval]
EIA_t	-0.016	0.036	-0.45	0.651	-0.087	0.054
EIA_t * ln DIST	0.098	0.033	2.92	0.003	0.032	0.163
EIA_t * ADJ	0.168	0.099	1.69	0.092	-0.027	0.363
EIA_t * LANG	-0.132	0.076	-1.74	0.081	-0.28	0.016
EIA_t * RELIG	-0.098	0.076	-1.3	0.194	-0.247	0.05
EIA_t * LEGAL	0.063	0.061	1.04	0.3	-0.056	0.182
EIA_t * COLONY	0.207	0.132	1.57	0.116	-0.051	0.465
Panel B: OLS with internal trade						
EIA_t	-0.112	0.054	-2.05	0.04	-0.219	-0.005
EIA_t * ln DIST	0.093	0.047	1.99	0.046	0.002	0.185
EIA_t * ADJ	-0.326	0.174	-1.87	0.061	-0.667	0.015
EIA_t * LANG	-0.186	0.098	-1.9	0.057	-0.377	0.006
EIA_t * RELIG	-0.27	0.091	-2.97	0.003	-0.448	-0.092
EIA_t * LEGAL	0.04	0.071	0.56	0.577	-0.1	0.179
EIA_t * COLONY	0.166	0.152	1.09	0.277	-0.133	0.465
Panel C: PPML Without internal trade						
EIA_t	0.002	0.04	0.06	0.952	-0.076	0.08
EIA_t * ln DIST	0.023	0.042	0.55	0.581	-0.06	0.106
EIA_t * ADJ	0.135	0.085	1.58	0.113	-0.032	0.303
EIA_t * LANG	-0.065	0.091	-0.72	0.472	-0.243	0.113
EIA_t * RELIG	-0.09	0.107	-0.84	0.401	-0.299	0.12
EIA_t * LEGAL	0.014	0.075	0.18	0.855	-0.133	0.16
EIA_t * COLONY	0.142	0.129	1.1	0.271	-0.111	0.395
Panel D: PPML with internal trade						
EIA_t	0.014	0.04	0.35	0.724	-0.064	0.093
EIA_t * ln DIST	0.023	0.042	0.55	0.581	-0.06	0.106
EIA_t * ADJ	0.135	0.085	1.58	0.113	-0.032	0.303
EIA_t * LANG	-0.065	0.091	-0.72	0.472	-0.243	0.113
EIA_t * RELIG	-0.09	0.107	-0.84	0.401	-0.299	0.12
EIA_t * LEGAL	0.014	0.075	0.18	0.855	-0.133	0.16
EIA_t * COLONY	0.142	0.129	1.1	0.271	-0.111	0.395

Table 7: BBC models significance of the coefficients
Note: In panel A, the statistical difference for the coefficients between columns 1 and 2 is compared. In panel B we repeat the process for columns 3 and 4. In panel C for columns 5 and 6 while in panel D for columns 7 and 8.