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The CAFTA-DR Free Trade Agreement — Analyzing its effects in a modern gravity framework

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Abstract

We study the effects of the Dominican Republic–Central America–United States Free Trade Agreement (CAFTA-DR), signed in 2004, on the trade flows of its member states. Relying on the structural gravity model of trade framework, we find evidence of both increases and decreases in members' bilateral trade, but also of significant differences in these effects depending on the direction of trade and the trading members. Using a counterfactual analysis, we are also able to measure the general equilibrium effects of CAFTA-DR, finding that it has, in general, increased both total exports and income levels for El Salvador, Guatemala, Honduras, and Nicaragua. However, we also find evidence of sizable trade diversion and welfare losses for Costa Rica and the Dominican Republic.

1 Introduction

In the year 2004, the Dominican Republic–Central America–United States Free Trade Agreement (CAFTA-DR) was signed. This agreement generated some expectation among other Latin American countries, as it was the first of its kind to be signed between the USA and a group of developing countries in the region. With entry into force, the agreement immediately liberalized the trade of almost all goods between members and phased in the market access for some of the members' most important export goods. This paper provides an empirical evaluation of the main effects of the CAFTA-DR agreement on the members' aggregate bilateral trade in

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goods more than 14 years after its entry into force. Using a state-of-the-art gravity model of trade, we analyze the specific effects of the CAFTA-DR agreement on each member's trade, distinguished by trade flow and by trade partner and direction of the exchange. Of particular interest are the effects of CAFTA-DR on the welfare and trade levels of members. To the best of our knowledge, no other paper has so far tried to evaluate these effects within the empirical context of the structural gravity model of trade.

For the members in Central America and the Dominican Republic, the CAFTA-DR market represents an important source of their imports and the main destination of their exports. In general, more than half of the exports from these members go to the CAFTA-DR market, mainly to the USA. Likewise, even before the signing of the agreement, the USA was one of the largest, if not the largest, source of imports for the CAFTA-DR members. In contrast, the CAFTA-DR market is of relatively minor importance for the USA: about 1% of its exports go to CAFTA-DR countries, and this market represents the 18th largest source of imports for the USA. The apparent dominance of the USA among CAFTA-DR member states is much greater than that in the USMCA,[1] of which the effects have been extensively explored in the literature. Also, the Southern Common Market (Mercosur, by its Spanish acronym), the second important intra-regional FTA in terms of trade size in the Americas, has attracted considerably more attention in the literature compared to CAFTA-DR despite the fact that CAFTA-DR was the first free trade agreement (FTA) of its kind signed between a group of six developing countries in America and the USA, and thus provides a good opportunity for studying the effects of an FTA formation between small developing economies and a large developed economy. In addition, some elements of CAFTA-DR would serve as a reference for other similar negotiations in the region, as CAFTA-DR consolidated several pre-existing trade commitments among its members (Granados and Cornejo 2006). Therefore, it is interesting to evaluate its effects in terms of promoting both bilateral trade and welfare among its members.

The CAFTA-DR negotiations began during 2003 and were concluded in 2004 with the signing of the CAFTA-DR agreement, which entered into force in 2006 for most of its members[2] and liberalized trade flows between Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, the Dominican Republic, and the USA. With its entry into force, CAFTA-DR instantly eliminated tariff collection and/or eased customs procedures for several categories of goods traded between its members, but, as is common for FTAs, many of its trade concessions for some important agricultural and industrial goods were gradually phased in over a period of up to 20 years. Studies focusing specifically on CAFTA-DR have been relatively few compared to those that focused on NAFTA or Mercosur. However, CAFTA-DR is also an important regional trade agreement in the Americas since it directly links the USA with part of

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[1] The United States-Mexico-Canada Agreement (USMCA) was established in 2020 and replaced the North American Free Trade Agreement (NAFTA) which came into effect in 1994.

[2] In the cases of the Dominican Republic and Costa Rica, it entered into force in 2007 and 2009, respectively.

those countries that lie in its direct "backyard" and have for a long time been influenced not only by US foreign policy, but also by the commercial interests of leading US multinationals. In a speech at the Organization of American States (OAS), US President George W. Bush stated that CAFTA-DR would help members improve the welfare of their citizens, as the cut in tariffs would increase trade among members and the agreement would attract more investment (OAS 2005). This paper therefore examines the effects of CAFTA-DR on its members' bilateral trade and welfare levels in the light of new theoretical advances pertaining to the estimation of the structural gravity model of trade.

In international trade, the gravity model has been widely used in empirical research. In its most basic form, this type of model relates the bilateral trade flows between two countries to their income levels and to a measure of their bilateral trade costs, such as the geographical distance between the two. During the beginning of the 2000s, the gravity model of trade received important contributions to its theoretical basis through the works of Eaton and Kortum (2002) and Anderson and van Wincoop (2003), who developed a more solid theoretical foundation for the gravity model based on the Ricardian trade model and the Armington-CES framework, respectively. Anderson and van Wincoop (2003) made an important contribution to the gravity literature by pointing out the importance of including multilateral resistance terms in the gravity model, which measure the ease of access to the market for importing and exporting countries (Head and Mayer 2014), and need to be accounted for in the model estimation.

The gravity model estimation technique has also improved considerably in recent years. It is by now common practice to use the Poisson pseudo-maximum likelihood (PPML) estimation instead of the more traditional OLS regression with log transformation, since PPML is more robust against the presence of heterogeneity in the data than OLS and can easily handle zero trade flow observations (Santos Silva and Tenreyro 2006). The importance of accounting for possible endogeneity when estimating the effects of FTAs, which can lead to a biased estimation of their effects, has also been acknowledged. This endogeneity problem can be solved, at least partially, by the inclusion of country-pair fixed effects in the estimation, which capture any country-pair unobservable characteristics (Baier and Bergstrand 2007). Another major improvement in the gravity estimation has been the inclusion of intranational trade flows (for reasons to include these trade flows despite empirical challenges to calculate them, see Yotov et al. 2016 and Yotov 2022). In particular, Bergstrand et al. (2015) point out that international trade costs have been falling over time and suggest accounting for this development by introducing additional indicator variables, either an international border variable or the geographical bilateral distance variable, interacted with year fixed effects, in the estimation.

In recent years, some authors have developed special approaches to simultaneously measure heterogeneity in the effects of different FTAs and also of member-pair and member-pair-direction effects within the same FTA, using gravity models of trade. Important examples of this are the empirical work of Carrère (2006) and the works of Zylkin (2016) and Baier et al. (2019), whose approaches allow deeper assessments of FTA effects. Regarding the welfare effects of FTAs, Yotov et al. (2016) develops a general procedure to estimate such effects, based on the general

equilibrium properties of the structural gravity model of trade, using the PPML estimator. Relying on this procedure, it is possible to measure the changes in income levels and total exports (trade creation or diversion) derived from, for example, the hypothetical creation or elimination of an FTA.

In general, most studies on CAFTA-DR focus on its trade concessions and its possible effects ex ante.[3] Regarding the analysis of CAFTA-DR's ex post effects, most existing studies analyze its effects on a particular member state. The results of studies focusing on CAFTA-DR's average effect on members' bilateral trade appear inconclusive. El Dahrawy Sánchez-Albornoz and Timini (2021) and Nguyen (2019) found no significant evidence of a positive average effect of CAFTA-DR on members' bilateral trade. As for the effects of CAFTA-DR on bilateral trade for particular members, the evidence is similarly mixed, ranging from positive to negative effects depending on the country. Moreover, the studies do not cover all members of the agreement. Sandoval et al. (2015) explores CAFTA-DR's effects on exports and imports of El Salvador, Koehler-Geib and Sanchez (2015) focus on Costa Rican exports and imports to and from the USA, and Reyes Peguero and Hansen (2019) only explore the agreement's effects on Dominican exports with a particular focus on the exports to the USA.

Additionally, Spilker et al. (2018) explores CAFTA-DR's effects on Costa Rica's intensive and extensive margins of trade to the USA, and Cruz Rodríguez and Calvo Clúa (2016) analyze the effects of CAFTA-DR on the Dominican Republic's intra-industry trade with the other member states. Hicks et al. (2014) analyze the political economy behind the referendum on CAFTA-DR ratification in Costa Rica. The role of trade openness and economic growth with a special emphasis on the case of CAFTA-DR has been explored by Poggio and Calderon (2010).

As the above literature review shows, the existing research on the CAFTA-DR agreement is far from comprehensive with regard to the evaluation of its effects. As mentioned above, many of the studies have focused on only one particular member and considered only the effects of CAFTA-DR on this member's exports or imports, but there is not yet a consistent estimate of the bilateral trade effects for all members. Similarly, to our knowledge, no estimate exists of the welfare effects of CAFTA-DR on its members, using the framework of the structural gravity model of trade. Knowing these effects, both with regard to members' bilateral trade and welfare levels, is of vital importance in comprehensively assessing any FTA, and in particular CAFTA-DR which has been deemed highly important not only for the involved Central American countries, but also by the USA seeking to tighten the economic connections to the states in their "backyard."

This paper expands the literature on the member-pair-direction heterogeneous effects within the same FTA by estimating these effects for CAFTA-DR by using a state-of-the-art gravity model. Therefore, this paper adds to the literature that studies the heterogeneous effects of FTAs, similarly to Zylkin (2016) and Baier et al. (2019). In addition, using the general procedure presented in Yotov et al. (2016), we

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[3] Some examples are the works of Paggi et al. (2005), Storrs et al. (2004), Granados and Cornejo (2006), and Pacheco and Valerio (2007).

conduct a counterfactual experiment to measure the general equilibrium effects of CAFTA-DR on members' income and trade levels, based on our initial estimates of its heterogeneous effects on the member states.

The remainder of this paper is organized as follows: Section 2 provides a brief overview on CAFTA-DR, its members, and previous research relating to it. Section 3 presents a description of the data used and explains how the dataset was constructed. In Section 4, we develop the empirical specifications used to measure the effects of CAFTA-DR on bilateral trade and welfare levels. In Section 5, the empirical results are presented. Section 6 summarizes our main findings about the effects of CAFTA-DR and concludes.

2 The CAFTA-DR Free Trade Agreement: a short overview

CAFTA-DR was signed in 2004 by its member states to improve and facilitate their commercial relationships. The CAFTA-DR negotiations began in January 2003 without the Dominican Republic, which joined the negotiations in July 2004 (Paggi et al. 2005; Storrs et al. 2004; Pacheco and Valerio 2007).

CAFTA-DR went into force in 2006 for most member states, except for the Dominican Republic and Costa Rica, where the agreement went into effect in 2007 and 2009, respectively (World Trade Organization 2016b). Costa Rica conducted a national referendum to ratify the agreement (Hicks et al. 2014). Among the objectives of CAFTA-DR were the increase and diversification of trade between members, and the elimination of trade barriers to improve the mobility of goods and services (United States, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua 2004). As a comprehensive agreement, CAFTA-DR not only did touch upon aspects related to bilateral trade, but also included provisions on intellectual property rights, labor and environmental regulations, and governmental procurement (United States et al. 2004; Storrs et al. 2004).

With its implementation, CAFTA-DR allowed 100% of non-textile and non-agricultural goods of member states to enter duty-free into the USA (Hornbeck 2012). In the case of textile and apparel goods, these can enter the USA duty and quota free if they meet the rules of origin criteria (Storrs et al. 2004; World Bank 2005). CAFTA-DR also includes tariff rate quotas for some sensitive goods of members with long-run tariff protection as a way to generate immediate market access for these sensitive goods (Paggi et al. 2005). For the United States' exports to the CAFTA-DR markets, CAFTA-DR immediately eliminated tariffs on 80% of non-textile manufactured goods and 50% of agricultural goods (Storrs et al. 2004). For the remaining shares of these goods, their access to the CAFTA-DR markets was phased in over periods from 10 up to 20 years (Storrs et al. 2004; Hornbeck 2012). Thus, CAFTA-DR generated a significant market opening for United States' agricultural goods in the long run, since Central American tariffs on these goods were higher in comparison to the ones applied to manufactured imports (Paggi et al. 2005).

Most of the adjustment from CAFTA-DR, in terms of trade, fell on Central American countries and the Dominican Republic. The US adjustment was relatively less significant, as they had given preferential trade access to the other members

already several decades before CAFTA-DR, even though the USA did not receive equal treatment from the other members (Paggi et al. 2005). Exports of the CAFTA-DR members received unilateral and preferential market access to the USA from three main sources: the Caribbean Basin Economic Recovery Act (CBERA), the Generalized System of Preferences (GSP), and the Caribbean Basin Trade Partnership Act (CBTPA) (Dypski 2002; Storrs et al. 2004; Hornbeck 2012). During 2004, the proportion of CAFTA-DR members' exports to the USA that benefited from the CBERA was as follows: Costa Rica, 32.7%; El Salvador, 54.6%; Guatemala, 37.6%; Honduras, 63%; Nicaragua, 33.6%; and the Dominican Republic, 57.3% (Pacheco and Valerio 2007). However, with the ratification of CAFTA-DR, the members were excluded from the benefits provided by both CBERA and CBTPA (Hornbeck 2012; Huegel and Kostrzewa 2013).

Prior to CAFTA-DR, Central American members already had a significant degree of economic and commercial integration. Their integration began during the 1960s with the signing of the General Treaty on Central American Economic Integration, the formation of the Central American Common Market (CACM) to promote economic growth, and the most recent formation of the Central American Integration System (SICA by its Spanish acronym) to foster cooperation (Storrs et al. 2004; Koehler-Geib and Sanchez 2015). In addition, the Dominican Republic also shared a certain degree of integration with these members prior to CAFTA-DR, having signed an FTA[4] with them in 1998 (Granados and Cornejo 2006; World Trade Organization 2016a) and becoming an associated member of SICA in 2003 and a full member in 2013 (SICA 2013). An important aspect of CAFTA-DR is that it recognizes these previous trade commitments and consolidates them into a single legal document, adopting an important part of their previous trade concessions with some modifications, preventing these countries from fragmenting their trade as a consequence of these commitments (Granados and Cornejo 2006).

The trade agreement signed between the Dominican Republic and Central America entered into force between late 2001 and late 2002 for its members, under the name Tratado de Libre Comercio entre Centroamérica y la República Dominicana (Central America-Dominican Republic Free Trade Agreement or CA-DR FTA in English). The agreement was negotiated with the intention of establishing a free trade zone between the Dominican Republic and each member from Central America, under the dispositions of Article XXIV of the General Agreement on Tariffs and Trade of 1994 and Article V of the General Agreement on Trade in Services (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua 1998). The members agreed to liberalize access to their respective markets through the total elimination of customs duties on trade in goods. The agreement is based on the principle of a negative list, as trade was liberalized immediately for all goods except those included in a special list (Granados and Cornejo 2006). This principle and the special treatment established by the Central America–Dominican Republic FTA were incorporated in the CAFTA-DR text, making the previous FTA

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[4] More information on this agreement, called Central America-Dominican Republic FTA, is given below.

unnecessary so that its members could agree on terminating it once CAFTA-DR took effect (Granados and Cornejo 2006). However, according to information from the World Trade Organization (WTO) of 2016, the agreement remains active for all its members (World Trade Organization 2016a). Despite the overlapping treaties, it is unlikely that this would generate any difficulties in trade between Central America and the Dominican Republic, as the member states could choose to use the concessions derived from CA-DR FTA or CAFTA-DR without much of a problem (Granados and Cornejo 2006).

For the Central American countries and the Dominican Republic, trade with the USA is very important, as the USA is not only their main source of investment and bilateral assistance, but also the most important source of imports and the main destination of their exports (Storrs et al. 2004). Between 1995 and 2004, the CAFTA-DR member exports to the USA represented more than half of their total exports (Fig. 1), but only around 1.5% of the US total exports went to these countries during the same period (Fig. 2). Hence, the trade dependence of the CAFTA-DR countries on the US market prior to the agreement was significant, in contrast to the limited importance of these countries' markets for the US exports.

After the CAFTA-DR entered into force, dependence on the US market as a major export destination decreased for all CAFTA-DR members, with the exception of Nicaragua (Fig. 1). As Fig. 1 shows, all members but Nicaragua significantly reduced their export shares to the USA between 2005 and 2019 compared to the period between 1995 and 2004: counterintuitively, CAFTA-DR members appear to be systematically moving away from the USA as their main export destination. The member who most reduced its exports to the USA was the Dominican Republic, going from more than 80% between 1995 and 1999 to around 50% between 2015 and 2019 (Fig. 1). On the other hand, exports to the CAFTA-DR market as a percentage of each member's total exports declined with its entry into force (Fig. 2), except for the USA, whose share slightly increased. This reduction in the members' share of exports to the CAFTA-DR zone is primarily a consequence of the declining importance of the USA as the main export destination for these countries.

The decline in the Dominican exports to the USA deserves special attention. Given its strong dependence on the US market before the enforcement of CAFTA-DR, one would have expected the share of Dominican exports to the USA to increase or, at least, remain constant. Three main developments could explain the observed decline: (1) increased competition with external competitors for the US market; (2) a structural change in Dominican exports due to the world financial crisis of 2007–2009; and (3) particular shocks to Dominican exports. With respect to the first possible explanation, Reyes Peguero and Hansen (2019) find evidence for a negative correlation between the real growth rate of Chinese exports to the US and of Dominican exports to the USA. In other words, Chinese exports could have replaced exports from the Dominican Republic and probably also other countries to the US market. This development probably started with China's WTO entry at the end of 2001. The second explanation seems a less likely cause of the observed decline in the share. As shown in Fig. 3, the share of Dominican exports to the rest of the world had already been increasing since the beginning of the 2000s. Likewise, Reyes Peguero and Hansen (2019) find no

evidence that the global financial crisis affected Dominican exports to the rest of the world or to the USA between 2008 and 2009. Lastly, Fig. 3 shows two possible external shocks for Dominican exports, as manifested in significant increases in the shares of Haiti and Canada. In the case of Haiti, this is probably a consequence of the destruction of its production capacity by the 2010 earthquake: As Haiti and the Dominican Republic share a direct border, the Dominican exports to Haiti would have increased because of the demand that could not be met by Haiti's diminished productive capacity. Exports to Canada would have increased as a result of mining concessions given to a Canadian company to extract gold and other metals in Pueblo Viejo, Dominican Republic. The production of this mine began around 2012–2013 (Redwood 2015), and since 2013, almost all Dominican exports to Canada have consisted of gold and other precious metals.

Another important aspect that needs to be addressed in more detail here is the Costa Rican exports to the USA. In Fig. 4, we can see the surprising increase of Costa Rican exports to the USA after 2009 and until 2013. After 2013, Costa Rican exports to the USA and also to the rest of the world decreased significantly. This development is difficult to explain, but it may be a consequence of exchange rate distortions between the Costa Rican colon and the US dollar: The colon appreciated considerably versus the US dollar in the winter of 2013/2014, whereas it had strongly depreciated in the fall of 2009 (based on daily exchange rates provided by St. Louis Federal Reserve online tool).

The empirical literature on the effects of CAFTA-DR on members' bilateral trade is relatively limited. In general, most studies on CAFTA-DR focus on its trade concessions and its possible effects ex ante, like Paggi et al. (2005), Storrs et al. (2004), Granados and Cornejo (2006), and Pacheco and Valerio (2007). Regarding the analysis of CAFTA-DR's ex post effects, the existing studies analyze its effects on a particular member state in most of the cases. The results of studies focusing on CAFTA-DR's average effect on members' bilateral trade appear inconclusive. Both El Dahrawy Sánchez-Albornoz and Timini (2021), which focused on the average effects of many trade agreements in the region of Latin America, and Nguyen (2019), which put a special effort on the average and trade diversion effects of several trade agreements, could not find significant evidence of any effect on members' bilateral trade.

As for the effects of CAFTA-DR on bilateral trade for particular members, the evidence is similarly mixed, ranging from positive to negative effects depending on the country. The studies typically do not cover all members of the agreement; however. Sandoval et al. (2015) explores CAFTA-DR's effects on exports and imports of El Salvador, finding no evidence that CAFTA-DR has had a significant and positive impact on imports or exports of this country. Another example is the work of Koehler-Geib and Sanchez (2015), who find that CAFTA-DR increased both Costa Rican exports to the USA and imports from the USA, although the agreement's effect on imports was not statistically different from zero. Also, a recent study on the effect of CAFTA-DR on the exports of the Dominican Republic concluded that it did not increase exports from the Dominican Republic to CAFTA-DR members and that the agreement is associated with a reduction in Dominican exports to the USA (Reyes Peguero and Hansen 2019).
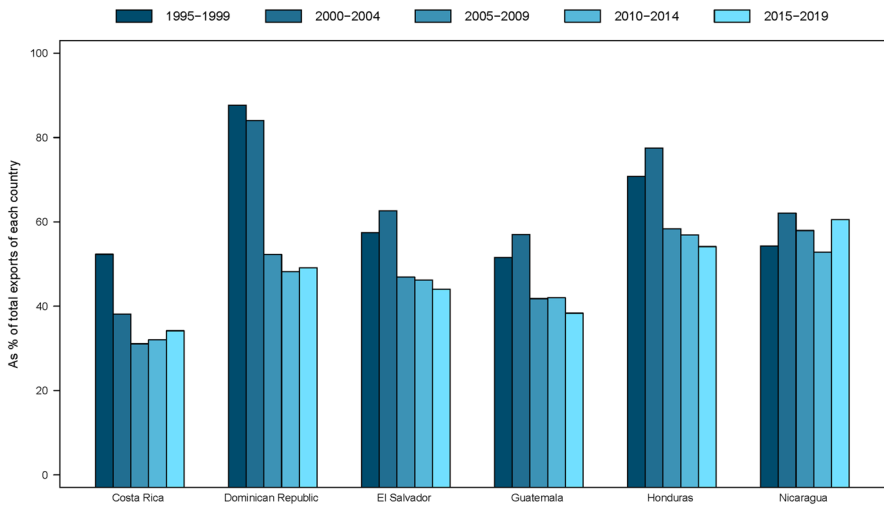
Fig. 1 Exports to the USA by CAFTA-DR member (share of total exports in each period). Source: own elaboration with information from the ITPD-E ver. 2 (2022, July)
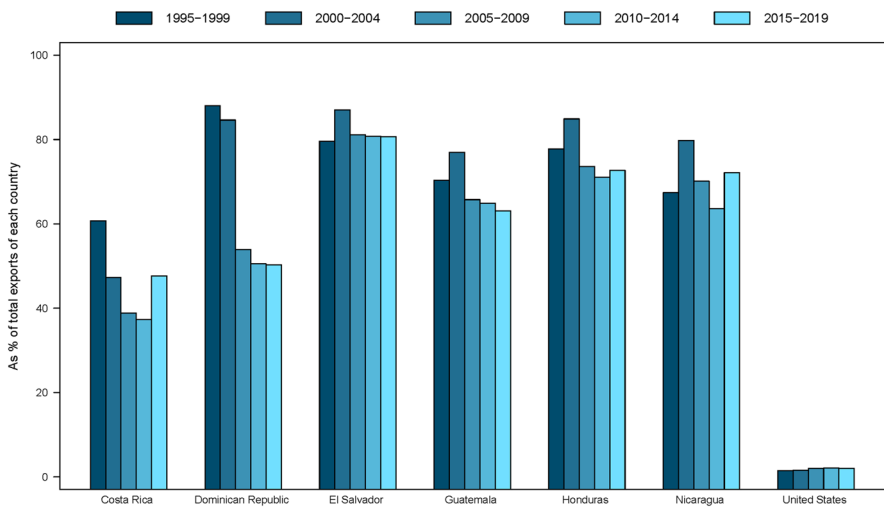
Fig. 2 Exports to the CAFTA-DR area by member (share of total exports in each period). Source: own elaboration with information from the ITPD-E ver. 2 (2022, July)

Additionally, Spilker et al. (2018) explores CAFTA-DR's effects on Costa Rica's intensive and extensive margins of trade to the USA, and Cruz Rodríguez and Calvo Clúa (2016) analyze the effects of CAFTA-DR on the Dominican Republic's intra-industry trade with the other member states. Hicks et al. (2014) analyzes the political economy behind the referendum on CAFTA-DR ratification in Costa Rica. The role of trade openness and economic growth with a special

Fig. 3 Dominican export share for selected countries. Source: own elaboration with information from the ITPD-E ver. 2 (2022, July)

Fig. 4 Costa Rican export to selected countries. Source: own elaboration with information from the ITPD-E ver. 2 (2022, July)

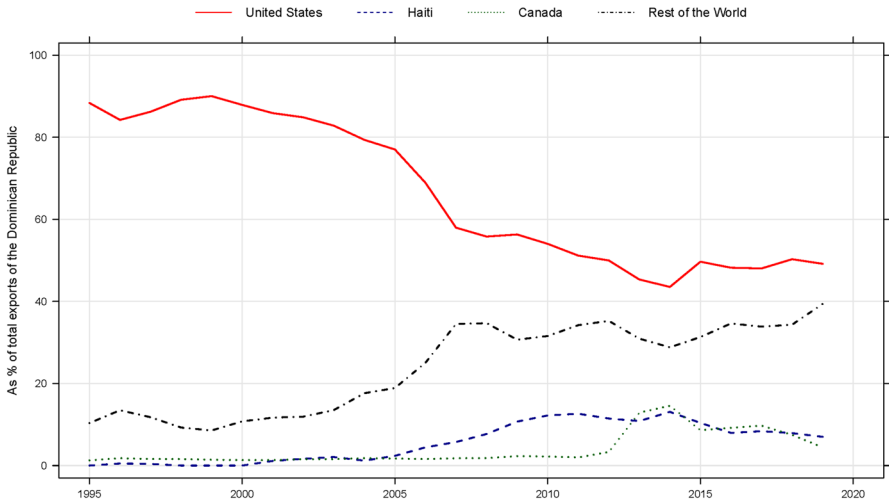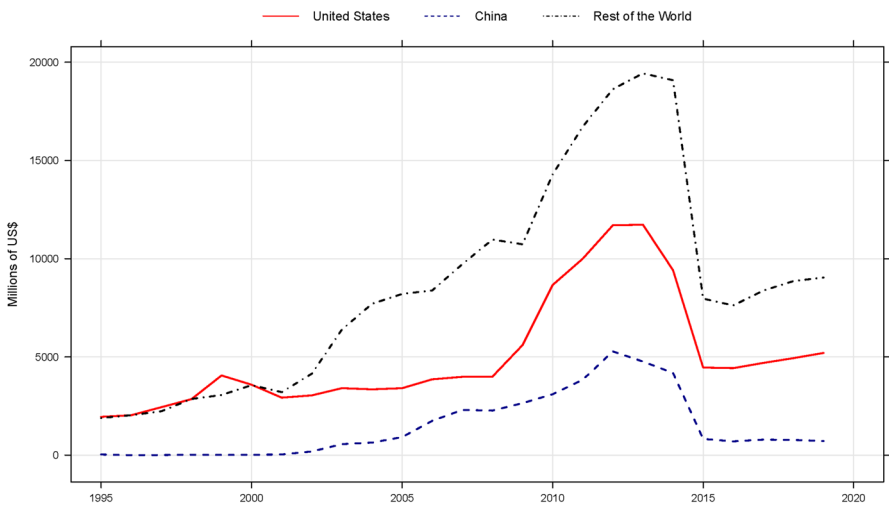emphasis on the case of CAFTA-DR has been explored by Poggio and Calderon (2010).

3 Data description

For the analysis of the CAFTA-DR effects on the bilateral trade of member states, the two main sources of data are the July 2022 (release 2) update of the International Trade and Production Database of Estimation (ITPD-E) and the May 2021 (release 2.1) Dynamic Gravity Dataset (DGD). The first data source includes consistent international and intranational trade data for 265 countries and 170 industries for the years 1986–2019 (Borchert et al. 2022). The second includes data on commonly used variables in gravity estimations, such as bilateral distance, existence of a common language or an FTA, among others (Gurevich and Herman 2018).

Regarding the trade data, ITPD-E includes international and intranational observations, expressed in nominal millions of dollars, of 170 industries. The inclusion of intranational trade in ITPD-E is an important feature. These types of observations allow for the estimation of theoretically consistent effects of FTAs on trade, given that FTAs affect both international and intranational trade flows (Yotov et al. 2016; Yotov 2022).

The industries included in ITPD-E are divided into four categories or bigger sectors: 28 agriculture (among them forestry and fishing), 118 manufacturing, 7 mining and energy, and 17 services sectors. Since our main focus in this paper is on the effects of CAFTA-DR on trade in goods, observations belonging to services were dropped. This leaves us with 153 instead of the original 170 industries. Although it would be ideal to analyze CAFTA-DR using the disaggregated data from those 153 industries in order to avoid any aggregation bias, the number of observations (more than 50 million) and fixed effects required in the estimation would make this task infeasible. In a recent article, Breinlich et al. (2022) showed that the Poisson pseudo-maximum likelihood (PPML) estimates from aggregate trade flows can, under certain circumstances, approximate the trade-weighted average of sector-level estimates. Therefore, the analysis is conducted using the aggregate data on trade in goods by importer, exporter, and year.

We use data from 1995 to 2018 because this creates a large enough sample to obtain representative effects of the agreement and the other control variables. There exist reasons to not use the whole period included in the second version of the ITPD-E. For the trade in goods, the data is only available for the three broad sectors after 1987. Using the data from 1995 onward limits the distortions in the data coming from country unifications, like Germany (1990), and divisions, like the Soviet Union (1991), Yugoslavia (1992) and Czechoslovakia (1993), without affecting the estimates of the CAFTA-DR effects. We have also noticed some odd behaviors of the ITPD-E intranational trade flows: After aggregating the values by exporter and year, the average value of intranational trade flows by year shows an abrupt decrease after 2015, as can be seen in Fig. 5. This appears to come from missing observations of intranational trade flows especially in the manufacturing sector after 2015, which results in inconsistent aggregate values of intranational trade flows.

In order to correct this problem in the ITPD-E data, we collected and calculated new values of intranational trade flows, broad sector by broad sector, using the same sources used in the ITPD-E (the FAO and the INDSTAT and the MINSTAT from UNIDO datasets),[5] and then we added up to obtain the aggregate values of intranational trade flows by country and year. This appears to solve the problem with the intranational trade flows after 2015, as Fig. 5 also shows that the new intranational trade flows do not exhibit the same decrease in the values after 2015. However, there still exists a strong decrease in 2019 in the new data that appears to come from a reduction in the number of reporting countries. In the ITPD-E data, we see a similar sudden decrease (see Fig. 6), which made us decide to leave that year out of the sample as well. We also calculated another proxy of intranational trade flows using the difference between the nominal GDP (included in the DGD[6]) and the total exports of our data. The three alternative ways to calculate intranational trade flows are all used for the estimation of the average CAFTA-DR effects, and the corresponding results are discussed in the following section.

From the Dynamic Gravity Dataset come the data for bilateral distance, country contiguity, common language, common colonizer, common legal origin, bilateral membership in the World Trade Organization (WTO), and signed free trade agreements. Some of these variables include missing values in case a country is not included in the DGD for some specific years. We have left these observations as missing values in our data, as oftentimes the country in question did not exist in these years. In addition, we also treat as missing the international trade observations corresponding to these countries. The bilateral distance variable is expressed in population-weighted kilometers between country-pairs and, as we also consider intranational trade flows in our data, includes both international and intranational distance. The original variable of bilateral WTO membership was slightly modified to be equal to one if both countries were WTO members and the observation corresponds to international trade, and zero otherwise.[7] Additionally, the FTA variable was modified to omit both the CA-DR FTA and the CAFTA-DR, being equal to one if both trading countries were in the same FTA, but not in CA-DR FTA or CAFTA-DR, and zero otherwise. The CAFTA-DR variable was constructed based on the effective date in each member state as reported to the WTO.

Our sample thus includes observations of 209 countries[8] between 1995 and 2018. It allows us to analyze the first 12 years of CAFTA-DR operation (2006–2018) and

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[5] However, we do not include the aggregate output values of forestry and fishing in the agricultural sector, and we mostly rely on the INDSTAT 2 (ISIC Revision 3) data for the aggregate output values of the manufacturing sector.

[6] GDP observations were taken from the Dynamic Gravity Dataset, which reports the GDP values registered in the World Bank's World Development Indicators. These GDP observations are only available until 2018, which is another reason to let the sample end in 2018 and thus ensure comparability between the alternative proxies of intranational trade flows.

[7] This change is made because the original WTO variable was equal to one in the case of intranational trade, which would prevent us from capturing any trade diversion effect from intranational sales to international trade originating from the WTO membership (Larch et al. 2019).

[8] The list of countries can be found in Appendix Table 6.

Fig. 5 Average value of intranational trade flows by year. Source: own elaboration with information from the ITPD-E ver. 2, FAOSTAT, UNIDO datasets (INDSTAT and MINSTAT), and the Dynamic Gravity Dataset ver. 2.1

Fig. 6 Number of countries with positive intranational trade by year. Source: own elaboration with information from the ITPD-E ver. 2, FAOSTAT, UNIDO datasets (INDSTAT and MINSTAT), and the Dynamic Gravity Dataset ver. 2.1

also to have observations from the years prior to the agreement. In order to obtain a balanced dataset, all possible trade flows between countries were considered in the sample. Since we include 209 countries and consider both international and intranational trade for the analysis, the balanced dataset consists of 209 exporters × 209

importers × 24 years = 1,048,344 exporter-importer-year observations. Any missing international trade observation was assumed to be equal to zero, i.e., interpreted as no trade between the considered two countries, except in the cases in which a country does not exist in the DGD for a given year. On the other hand, missing intranational trade observations were kept as missing. Table 1 provides a brief summary of our variables.

4 Empirical modeling

This section discusses the empirical models used to measure the impact of CAFTA-DR, their theoretical basis, and the specifications used for the analysis. The models used are divided into two categories: partial equilibrium and general equilibrium models. The former is used to measure the direct effect of CAFTA-DR on the bilateral trade of member states, and the latter to analyze its effects on trade and welfare levels.

4.1 Partial equilibrium models

To measure the direct effects of CAFTA-DR on members' bilateral trade, we rely on the most recent developments made to the theoretical and empirical framework of the structural gravity model of trade. Specifically, our work is based on the demand-side Armington-CES gravity formulation introduced in Anderson and van Wincoop (2003) and on its more recent derivation in Yotov et al. (2016). Thus, the theoretical gravity equation takes the following form[9]:

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}. \tag{1}$$

Equation (1) consists of three main parts: the trade flow X_{ij}, the size term $\frac{Y_i E_j}{Y}$, and the trade cost term $\left(\frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}$. Sub-indices i and j represent exporter and importer countries, respectively. Y_i represents the exporter's total income, E_j represents the importer's total expenditure, Y is the total world (or sample) income, which is equal to $\sum_i Y_i$, and σ is the trade elasticity of substitution. t_{ij} represents the bilateral trade costs between exporter i and importer j. Lastly, Π_i and P_j are the (exporter) outward and (importer) inward multilateral resistance terms, respectively, which are endogenous and connected by the following relationships:

$$\Pi_i^{1-\sigma} = \frac{E_j}{Y} \sum_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma}, \tag{2}$$

$$P_j^{1-\sigma} = \frac{Y_i}{Y} \sum_i \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma}. \tag{3}$$

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[9] We omit here the time index for simplicity.

Table 1 Summary of variables

Variables	N^{d}	Missing values	Median	Mean	Standard deviation	Min.	Max.
International trade [a]	1,010,012	33,316	0.04	272.46	3,704.00	0.00	556,154.11
Intranational trade (ITPD-E)[a]	3,733	1,283	3,587.69	116,703.12	684,767.10	0.01	16,072,866.91
Intranational trade (FAO/UNIDO)[a]	3,727	1,289	5,129.27	153,164.95	855,853.65	0.10	16,734,443.48
Intranational trade (GDP–Xt)[a]	4,507	509	10,929.78	227,874.55	1,099,216.26	0.47	18,943,228.15
Bilateral distance [b]	1,005,101	43,243	7,812.32	8,213.43	4,638.00	1.00	19,746.33
Contiguity [c]	1,015,028	33,316	0.00	0.01	0.12	0.00	1.00
Common language [c]	1,015,028	33,316	0.00	0.35	0.48	0.00	1.00
Common colonizer [c]	1,015,028	33,316	0.00	0.07	0.26	0.00	1.00
Common legal origin	1,015,028	33,316	0.00	0.05	0.22	0.00	1.00
FTA [c]	1,015,028	33,316	0.00	0.09	0.28	0.00	1.00
WTO membership [c]	1,015,028	33,316	0.00	0.45	0.50	0.00	1.00
CAFTA-DR [c]	1,048,344	0	0.00	0.00	0.02	0.00	1.00
CA-DR FTA [c]	1,048,344	0	0.00	0.00	0.01	0.00	1.00
Nominal GDP [a]	4,591	425	15,837.45	281,935.51	1,233,861.68	11.03	20,544,343.46

[a]Values in millions of US dollars. [b]Values in population weighted km. [c]Dummy variable equal to 0 or 1. [d]Total sample size is equal to the sum of N and Missing values columns

The recognition of the theoretical importance of multilateral resistance terms has led to significant improvements in the estimation methodology of gravity models. The outward multilateral resistance term Π_i and the inward multilateral resistance term P_j can be understood as a measurement of exporter i's and importer j's ease of market access. The multilateral resistance terms "translate the initial, partial equilibrium effects of trade policy at the bilateral level to country-specific effects on consumer and producer prices" (Yotov et al. 2016, p. 16). Omitting the multilateral resistance terms in the gravity estimation not only would lead to omitted variable bias, but would also prevent us from estimating any general equilibrium effect through the model. Their inclusion in the estimation of the gravity model is crucial to obtain theoretically consistent estimates, and one way to account for the multilateral resistance terms and avoid omitted variable bias is by using panel data and exporter- and importer-time fixed effects (Head and Mayer 2014; Yotov et al. 2016). Therefore, all our estimations use panel data and include such importer-time and exporter-time fixed effects.

Bergstrand et al. (2015) suggest to also control for the negative trend in trade costs over time by either introducing interaction terms between an international border dummy and year effects or interaction terms between geographical distance and year effects. We experiment with both these suggestions as well. It is clear, however, that these controls absorb much of the time variation in the data. Since trade flows, WTO membership, and the number of FTAs all increase over time, the estimated effects of these trade policy variables become smaller and often insignificant and, at least in our sample, the inclusion of international border and time interaction in particular entails a negative and significant estimated effect of CAFTA-DR, which is hard to rationalize.

Following the recommendations in Yotov et al. (2016) and Santos Silva and Tenreyro (2022), all estimations were performed using the Poisson pseudo-maximum likelihood (PPML) method, which allows us to estimate the gravity model in its multiplicative form and to include zero trade observations. In addition, PPML is also preferred to OLS when the natural logarithm of trade is used as dependent variable, since the former estimator is more robust to the heteroskedasticity of data often found in trade observations (Santos Silva and Tenreyro 2006).

Since our main objective is to determine the effects of CAFTA-DR, we take into account the possible endogeneity present in the formation of an FTA. In the context of the gravity model of trade, this endogeneity problem could be solved by including country-pair (symmetric) fixed effects,[10] which capture any time-invariant country-pair-specific characteristics in the sample (Baier and Bergstrand 2007). One of the drawbacks of including these fixed effects is that traditional gravity variables, such as bilateral distance and common language, must be omitted from the regression, as these time invariant variables would be collinear with the country-pair fixed

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[10] An alternative to the usage of fixed effects, which also eliminates the endogeneity issue, is to estimate the model in first differences (Baier and Bergstrand 2007).

effects. Given the high number of fixed effects that must be included in the model estimation, the computational feasibility of estimating the gravity model could be limited.[11] To overcome this technical issue without omitting any fixed effects or reducing the amount of observations, PPML estimations were performed using the algorithms developed in Bergé (2018) for efficient estimation of maximum likelihood models with high-dimensional fixed effects.

Our first model specification deals with the average CAFTA-DR effect on members' bilateral trade, accounting for the effects of any other FTA apart from CAFTA-DR and for bilateral membership in the WTO. We also consider the possibility of some overlapping effects between the CAFTA-DR and the CA-DR FTA by including a CA-DR dummy variable and omitting its effects from the FTA variable.[12] Since FTAs in general tend to phase in their concessions over time, we must consider these effects for both CAFTA-DR and CA-DR and any other FTA in the model. In their seminal article, Baier and Bergstrand (2007) account for the phasing in effects of FTAs by including 5- and 10-year lags of the FTA variable, arguing that FTAs tend to be phased in typically over 5 to 10 years. A similar approach is used in Baier et al. (2019), but they only include 5-year lags of their FTA variables. In Yotov et al. (2016), it is also recommended to account for these phasing-in effects. Since our sample only includes the first 12 years of CAFTA-DR, 2006–2018, and in order to obtain comparable effects for the other FTAs in our sample, we include a 5-year lag for the CAFTA-DR, CA-DR FTA, and the other FTA variables, as in Baier et al. (2019). Another reason to include only a 5-year lag for the CAFTA-DR variable is that a 10-year lag would account for the phasing-in effects of members which entered the agreement in 2006 and 2007, but leaving out Costa Rica. Thus, the 10-year lag would not represent the average phasing-in effect of the entire CAFTA-DR, but only a part of it. In all specifications, our 5-year lags are equal to one for all years from the fifth year of the entry into force of CAFTA-DR, CA-DR FTA, and other FTAs onwards. The expectation is that the CAFTA-DR, CA-DR FTA, and FTA lag variables will have a positive coefficient because the trade-enhancing effects will be stronger after the initial phasing-in period: In the first 5 years of CAFTA-DR, the initial phasing-in effects are captured by CAFTA-DR, and then the total effect of CAFTA-DR is measured by CAFTA-DR plus the CAFTA-DR lag effect. Additionally, our model also accounts for the effects of bilateral WTO membership as it has been found that WTO membership tends to increase international trade between members (Larch et al. 2019). Thus, the basic gravity equation used to measure CAFTA-DR's effect on bilateral trade is:

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[11] Given our sample, in total, 209×24 exporter-year FE, 209×24 importer-year FE, and, by combination of exporter-importer, 21,736 symmetric country-pair FE must be included: more than 31,000 fixed effects.

[12] As discussed previously, the CAFTA-DR allows members, but not the USA as exclusive CAFTA-DR member, to choose between their individual CA-DR FTA, CACM, and CAFTA-DR concessions when trading with another member. Therefore, the CAFTA-DR operates at the same time as the CA-DR FTA and CACM. We cannot directly estimate the effects of the CACM with our data, as the variable used to measure the effects of the CACM would be constant and, thus, collinear with the pair fixed effects. However, its effects on bilateral trade are controlled for by the country-pair fixed effects.

$$X_{ij,t} = exp\left[\begin{array}{c} \pi_{i,t} + \chi_{j,t} + \mu_{ij} + \beta_1 FTA_{ij,t} + \beta_2 FTA_{ij,t-5} + \beta_3 WTO_{ij,t} + \beta_4 \text{CA-DR}_{ij,t} + \beta_5 \text{CA-DR}_{ij,t-5} \\ +\beta_6 \text{CAFTA-DR}_{ij,t} + \beta_7 \text{CAFTA-DR}_{ij,t-5} \end{array}\right] \times \varepsilon_{ij,t}. \quad (4)$$

In Eq. (4), $X_{ij,t}$ is the value of the trade flow from exporter i to importer j during year t. $\pi_{i,t}$ and $\chi_{j,t}$ are exporter- and importer-time fixed effects, respectively. These two FE capture the effect of the outward and the inward multilateral resistance term, but also the effect of income, expenditure, and total income from (1). μ_{ij} is a country-pair fixed effect that captures any bilateral characteristics, observable or not, affecting bilateral trade between i and j. FTA $_{ij,t}$ is a dummy variable equal to one if i and j were in the same FTA and this was different from CA-DR and CAFTA-DR $_{ij,t}$ during the year t, and zero otherwise. WTO $_{ij,t}$ is a dummy variable accounting for the bilateral membership in the WTO effect, being equal to one if both i and j (with $i \neq j$ to exclude intranational trade flows) were members of the WTO during period t, and zero otherwise. CA-DR $_{ij,t}$ is a dummy variable equal to one if i or j is a Central American member of CA-DR FTA[13] and j or i is the Dominican Republic, which excludes bilateral trade between Central American members, and zero otherwise. CAFTA-DR $_{ij,t}$ is a dummy equal to one if i and j are members of the CAFTA-DR agreement during the year t, and zero otherwise. $\varepsilon_{ij,t}$ is assumed to be the multiplicative error term of the PPML estimator. In extensions of Eq. (4), we also include an international border dummy IB $_{ij}$, which takes value one in case of an international trade flow ($i \neq j$), or the natural logarithm of the population-weighted geographical distance variable Dist $_{ij}$ and interact the respective variable with the different year dummies to account for the decrease in trade costs and, in particular transport, costs, over time.

The coefficient of the CAFTA-DR$_{ij,t}$, CA-DR$_{ij,t}$, and FTA $_{ij,t}$ variables can be interpreted as their average partial equilibrium effect on bilateral trade flows or as their average treatment effect on bilateral trade costs (Baier et al. 2019). The inclusion of the FTA $_{ij,t}$ variable allows us to compare its effects on bilateral trade with those from CAFTA-DR or the CA-DR. We perform this comparison expressing the effects as the percentage change in bilateral trade by $\left(e^\beta - 1\right) \times 100$[14]. Additionally, to summarize the effect of CAFTA-DR, CA-DR FTA, and other FTAs, we construct their total effect on bilateral trade by adding their contemporaneous and phased in effects,[15] $\beta_6 + \beta_7$ for CAFTA-DR, $\beta_4 + \beta_5$ for CA-DR, and $\beta_1 + \beta_2$ for other FTAs, similarly as in Baier et al. (2019).

The effects of a given FTA on the trade of its own members could be different among them. These differences could arise not only between members, but also in the trade flows of the members: An FTA could affect member's exports differently

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[13] This includes Costa Rica, El Salvador, Honduras, Guatemala, and Nicaragua.

[14] The same interpretation holds for other dummy variables used in the PPML estimation of gravity models.

[15] The standard error corresponding to the sum of the coefficients was calculated as $\sigma_{1,2} = (\sigma_1^2 + \sigma_2^2 + 2Cov_{1,2})^{0.5}$, where $\sigma_{1,2}$ is the standard error of the sum of coefficients 1 and 2, σ_1^2 is the variance of coefficient 1, σ_2^2 is the variance of coefficient 2, and $Cov_{1,2}$ is the covariance of coefficients 1 and 2 (Wooldridge 1999, p. 683). The same procedure was used when calculating the other total effects for the FTA and CA-DR variables, the total average effect of CAFTA-DR on each member in (5), and the total directional effects in (6).

from the same member's imports. To account for this possibility, our second specification allows us to identify CAFTA-DR's heterogeneous effects on each member state's trade flow. Taking the same basic form of (4), our second specification is formulated as:

$$X_{ij,t} = \exp\left[\begin{array}{l} \pi_{i,t} + \chi_{j,t} + \mu_{ij} + \beta_1 FTA_{ij,t} + \beta_2 FTA_{ij,t-5} + \beta_3 WTO_{ij,t} + \beta_4 \text{CA-DR}_{ij,t} + \beta_5 \text{CA-DR}_{ij,t-5} \\ + \sum_k \sum_f \beta_{6,k:f} \text{CAFTA-DR}_{ij,t} + \sum_k \sum_f \beta_{7,k:f} \text{CAFTA-DR}_{ij,t-5} \end{array} \right] \times \varepsilon_{ij,t}. \quad (5)$$

Equation (5) includes the sub-index k, which represents all members of CAFTA-DR, and the sub-index f, which indicates the trade flow inside the CAFTA-DR by member. This equation includes a set of dummy variables for all seven CAFTA-DR members k equal to one if k is exporting to or importing from another CAFTA-DR member during the period t, and zero otherwise. As in (4), a set of 5-year lags for CAFTA-DR's effects for each member is included. The sum of coefficients $\beta_{6,k:f}$ and $\beta_{7,k:f}$ in (5) represents the total average effect of CAFTA-DR on each member's trade. Due to problems with perfect collinearity, the effects of CAFTA-DR on each member trade flow f must be estimated separately. This implies the estimation of two regressions, one for f equal to exporter and the other for f equal to importer.

Our third specification is used to measure deeper heterogeneous effects of CAFTA-DR: for each member pair by trade direction. Our specification is based on the approach introduced in Zylkin (2016) and expanded in Baier et al. (2019) and allows us to identify 42 different directional effects of CAFTA-DR on its members.[16] Our third specification takes the following form:

$$X_{ij,t} = \exp\left[\begin{array}{l} \pi_{i,t} + \chi_{j,t} + \overrightarrow{\mu_{ij}} + \beta_1 FTA_{ij,t} + \beta_2 FTA_{ij,t-5} + \beta_3 WTO_{ij,t} + \beta_4 \text{CA-DR}_{ij,t} + \beta_5 \text{CA-DR}_{ij,t-5} \\ + \sum_x \sum_m \beta_{6,x:m} \text{CAFTA-DR}_{ij,t} + \sum_x \sum_m \beta_{7,x:m} \text{CAFTA-DR}_{ij,t-5} \end{array} \right] \times \varepsilon_{ij,t}. \quad (6)$$

Equation (6) includes the sub-indices x and m, which indicate all the exporter and importer members of the CAFTA-DR, respectively. The pairs ij and ji are treated as different ones ($ij \neq ji$)[17] to allow the identification of all the directional member-pair effects of CAFTA-DR. Since the separate estimation of these directional effects implies that the CAFTA-DR does not affect each member equally, the symmetric country-pair fixed effects μ_{ij} need to be replaced by asymmetric ones (Zylkin 2016; Baier et al. 2019). The vector $\overrightarrow{\mu_{ij}}$ in (6) represents those asymmetric fixed effects for all country pairs in our sample. As in the previous equations, the total directional effect of the CAFTA-DR is defined as the sum of $\beta_{6,x:m} + \beta_{7,x:m}$. With (6), it is possible to measure a deeper level of heterogeneity from CAFTA-DR's effects on members, allowing us to identify the CAFTA-DR's specific effect not only by member pair, but also depending on the trade directions of each pair.

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[16] Since CAFTA-DR has seven members and two trade directions, exports and imports, by permutation, in the agreement, there exist $7 \times 6 = 42$ country-pair trade directions.

[17] The directional effect of, for example, the exports of the Dominican Republic to the USA is different from the one of the imports of the Dominican Republic from the USA.

4.2 General equilibrium model

In the previous section, we presented the specifications used in Eqs. (4) to (6) to measure the partial equilibrium (direct) effect of CAFTA-DR. In this section, we present the approach used to measure theoretically consistent general equilibrium effects of CAFTA-DR. To perform this analysis, we rely on the general procedure developed in Yotov et al. (2016) to estimate the general equilibrium effects of gravity models of trade using the PPML estimator.[18]

The procedure for the estimation of general equilibrium effects developed in Yotov et al. (2016) consists of estimating a baseline gravity equation and recovering the matrix of baseline trade costs from it. Then, a counterfactual scenario is established, in which a shock is introduced to the matrix of baseline trade costs. With this new matrix of counterfactual trade costs, we estimate the effects of the initial shock on bilateral trade through the change in the multilateral resistance terms, while income and expenditure are held constant. Assuming that each country in the sample is endowed with a fixed amount of produced goods, the effects on income, expenses, and prices are then calculated, and the process is repeated until the variation of prices stops. Lastly, the general equilibrium effects are computed as the percentage of change with respect to the baseline scenario.

As this procedure requires selecting a reference country, given that some of the calculated variables are subject to normalization (Yotov et al. 2016), we designate Germany, a major exporting nation, as the reference. A reason to select this country is that the CAFTA-DR is unlikely to have significantly affected Germany's international trade dynamics, and therefore the normalization of the variables would be less affected by the effects of CAFTA-DR. In addition, we need to assume a value for the trade elasticity of substitution, σ, since we have not explicitly estimated it. It is needed for the construction of the multilateral resistance terms and other variables of the structural gravity model of trade (Yotov et al. 2016). For our counterfactual exercise, we borrow $\sigma = 4.46$ from the upper range estimated in Simonovska and Waugh (2014). The work of Simonovska and Waugh (2014) provides evidence of an upward bias in the estimation of the trade elasticity of substitution commonly found in the literature. Using a simulated method of moment estimator, and through several estimation exercises, these authors obtain estimates of the trade elasticity of substitution ranging between 2.79 and 4.46. We have chosen the upper estimate of 4.46 to avoid overestimating our counterfactual effects, since the lower the trade elasticity of substitution, the larger the corresponding estimated welfare changes will be.

The baseline equation used to measure the initial partial equilibrium effects of the agreement is (6). From this equation, only coefficients that were statistically significant at the 5% level are used in the construction of the matrix of baseline trade costs. This matrix of costs is defined as:

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[18] The authors like Zylkin (2016), Baier et al. (2019), and El Dahrawy Sánchez-Albornoz and Timini (2021), among others, also have estimated the general equilibrium effects of FTAs within the structural gravity model of trade framework.

$$\left[\hat{\tau}_{ij,t}^{1-\sigma}\right]^{BLN} = exp\left[\begin{array}{l}\hat{\bar{\mu}}_{ij} + \hat{\beta}_1 FTA_{ij,t} + \hat{\beta}_2 FTA_{ij,t-5} + \hat{\beta}_3 WTO_{ij,t} + \hat{\beta}_4 \text{CA-DR}_{ij,t} + \hat{\beta}_5 \text{CA-DR}_{ij,t-5}\\ +\sum_x \sum_m \hat{\beta}_{6,x:m}\text{CAFTA-DR}_{ij,t} + \sum_x \sum_m \hat{\beta}_{7,x:m}\text{CAFTA-DR}_{ij,t-5}\end{array}\right].$$

(7)

Due to country-pair observations equal to zero during the entire sample period, some observations of the matrix of baseline trade costs are missing, leading to an incomplete matrix of costs. To fill in these missing observations, we regress the country-pair fixed effects from (6) on some traditional time-invariant gravity variables and use the estimation results to replace any missing value in the matrix of bilateral trade costs, as suggested in Yotov et al. (2016). This auxiliary regression includes as independent variables the natural logarithm of bilateral distance, $lnDist_{ij}$, country contiguity, $CNTG_{ij}$, common language, $ComLang_{ij}$, common colonizer, $ComCol_{ij}$, common legal origin, $ComLeg_{ij}$, international borders, IB_{ij}, and exporter and importer fixed effects.[19] The auxiliary regression used for the estimation of the missing trade costs takes the following form:

$$exp\left[\hat{\bar{\mu}}_{ij}\right] = exp\left[\pi_i + \chi_j + \beta_1 lnDist_{ij} + \beta_2 CNTG_{ij} + \beta_3 ComLang_{ij} + \beta_4 ComCol_{ij} + ComLeg_{ij} + IB_{ij}\right] \times \varepsilon_{ij}.$$

(8)

In addition, any missing intranational trade observations, $X_{ii,t}$, are replaced with its predicted values from (6), which is a possible approach suggested in Fally (2015) to fill in such missing observations.

The counterfactual scenario analyzed is the elimination of the CAFTA-DR for the year 2018. The year 2018 was selected because, as the last year in our sample, it provides a broad and more representative point of comparison, as it would capture the latest effects of the CAFTA-DR on members' bilateral trade. The assumption of the elimination of the agreement in 2018 would allow us to compare this counterfactual scenario with what was observed in 2018, when CAFTA-DR remained in force. Thus, the difference observed between the two scenarios can be understood as the impact of CAFTA-DR on member and non-member countries. Therefore, the effects of CAFTA-DR's coefficients are omitted in the construction of the matrix of counterfactual trade costs:

$$\left[\hat{\tau}_{ij,t}^{1-\sigma}\right]^{CFL} = exp\left[\hat{\bar{\mu}}_{ij} + \hat{\beta}_1 FTA_{ij,t} + \hat{\beta}_2 FTA_{ij,t-5} + \hat{\beta}_3 WTO_{ij,t} + \hat{\beta}_4 \text{CA-DR}_{ij,t} + \hat{\beta}_5 \text{CA-DR}_{ij,t-5}\right].$$

(9)

The general equilibrium effects derived from this initial shock on the matrix of counterfactual trade costs are estimated via the iterative procedure developed in Yotov et al. (2016), which assumes that the quantities produced in each country are constant. The estimated general equilibrium effects of CAFTA-DR's counterfactual elimination are the changes of total exports and imports and welfare level, and also of the inward multilateral resistance terms and of factory-gate prices.

Total exports and imports are defined as $X_i^T = \sum_i X_{ij}$ and $M_i^T = \sum_j X_{ij}$, respectively, and both omit intranational trade $X_{ij=i}$. The effects on welfare levels are measured through the change in the terms of trade (ToT_i), defined as the ratio between the factory-gate prices in country i and its inward multilateral resistance term, $ToT_i = \frac{\hat{p}_i}{\hat{P}_i}$, where $\hat{p}_i = \widehat{p_i Q_i}$ could

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[19] Results of this auxiliary regression can be found in Appendix Table 10.

be interpreted as the change in nominal income in i and $\hat{p}_i$ could be interpreted as the change in consumer prices in i (Yotov et al. 2016, p. 87). Factory-gate prices are defined as $p_i = \frac{1}{\alpha_i \Pi_i} \left(\frac{Y_i}{Y} \right)^{\frac{1}{1-\sigma}}$, with α_i being a preference parameter (Yotov et al. 2016, p. 89).

The general equilibrium effects are presented as percentage change with respect to the counterfactual scenario. This formulation of the indices allows us to interpret them as the effects of CAFTA-DR on the variables of interest during the base year 2018. With I being the index of interest, *BLN* the baseline scenario, and *CFL* the counterfactual scenario, the general equilibrium effects are defined as:

$$\Delta \% \hat{I}_{i,t} = \left(\frac{\hat{I}_{i,t}^{BLN}}{\hat{I}_{i,t}^{CFL}} - 1 \right) \times 100. \tag{10}$$

5 Empirical results

In this section, we present the empirical results from the models specified above to measure the different effects of CAFTA-DR. First, the results of the partial equilibrium models are presented, and then the general equilibrium effects on the member states.

5.1 Estimated average CA-DR and CAFTA-DR effects

For the reasons discussed in Section 3 about the intranational trade flow proxy values, we start by comparing the impact of our three intranational trade proxies on our regressions. The results of our main specification (Eq. (4)) are presented in columns 1 to 3 of Table 2. Column 1 uses data from FAO and UNIDO to calculate intranational trade flows, whereas in column 2, intranational trade flows are directly taken from the revised ITPD-E database in its July 2022 version. In column 3, intra-national trade flows are approximated by a country's GDP minus the sum of its exports. All international trade observations are taken from the ITPD-E ver. 2.

According to our estimations, columns 1 to 3 of Table 2, the different intra-national trade proxies generate some degree of variation in the estimated coefficients. Given that all our estimations share the same international trade flow values, the only explanation for this variation is the difference in intranational trade flows. In general, the lagged FTA effects are positive and significant in the three columns, but of different magnitude. These positive effects are in line with the literature, although showing a smaller FTA effect on bilateral trade when comparing it with the seminal work of Baier and Bergstrand (2007) and the meta-analysis of Head and Mayer (2014): Our total FTA effect in column 1 of Table 2 is associated with $\left(e^{0.262} - 1 \right) \times 100 \approx 30\%$ more trade between members, whereas Baier and Bergstrand (2007) provide an estimate of $\left(e^{0.76} - 1 \right) \times 100 \approx 113.8\%$ more bilateral trade and the meta-analysis in Head and Mayer (2014) reports an average coefficient of 0.36, which is equivalent to an increase in bilateral trade of around

Table 2 Estimated effects of CA-DR and CAFTA-DR

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FTA	0.054*	0.201***	0.041	0.055*	0.015	−0.023	−0.042	−0.023	−0.001
	(0.030)	(0.054)	(0.034)	(0.030)	(0.029)	(0.031)	(0.037)	(0.031)	(0.031)
FTA $_{t-5}$	0.208***	0.131***	0.157***	0.209***	0.003	0.154***	0.165***	0.154***	0.084***
	(0.046)	(0.036)	(0.042)	(0.046)	(0.036)	(0.038)	(0.045)	(0.038)	(0.031)
FTA $_{t-10}$									0.132***
									(0.021)
WTO	0.197***	0.041	0.351***	0.197***	−0.010	0.064*	0.066	0.064*	0.069*
	(0.034)	(0.053)	(0.042)	(0.034)	(0.037)	(0.037)	(0.041)	(0.037)	(0.037)
CA-DR	0.667***	0.741***	0.576***	0.589***	0.694***	0.620***	0.469***	0.616***	0.634***
	(0.113)	(0.159)	(0.094)	(0.168)	(0.126)	(0.113)	(0.149)	(0.113)	(0.113)
CA-DR $_{t-5}$	0.202	0.155	0.339*	0.228	0.191	0.185	0.256*	0.187	0.256
	(0.192)	(0.166)	(0.178)	(0.243)	(0.185)	(0.188)	(0.150)	(0.187)	(0.183)
CA-DR $_{t-10}$									−0.132
									(0.093)
CAFTA-DR	−0.011	−0.054	0.030	−0.008	−0.133*	−0.066	−0.041	−0.077	−0.064
	(0.064)	(0.079)	(0.111)	(0.066)	(0.071)	(0.072)	(0.073)	(0.080)	(0.072)
CAFTA-DR $_{t-5}$	−0.011	−0.077	−0.166	−0.007	−0.084	−0.035	−0.031	−0.018	−0.036
	(0.078)	(0.075)	(0.113)	(0.084)	(0.075)	(0.077)	(0.090)	(0.071)	(0.081)
CAFTA-DR $_{t-10}$									−0.002
									(0.093)
CAFTA-DR $_{t+5}$								0.022	
								(0.063)	

Table 2 (continued)

Total effect									
FTA	0.262***	0.333***	0.198***	0.264***	0.018	0.131***	0.123*	0.131***	0.215***
	(0.051)	(0.070)	(0.047)	(0.051)	(0.047)	(0.045)	(0.050)	(0.045)	(0.053)
CA-DR	0.869***	0.896***	0.915***	0.817***	0.885***	1.214***	0.938***	1.231***	0.758***
	(0.220)	(0.259)	(0.197)	(0.263)	(0.224)	(0.225)	(0.297)	(0.227)	(0.227)
CAFTA-DR	−0.021	−0.131	−0.136*	−0.015	−0.218*	−0.100	−0.072	−0.094	−0.102
	(0.103)	(0.094)	(0.076)	(0.109)	(0.111)	(0.114)	(0.120)	(0.111)	(0.133)
Fixed effects									
Exp/Imp-year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IB×year	No	No	No	No	Yes	No	No	No	No
Ln(Dist)×year	No	No	No	No	No	Yes	Yes	Yes	Yes
# of observations	940,211	937,077	941,291	717,243	940,211	938,235	298,857	938,235	928,623
R^2	0.9995	0.9965	0.9997	0.9995	0.9995	0.9995	0.9995	0.9995	0.9996
Wald test, p value	$2.8e-17$	$3.5e-8$	$8.7e-25$	$6.5e-12$	$8.3e-191$	$1.5e-159$	$3.7e-21$	$1.3e-158$	$3.5e-157$

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: all estimates obtained using the PPML method. *Note 3*: coefficient estimates for fixed effects and international border and distance effects interacted with year dummies omitted for brevity. *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed missing. *Note 5*: a complete version of the table without the fixed effect coefficients is provided in Appendix Table 7

$\left(e^{0.36} - 1\right) \times 100 \approx 43.3\%$. Likewise, the effects from CA-DR FTA are positive and significant in columns 1 to 3, resembling the findings of El Dahrawy Sánchez-Albornoz and Timini (2021). For the case of the WTO membership, its effects on bilateral trade are positive and significant only in columns 1 and 3, but not in column 2 where intranational trade flows from ITPD-E are used. On the other hand, the CAFTA-DR effects are always negative and statistically insignificant at conventional levels. These results for CAFTA-DR are, in general, surprising, not only because of their apparent null impact on members' bilateral trade, but also because they appear to be negative. Therefore, these results deserve a more careful discussion.

As discussed in Section 2, Central American members and the Dominican Republic already received some degree of preferential unilateral treatment when exporting to the USA (the US GSP, the Caribbean Basin Initiative, etc.). Thus, one would expect a limited or small, but positive, effect on their exports to the USA after CAFTA-DR. Likewise, it was expected that US exports would gain some additional trade access to the CAFTA-DR area thanks to the agreement (a positive and significant effect from the CAFTA-DR on US exports). However, our estimations show that the effects of the CAFTA-DR are rather null (negative, but not different from zero) in columns 1 and 2 or negative and significant if we take into account the total CAFTA-DR effects in column 3 (intranational trade flows calculated as GDP minus exports). Our average effects for the CAFTA-DR also differ from those found by El Dahrawy Sánchez-Albornoz and Timini (2021) and Nguyen (2019). Both articles found null effects coming from the agreement. The former estimated an effect equal to $\left(e^{0.110} - 1\right) \times 100 \approx 11.6\%$ more trade, and the latter an effect of $\left(e^{0.130} - 1\right) \times 100 \approx 13.9\%$ more trade in one of their main regressions (Table 3, column (3)). In our case, the total average effect of CAFTA-DR estimated is $\left(e^{-0.021} - 1\right) \times 100 \approx -2.1\%$ less trade in column 1 of Table 2. But like El Dahrawy Sánchez-Albornoz and Timini (2021) and Nguyen (2019), our estimates are also not significant in columns 1 and 2, i.e., when we use FAO-UNIDO or ITPD-E data for intranational trade flows. It is, however, hard to argue that CAFTA-DR has diverted trade among members rather than created it. If we analyze more in depth the trade share of CAFTA-DR members to the USA, we observe, in Fig. 7,[20] that the importance of the USA as the main export destination has been decreasing since the beginning of the 2000s except for Nicaragua. The same can be said for the role of the USA as the main source of imports for the CAFTA-DR members (Fig. 8): the US import share has also been decreasing, on average, during the whole period analyzed. It would be reasonable to assume, as a possible explanation for our results, the existence of a common exogenous trend among CAFTA-DR members to diversify trade from the USA to the rest of the world. This would explain their shift away from the USA as their main export destination and import source. This trend seems to have set in slightly before CAFTA-DR. This in turn would cause our CAFTA-DR variables to capture part of its effects and affect our estimates. An alternative explanation for the null effects of the CAFTA-DR would be that its average effects among members hide significantly diverse effects. Thus, since the coefficients of the

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[20] See Fig. 12 for the nominal values in US $ of Figs. 7 and 8.

model from Eq. (4) represent the average effect of the agreement, the effect measured by our variable results in a null statistical effect. As will be shown later when estimating Eqs. (5) and (6), CAFTA-DR does exhibit important degrees of heterogeneity that one must consider.

We now continue exploring the CAFTA-DR effects using the results of the intranational trade flows from FAO/UNIDO, whose results are shown in column 1 of Table 2, our preferred benchmark estimation, for two main reasons: (1) in column 2 (based on ITPD-E intranational trade flows), the observations for intranational trade flows appear to be inconsistent after 2015, as one can see in Fig. 5, which is likely affecting the coefficient estimates; and, (2) the intranational trade flows in column 3 (intranational trade flows calculated as GDP minus exports), though more consistent than those in column 2, are built based on the difference between nominal GDP, a value-added measure, and total exports of each country, a gross value measure, which likely leads to bias in the estimation.[21] Furthermore, given that the GDP also includes the service value-added, the intranational trade flows based on this approximation could be upward biased (compare Fig. 5). Therefore, for the coming robustness tests on the CAFTA-DR effects and the estimation of the other model specifications (Eqs. (5) and (6)), we rely on the intranational trade flows based on the FAO and UNIDO datasets that we used for column 1 of Table 2.

Our first robustness test is to check if the lack of an "anchor" intranational trade flow has any effect on the estimation. This means that we only consider in the estimation those exporters and importers that, for each particular year, have a positive observation for the intranational trade flow. If a country does not have a positive intranational observation, we drop all its international trade observations for the same year. This significantly reduces the number of observations. As can be seen in column 4 of Table 2, however, the removal of more than 200,000 observations does not really change the estimation results compared to column 1. In particular, the CAFTA-DR effects remain statistically insignificant.

Another robustness test, reported in column 5, controls for any kind of common trend in the data, for example, due to a decrease in transportation costs over time. Following Bergstrand et al. (2015), this can be done by three alternative methods: (1) interacting a set of year dummies with a dummy variable representing international trade; (2) interacting a set of year dummies with the logarithm of bilateral distance; and (3) interacting each pair fixed effect with a time trend. For technical feasibility reasons, we only consider the first two methods.[22] As including all year dummies in the model would generate a problem of collinearity, we have selected 2004 as the reference year: The coefficients of the yearly international border and yearly distance effects should be interpreted as deviations from this reference year. Column 5 of Table 2 shows the results from interacting year dummies with an indicator variable for international trade. The results from this estimation are strange: FTA

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[21] In a recent paper, Campos et al. (2021) show that the GDP minus total exports could be a valid proxy for the estimation of the partial effects of gravity models, as their results tend to approximate the ones of estimations that used gross output minus total export. However, they also show that using GDP minus total exports yields different results when calculating the general equilibrium effects of a gravity model.

[22] The third method would imply too many pair and pair-trend fixed effects to keep the estimation feasible.

Table 3 Estimated effect of the CAFTA-DR on members by trade flow type

Dependent variable	Trade flow							
Model	Exports		Imports		Exports		Imports	
	(1)		(2)		(3)		(4)	
	β	s.e	β	s.e	β	s.e	β	s.e
Total effects by member								
CAFTA-DR: CRI	−0.678***	(0.249)	0.236	(0.290)	−0.229	(0.326)	−0.421	(0.309)
CAFTA-DR: HND	0.235	(0.228)	−0.143	(0.229)	−0.100	(0.251)	0.356*	(0.206)
CAFTA-DR: SLV	0.747***	(0.199)	−0.348*	(0.197)	0.077	(0.141)	0.345**	(0.163)
CAFTA-DR: GTM	0.243	(0.207)	−0.152	(0.197)	−0.217*	(0.118)	0.324*	(0.127)
CAFTA-DR: NIC	0.797**	(0.342)	−0.088	(0.286)	0.606*	(0.327)	0.592*	(0.304)
CAFTA-DR: DOM	−0.403**	(0.194)	−0.346*	(0.155)	−1.110***	(0.168)	−0.141	(0.120)
CAFTA-DR: USA	−0.093	(0.113)	−0.089	(0.166)	0.088	(0.130)	−0.304**	(0.137)
Regular coefficients								
FTA	−0.023	(0.031)	−0.023	(0.031)	−0.024	(0.032)	−0.024	(0.032)
FTA$_{t-5}$	0.154***	(0.038)	0.154***	(0.038)	0.150***	(0.038)	0.150***	(0.038)
WTO	0.064*	(0.037)	0.064*	(0.037)	0.064*	(0.037)	0.064*	(0.037)
CA-DR	0.649***	(0.120)	0.597***	(0.115)	0.709***	(0.120)	0.711***	(0.122)
CA-DR$_{t-5}$	0.233	(0.171)	0.274	(0.209)	0.350*	(0.180)	0.032	(0.144)
Fixed effects								
Country pair	Yes		Yes		No		No	
Exp/Imp-year	Yes		Yes		Yes		Yes	
Ln(Dist)×year	Yes		Yes		Yes		Yes	
Country pair Asym	No		No		Yes		Yes	
# of observations	938,235		938,235		895,470		895,470	
R^2	0.9995		0.9995		0.9997		0.9997	
Wald test (*p* value)	1.7e−166		7.1e−166		5.98e−170		9.4e−167	

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: all estimates obtained using the PPML method. *Note 3*: only FTA-related coefficients reported for brevity. *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed missing. *Note 5*: a more detailed version of the table, without the fixed effect estimates, is provided in Appendix Table 8

and WTO membership have a null effect on bilateral trade, whereas the CAFTA-DR effects are still negative, but their negative coefficients are bigger in absolute value and the total CAFTA-DR effect is negative and significant at the 10% level. The only variable that maintains its significance and positive effect is the CA-DR agreement.
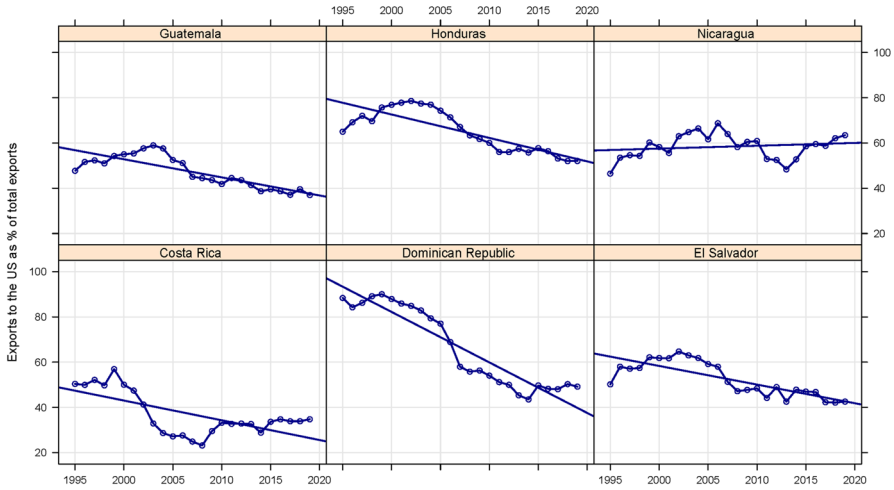
Fig. 7 Export shares to the USA by year. Source: own elaboration with information from the ITPD-E ver. 2 (2022, July). Note: solid dotted line represents observed values and solid line represents a simple OLS time trend
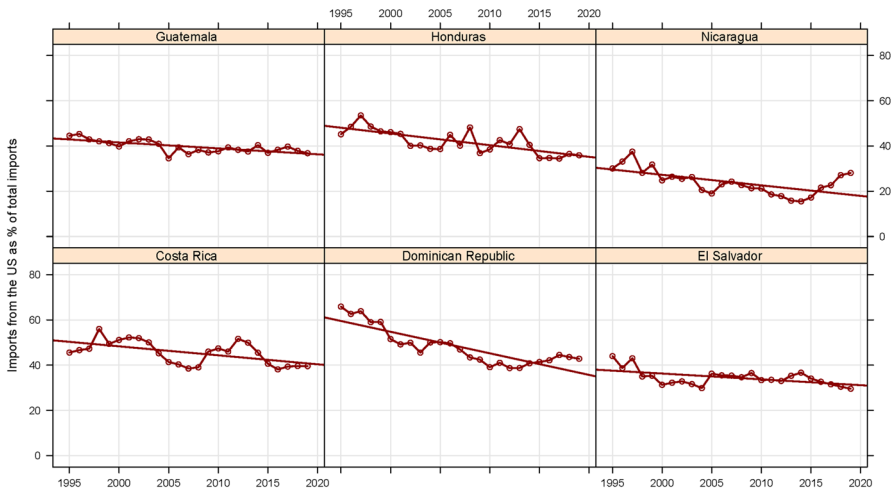
Fig. 8 Import shares from the USA by year. Source: own elaboration with information from the ITPD-E ver. 2 (2022, July). Note: solid dotted line represents observed values and solid line represents a simple OLS time trend

The results in column 5 of Table 2 not only are strange, but would also imply that neither other FTAs nor WTO membership has any effect on bilateral trade. This puts a question mark on the year dummies approach, as these variables could be controlling for something more than a negative trade cost trend in the data.

We proceed with the second alternative to control for a decreasing trade cost trend by estimating Eq. (4) with a set of year dummies interacted with the logarithm

of bilateral distance (international and intranational). A major difference to the first alternative is that intranational trade flows are also subject to a trade cost trend over time, since the intranational distance is typically not zero. Moreover, trade cost decreases are allowed to matter more for countries that are further apart geographically. The results of this estimation are presented in column 6 of Table 2 and yield more reasonable results. Now, the FTA variable shows a smaller but significant and positive coefficient, increasing bilateral trade by $\left(e^{0.131} - 1\right) \times 100 \approx 14\%$ (total effect). The WTO effect, on the other hand, strongly decreases, and it is now only significant at the 10% level. However, this is still a more consistent effect than the one found in column 5. The CAFTA-DR coefficients are still statistically insignificant. The effects of the CA-DR FTA are surprisingly more robust than of the other variables, even increasing slightly and maintaining statistical significance. When comparing the time effects captured by the two methods, we see in Figs. 9 and 10 that both have a similar trend over time: Trade costs indeed seem to decrease over time. The main difference between the two figures is the magnitude of the variables used to measure the trend, but their evolution over time is practically the same. Given the more consistent results found when including the year dummies interacted with the bilateral distance, we keep them for the next robustness tests of Eq. (4) and also include them when estimating Eqs. (5) and (6), in order to control for the common time trend in the trade data and in intra-CAFTA-DR trade in particular.

In column 7 of Table 2, we estimate the model using 3-year intervals to ensure that we allow trade flows to react to changes in trade policies (Yotov et al. 2016). The results of this estimation are consistent with the estimation in column 6 of Table 2. Some coefficients show small variations, but the estimates remain close to the results in column 6 and maintain their statistical significance, except for the WTO variable which becomes insignificant. Our estimates of the effect of CAFTA-DR remain statistically insignificant and with little change compared to column 6 where all years were included.

We also test the strict exogeneity of the variables used to measure the CAFTA-DR effects. A 5-year lead for CAFTA-DR is included in the model to measure the future effect of this agreement on bilateral trade. In the absence of reverse causality, this lead must be statistically insignificant (Yotov et al. 2016). As is shown in column 8 of Table 2, the coefficient on this lead variable is indeed statistically insignificant at the 10% level, and the other coefficients remain statistically significant and with practically no change. In light of these results, it is reasonable to assume that the dummy variables used to measure the effects of CAFTA-DR are strictly exogenous, and that there are no signs of reverse causality in our model. Yet, the effects of the CAFTA-DR on bilateral trade remain statistically insignificant.

As a last robustness test for our benchmark specification, we decided to include a 10-year lag for all our free trade agreement variables. The reason for this is to also reflect any long-term phase-in effects from the agreements, which have been found in other research. The inclusion of the 10-year lag for the CAFTA-DR, CA-DR FTA, and other FTA variables improve the results and total effect for our FTA variable and, curiously, reduced the total effect from the CA-DR FTA. In the case of CAFTA-DR, the inclusion of the 10-year lag does not change the main effect of this agreement on bilateral trade: it remains statistically insignificant.
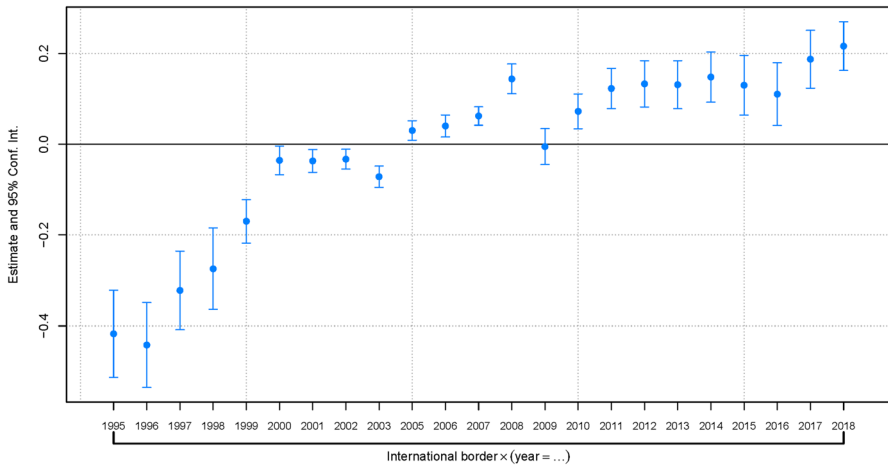
Fig. 9 International border effects with reference year 2004. Source: own estimations
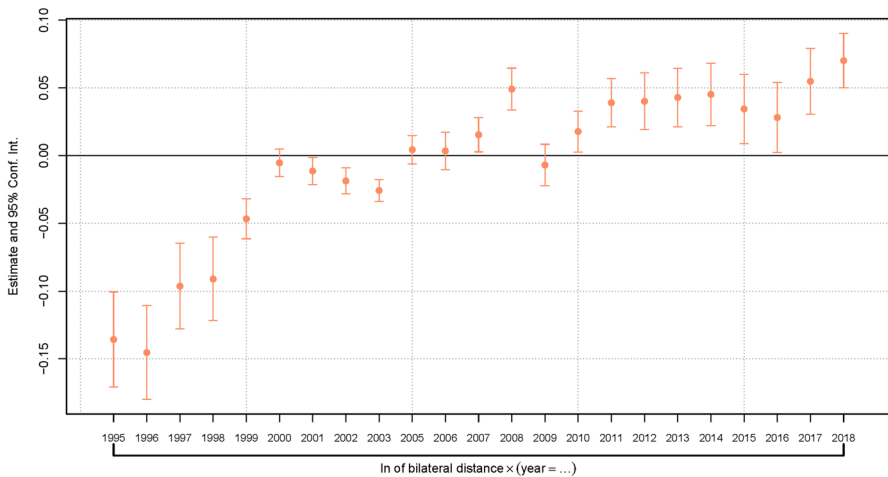
Fig. 10 Bilateral distance effects with reference year 2004. Source: own estimations

In sum, all our estimations and tests lead to the same conclusion. When considering its average (treatment) effect, there is no evidence that CAFTA-DR has a positive or negative effect on members' bilateral trade. However, we were able to find evidence in favor of the trade enhancing effects of other FTAs in general and of the CA-DR FTA in particular. In addition, we also find a trade-enhancing WTO effect, but it is only marginally significant (at the 10% level).

Even when controlling for a reduction of trade costs over time by introducing the geographical distance variable interacted with year dummies, the effects of the CAFTA-DR remain statistically insignificant. In an additional set of regressions, we explore whether any single member of CAFTA-DR is responsible for this null result. Table 12 shows

in columns 1 and 7 that excluding Costa Rica and the Dominican Republic from our sample, respectively, alters our estimates of the 5-year lag CAFTA-DR effect, especially when excluding the Dominican Republic. Figures 3 and 4 had already shown peculiarities in the trade data of these two countries. If we exclude both countries from the sample, the CAFTA-DR total effect is positive and statistically significant at the 5% level. As we will show later, the change in sign and significance of the coefficients is related to the negative effects of CAFTA-DR on Costa Rica and the Dominican Republic. We will now explore the possibility of heterogeneous effects from the agreement on members' trade flows by trade flow type (Eq. (5)) and trade direction (Eq. (6)).

5.2 Effects by member and trade flow type

In this part, we show the results from estimations of Eq. (5), which measures CAFTA-DR's effects on members' exports and imports. Results from this estimation are presented in Table 3, which only reports the total effects of CAFTA-DR by member and the regular coefficients of the FTA and WTO variables. Estimation result details can be found in Appendix Table 8.

In all estimations, i.e., columns 1 to 4 of Table 3, the effects of other FTAs and WTO membership are practically the same as estimated in Table 2. The estimates of the CA-DR FTA differ between columns, implicating some correlation between this previous agreement and the trade flows by member within CAFTA-DR, but remain positive and significant in all columns. This may indicate that the dummy variables introduced to measure the CAFTA-DR effect on trade flows are not affecting the estimation of the other variables' effects, except for the CA-DR variables. In consequence, our specification in (5) should be adequately measuring these effects.

Our estimates show that the effects of CAFTA-DR differ by member and trade flow type considered. Considering the total effect of CAFTA-DR on exports by member (column 1), only El Salvador and Nicaragua increase their exports to the other members, whereas Costa Rica and the Dominican Republic reduce their exports to all members. On the other hand, the estimates of import effects were mostly not different from zero for all members, with the estimates of El Salvador and the Dominican Republic being negative and significant at the 10% level. These early results can help us explain the null effects found by other authors and our own estimations in Table 2 for the CAFTA-DR effects. The individual country effects, mostly concentrated in a few members with the opposite sign of the effect, would be neutralizing the average effects of the agreement shown in Table 2, which would explain the null effects found for the agreement. These results provide some evidence of the heterogeneous effects that CAFTA-DR would have on its members.

Since we have already indirectly introduced some degree of asymmetry when measuring the particular effect of CAFTA-DR on each member in (5), we now re-estimate this model including asymmetric country-pair fixed effects (like in Eq. (6)). The estimation results are shown in columns 3 and 4 of Table 3, yielding some important differences compared to the first two estimations. Now the effects on exports are only significant for Guatemala (at the 10% level) and in particular the Dominican Republic, showing an important reduction of Dominican exports to the CAFTA-DR

area (about 67%), which appears to follow the evolution of the Dominican exports in Fig. 3. On the other hand, the effects on imports are now mostly positive and also significant. The results for the imports also show evidence of a general decrease in US imports from the CAFTA-DR area. This could be linked to the negative trend observed for CAFTA-DR member imports from the USA in Fig. 8.

The results from columns 3 and 4 of Table 3, which are more consistent with the data (see Figs. 1, 2, 7, and 8) and with our estimates presented below for Eq. (6), only arise after considering differentiated effects by member, trade flow, and asymmetric trade costs (asymmetric pair fixed effects). This draws attention to the importance of considering the presence of asymmetric factors in countries' trade relationships when analyzing them.

5.3 Effect by direction and country pair

The estimates of CAFTA-DR's directional effects, presented in Table 4, are divided into three categories: positive effects, for those directional country pair effects that increase bilateral trade; negative effects, for those that decrease bilateral trade; and insignificant or null effects, for those in which the estimated coefficients are not statistically significant at least at the 10% level. Our estimates provide evidence of the increase or decrease in trade between members as a function of pairs and the direction of trade. A more detailed graphical view of these directional effects, showing all coefficients and confidence bands, is shown in Fig. 11.

According to these results, CAFTA-DR increased exports of four out of seven members. These increases are concentrated on El Salvador, Honduras, Nicaragua, and the USA. It is important to note that only Nicaragua actually increased its exports to the USA during the time period. In the case of the USA, CAFTA-DR led to an increase in its exports to El Salvador, Honduras, Guatemala, and Nicaragua. The other CAFTA-DR members with positive export effect trade more with other Central American members or with the Dominican Republic.

Concerning CAFTA-DR's negative directional effects, these are concentrated on Guatemala and the Dominican Republic. Our estimations provide evidence of a reduction in Guatemalan exports to the USA and the Dominican Republic (and marginally to Costa Rica). Likewise, the Dominican Republic reduced its exports to Honduras, Costa Rica, and the USA. One explanation for part of the trade reduction of these countries is that they are diverting trade from the CAFTA-DR area to the rest of the world, as the export and import shares of these and other members show (Fig. 2). Similarly, another possible explanation is that their reduction is a consequence of being displaced by other members within the CAFTA-DR area.

Relating our estimates to the literature on the effects of CAFTA-DR, our results differ from some of the previously estimated effects on some members. Our results for Costa Rica do not support the findings of Koehler-Geib and Sanchez (2015) concerning its exports to and imports from the USA, as we could not find evidence of an increase in either. Contrary to the work of Sandoval et al. (2015), we do not find any significant effect indicating trade reductions in the case of El Salvador stemming from CAFTA-DR. In our case, CAFTA-DR is associated with an increase in

Table 4 Estimated directional effect of CAFTA-DR by country pair

Dependent variable			Trade flow		
Trade direction	β	s.e	Trade direction	β	s.e
Total effect by trade direction					
Positive effect ($p<0.1$)					
HND⇒NIC	1.068***	(0.277)	USA⇒NIC	0.464**	(0.193)
HND⇒SLV	0.777***	(0.240)	USA⇒SLV	0.440***	(0.141)
NIC⇒USA	0.615**	(0.274)	USA⇒HND	0.425**	(0.183)
SLV⇒NIC	0.602*	(0.235)	HND⇒GTM	0.416*	(0.225)
HND⇒DOM	0.530**	(0.251)	USA⇒GTM	0.376***	(0.116)
NIC⇒GTM	0.515*	(0.291)	SLV⇒GTM	0.300*	(0.174)
SLV⇒HND	0.478**	(0.224)	-		
Insignificant effects ($p>0.1$)					
GTM⇒NIC	0.213	(0.222)	SLV⇒DOM	−0.165	(0.207)
GTM⇒HND	0.167	(0.212)	NIC⇒CRI	−0.225	(0.418)
CRI⇒NIC	0.145	(0.335)	NIC⇒HND	−0.243	(0.328)
NIC⇒SLV	0.131	(0.307)	HND⇒USA	−0.273	(0.195)
DOM⇒NIC	0.083	(0.288)	DOM⇒GTM	−0.287	(0.245)
CRI⇒HND	0.071	(0.336)	DOM⇒SLV	−0.291	(0.261)
GTM⇒SLV	0.053	(0.178)	SLV⇒CRI	−0.301	(0.313)
USA⇒DOM	0.025	(0.108)	CRI⇒SLV	−0.311	(0.300)
CRI⇒GTM	−0.012	(0.297)	HND⇒CRI	−0.353	(0.352)
SLV⇒USA	−0.146	(0.137)	USA⇒CRI	−0.427	(0.294)
CRI⇒USA	−0.167	(0.266)	-		
Negative effect ($p<0.1$)					
GTM⇒USA	−0.262**	(0.110)	NIC⇒DOM	−0.651**	(0.324)
GTM⇒CRI	−0.521*	(0.315)	DOM⇒HND	−1.035***	(0.292)
GTM⇒DOM	−0.567***	(0.192)	DOM⇒USA	−1.098***	(0.176)
CRI⇒DOM	−0.595*	(0.342)	DOM⇒CRI	−1.325***	(0.363)
Regular coefficients					
Variable	β	s.e	Variable	β	s.e
FTA	−0.024	(0.032)	WTO	0.064*	(0.037)
FTA_{t-5}	0.150***	(0.038)	-		
CA-DR	0.728***	(0.129)	$CA\text{-}DR_{t-5}$	0.474***	(0.169)
# of observations	895,471		-		
Fixed effects			Goodness of fit statistics		
Country-pair Asym		Yes	R^2		0.9997
Exp/Imp-year		Yes	Wald test (p value)		$2.2e-16$
Ln(Dist)×year		Yes			

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: estimates obtained using the PPML method. *Note 3*: only FTA-related coefficients reported for brevity. *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed missing. *Note 5*: a more detailed version of the table, without the fixed effect estimates, is provided in Appendix Table 9

Fig. 11 Estimated directional trade effects of CAFTA-DR, with 95% confidence intervals. Source: own estimations. Note: coefficients ordered by size

the exports of El Salvador to Honduras (and possibly to Guatemala and Nicaragua, significant at the 10% level) and in its imports from the USA and Honduras. On the other hand, we do find evidence indicating that CAFTA-DR would have reduced the Dominican Republic's exports to the USA, like in Reyes Peguero and Hansen (2019).[23]

Regarding the other total directional effects of the agreement, which were not statistically significant at the 10% level, these are concentrated among the Central American countries and the Dominican Republic. A possible explanation of this may be previous preferential trade agreements predating the CAFTA-DR among those countries, such as the CA-DR FTA and the Central American Common Market (CACM). As a consequence of those previous agreements, it is possible that the CAFTA-DR does not contribute to enhancing trade among these members or it does so in a very limited way, given that these members already have reduced their trade barriers prior to the CAFTA-DR. This is consistent with our findings on the CA-DR FTA effects, as these were significant and positive and CAFTA-DR was expected to add little to bilateral trade between Central American members and the Dominican Republic.

The results of Eq. (6) can be also related to the CAFTA-DR null effects from Eq. (4). The coefficients estimated using Eq. (6) are distributed around zero and being statistically not different from it, as Fig. 11 shows. These null effects were likely to be the ones estimated by Eq. (4). This also could be a consequence of

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[23] One might still suspect other possible factors, exogenous, but contemporary to CAFTA-DR, leading to the notable reduction in the importance of the USA as the Dominican Republic's largest trading partner. Figures 2, 7, and 8 also show that the decrease of the US importance for the Dominican Republic precedes the agreement.

considering all possible trade directions within the agreement (for the reasons discussed earlier). Again, our results highlight the importance of considering the presence of asymmetric effects within an FTA.

5.4 Estimated general equilibrium effects of the CAFTA-DR

Contrary to our estimates in Tables 2, 3, and 4, which represent only the partial equilibrium effects of CAFTA-DR on bilateral trade, the results from our general equilibrium exercise presented in Table 5 (and Appendix Table 11) give us a better understanding of the impact of the agreement on member and non-member countries. Our general equilibrium calculations represent the impact of CAFTA-DR during the reference year 2018, when one considers its partial equilibrium effects (the coefficients from Eq. (6)) and their impact on inward and outward multilateral resistance terms, income and expenditure levels, and factory-gate prices, while keeping the trade balances between countries and countries' total production quantities constant. As a consequence of the normalization of some of the key indices required to build the general equilibrium values, one must be careful with the interpretation of the results, as they represent the relative effect on each country in the sample with respect to the reference country. In the case of this study, the general equilibrium effects from CAFTA-DR are calculated with respect to those of Germany. Under the assumption that the formation of CAFTA-DR would have no significant effect on Germany, which is likely to be the case, we consider our general equilibrium effects as the true effect on each country.

As mentioned above, the general equilibrium effects of CAFTA-DR shown in Table 5 are estimated using the coefficients of Eq. (6), taking as counterfactual scenario the hypothetical elimination of CAFTA-DR in the year 2018[24]. The results from our analysis are, in general, coherent with theoretical expectations and our own empirical findings on the partial equilibrium effects of CAFTA-DR. CAFTA-DR increases, in general, both total exports and real income of members. However, we also find sizable negative effects on Costa Rica and in particular the Dominican Republic.

According to our estimates, CAFTA-DR would have increased both total exports and imports of El Salvador, Guatemala, Honduras, and Nicaragua. In Nicaragua, the agreement is associated with an increase of more than 10% of its total exports and more than 8% of its total imports. For El Salvador and Guatemala, the effects are an increase of about 4% for total exports and 2% for total imports, whereas for Honduras the effects are both close to an increase of 2%. These countries also experienced an increase in their welfare, measured by their real income, between 1.54% in Guatemala up to 3.97% in Honduras. The impact of CAFTA-DR on these countries' welfare levels is concentrated on the consumer side, as the reduction of their inward multilateral resistance terms can be understood as a reduction of their consumer price indices, according to

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[24] Only the coefficients which are statistically significant at the 5% level are used in the estimation of the general equilibrium effects. A more detailed version of the estimates of Eq. (6) can be found in Appendix Table 9.

Table 5 Estimated general equilibrium effects of CAFTA-DR

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
Costa Rica	− 4.23	− 3.86	− 4.46	5.18	0.49
Dominican Rep	− 24.62	− 18.62	− 8.66	− 2.29	− 12.04
El Salvador	4.53	2.07	3.49	− 2.97	0.41
Guatemala	4.40	2.27	1.54	− 2.96	− 1.49
Honduras	2.06	2.11	3.97	− 3.60	− 0.23
Nicaragua	10.08	8.15	3.76	− 2.68	0.97
USA	− 0.17	− 0.19	− 0.01	0.03	0.02
Non-members	1.08	− 1.12	0.17	− 2.38	− 2.23

Note 1: Percentage change measure with respect to the counterfactual scenario, as stated in Eq. (10). *Note 2*: A complete version of the table, with the effects for the other countries, is provided in Appendix Table 11. *Note 3*: The year of analysis is 2018. *Note 4*: The effect on *non-member countries* is the simple average of those countries' indices. *Note 5*: Coefficients used for the baseline scenario come from Appendix Table 9

Yotov et al. (2016). The impact on the welfare levels of producers is more heterogeneous among these countries: i.e., it is positive for Nicaraguan producers (an increase of about 1%), but negative for Guatemalan producers (a decrease of about 1.5%).

Although the estimates of Eq. (6) in Table 6 show that the USA increase their exports to many CAFTA-DR members, but also decrease their imports from Guatemala and the Dominican Republic, the general equilibrium effects of the agreement on the USA are, not surprisingly, relatively small in comparison to those for the other members. These small effects can be explained by the relatively low share of US exports to CAFTA-DR markets, about 2%, between 2010 and 2019, the relatively and absolutely larger size of the US economy, and to some degree by trade diversion effects from CAFTA-DR that are not present in the partial equilibrium analysis. Additionally, and following the structural gravity theory, the low impact on the US real income is also explained by the small impact on its inward multilateral resistance terms and on factory-gate prices.

For members like Costa Rica and the Dominican Republic, the CAFTA-DR general equilibrium effects show important trade diversion and welfare losses. For Costa Rica, the agreement is associated with 4% less trade and a decrease of real income of 4.5%. In the case of the Dominican Republic, the decrease of trade is more pronounced: 24.6% less exports and 18.6% less imports. Likewise, CAFTA-DR is associated with a decline in the Dominican Republic's real income of more than 8%. Changes in welfare levels in both countries differ in terms of their impact on consumers and producers. In Costa Rica, the welfare loss derives mainly from the increase in the consumer price index, represented by the increase of the inward multilateral resistance term (5.18%). In the Dominican Republic, producers are the most affected by welfare losses, as their factory-gate prices decrease by 12%, while consumers experience a welfare increase via a reduction in consumer prices (2.29%).

If we only consider the effects of CAFTA-DR on El Salvador, Guatemala, Honduras, and Nicaragua, the found changes in members' welfare levels are consistent

with the theoretical case of trade liberalization in small countries. Considering the Central American countries as price takers in their trade with the USA, the formation of CAFTA-DR would have led to lower internal prices and a net welfare gain in these price-taking countries, as consumer welfare gains would exceed producer welfare losses. In addition, for a big economy like the USA, in general, the effects from a trade agreement are rather less important than for a small economy. These are the same effects that we find for CAFTA-DR after accounting for its general equilibrium effects, with only Costa Rica and the Dominican Republic diverting from these results.

For the rest of the countries in the sample, the *non-members* in Table 5, the estimated CAFTA-DR general equilibrium effects are, on average, very small. Our results show some degree of trade creation and diversion, and an average welfare gain in this group of countries. In particular, it is important to note that the CAFTA-DR general equilibrium effects are relatively higher in countries close to or inside Central America and the Caribbean, like Barbados, Belize, Colombia, Curacao, Haiti, Jamaica, Panama, and Saint Lucia (see Table 11 in the Appendix).

Our results show the importance of considering heterogeneous partial equilibrium effects and considering them within a general equilibrium framework. The former is relevant because trade policies, such as FTA formation, do not affect all members equally, and the latter because such trade policies also affect third countries, which are not the main target of such policies.

6 Conclusion

The formation of CAFTA-DR has been viewed as an important step towards the commercial and economic integration of its members, being the first of its kind signed between the USA and a group of six developing countries in Central America and the Caribbean, and has been considered an important reference for negotiations of similar FTAs in the Americas and beyond. Although CAFTA-DR has been in operation since 2006 and despite its regional importance as an important trade-facilitating agreement between the USA on the one hand and the developing countries in its regional "backyard" on the other hand, the effects of CAFTA-DR have been relatively less explored in comparison to other FTAs in the Americas, such as NAFTA and Mercosur. This leaves an incomplete picture of the consequences of FTAs formed between large economies, such as the USA, and small developing economies, such as the other CAFTA-DR members. Relying on recent theoretical advances pertaining to the estimation of the structural gravity model of trade, this paper identifies the effects of CAFTA-DR on members' bilateral trade and welfare levels.

Our results help expand the literature on the ex post effects of FTAs, using CAFTA-DR as an example, providing evidence of and identifying heterogeneous effects within the agreement with regard to different member pairs and trade direction. If one only considers the average (treatment) effect from CAFTA-DR on bilateral trade, like in previous studies, the impact of the agreement on members' bilateral trade is statistically not different from zero. When considering the directional trade effects of the agreement, we are able to provide evidence of

both increases and reductions of bilateral trade flows within the agreement area. Relying on these heterogeneous effects, we evaluated the impact of CAFTA-DR on trade and welfare levels, allowing for a more comprehensive evaluation of its effects. We can conclude that CAFTA-DR has generally contributed to increasing welfare and trade levels of most of its members, although there is also evidence of adverse effects on some of them.

The formation of CAFTA-DR, in general, has increased members' bilateral trade, but to different degrees depending on the member pair and the trade direction. The USA managed to increase its exports to at least 4 out of 6 members. Similar effects were found for Nicaraguan exports to the USA. In addition, there is little evidence of an increase in trade between Central American countries and the Dominican Republic as a result of CAFTA-DR, which can be explained by high previous levels of commercial integration and other trade agreements between these countries prior to the formation of CAFTA-DR. The agreement is associated with strong trade creation for El Salvador, Guatemala, Honduras, and Nicaragua, when considering its general equilibrium effects. Interestingly, the agreement is also associated with important degrees of trade diversion for members like Costa Rica and, especially, the Dominican Republic.

Based on a counterfactual experiment, which evaluates the general equilibrium effects of the elimination of CAFTA-DR during the year 2018, we find that CAFTA-DR has affected the real income of members differently. For El Salvador, Guatemala, Honduras, and Nicaragua, CAFTA-DR is associated with an increase in real income and, therefore, their welfare levels. Its effects on the US real income are small and close to zero, as one would expect for a big economy. On the other hand, the net welfare levels in Costa Rica and the Dominican Republic have been reduced by the formation of CAFTA-DR. Most of the welfare gains from the agreement come from the consumer side, as, with the notable exception of Costa Rica, CAFTA-DR reduced members' inward multilateral resistance terms, which can be understood as a reduction in their consumer price indices. Welfare losses come mainly from the reduction in members' factory-gate prices, except in Costa Rica, where welfare losses are concentrated on the consumer side, due to higher consumer prices (an increase in the country's inward multilateral resistance term).

In terms of effects on third countries, the formation of CAFTA-DR has generally had little effect on countries outside the agreement in terms of trade diversion and welfare losses. Most of these effects are concentrated in the countries close to or in Central America and the Caribbean, with Belize, Haiti, and Panama being among the most affected.

Although our estimates help better understand the effects of CAFTA-DR on members' bilateral trade in goods, highlighting the importance of heterogeneous effects within the same FTA, there are some aspects of the agreement that still need to be addressed. One important aspect left for future investigation is the effect of CAFTA-DR by disaggregated goods category, since the use of aggregate data could be hiding important differences in CAFTA-DR's effects.

Appendix
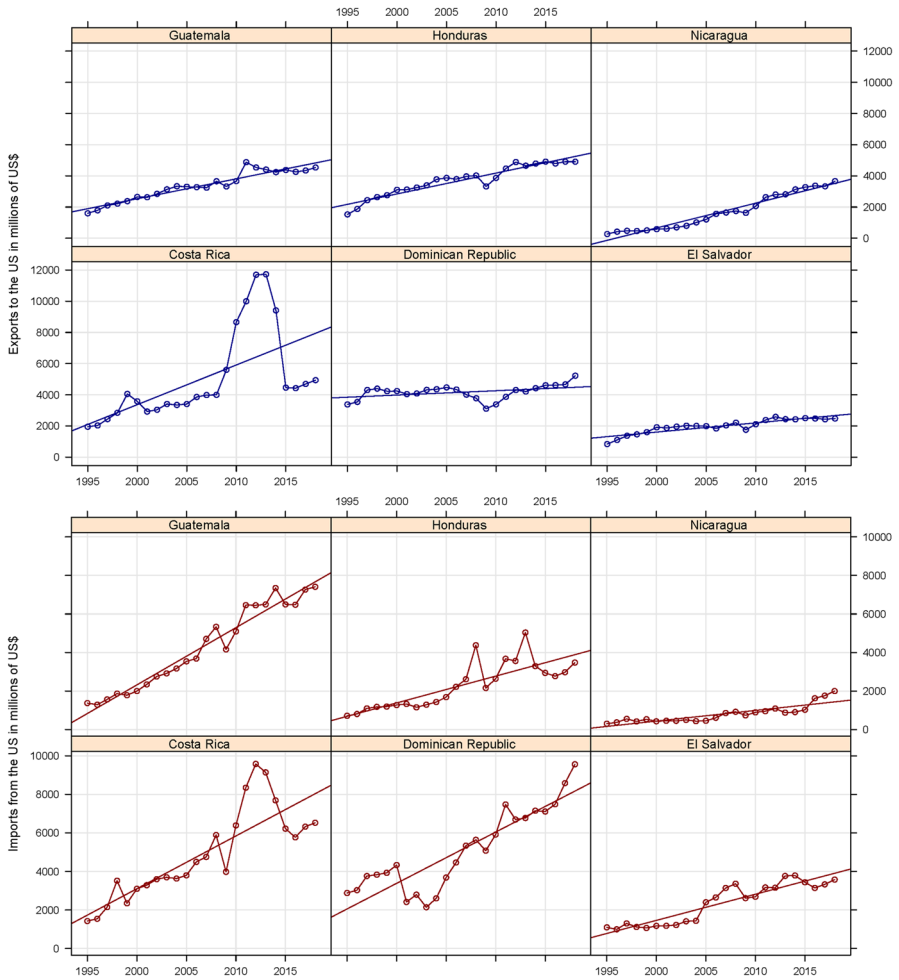
Fig. 12 CAFTA-DR exports and imports to and from the USA in millions of US dollars. Source: own elaboration with information from the ITPD-E ver. 2 (2022, July). Note: solid dotted line represents observed values and solid line represents a simple OLS time trend

Table 6 Sample of countries

Country	ISO
Afghanistan, Islamic Rep. of	AFG
American Samoa	ASM
Albania	ALB
Andorra	AND
Algeria	DZA
Angola	AGO
Antigua and Barbuda	ATG
Anguilla	AIA
Argentina	ARG
Armenia, Rep. of	ARM
Aruba, Kingdom of the Netherlands	ABW
Australia	AUS
Austria	AUT
Madagascar, Rep. of	MDG
Azerbaijan, Rep. of	AZE
Bahamas, The	BHS
Bahrain, Kingdom of	BHR
Bangladesh	BGD
Barbados	BRB
Belarus, Rep. of	BLR
Belgium	BEL
Belgium-Luxembourg	BLX
Belize	BLZ
Benin	BEN
Bermuda	BMU
Bhutan	BTN
Bolivia	BOL
Bosnia and Herzegovina	BIH
Botswana	BWA
Brazil	BRA
Brunei Darussalam	BRN
Bulgaria	BGR
Burkina Faso	BFA
Burundi	BDI
Cabo Verde	CPV
Cambodia	KHM
Cameroon	CMR
Canada	CAN
Central African Republic	CAF
Chad	TCD
Chile	CHL
China, P.R.: Hong Kong	HKG
China, P.R.: Macao	MAC

Table 6 (continued)

Country	ISO
China, P.R.: Mainland	CHN
Colombia	COL
Comoros, Union of the	COM
Congo, Democratic Republic of the	COD
Congo, Rep. of	COG
Cook Islands	COK
Costa Rica	CRI
Côte d'Ivoire	CIV
Croatia, Rep. of	HRV
Cuba	CUB
Curacao	CUW
Cyprus	CYP
Czech Republic	CZE
Denmark	DNK
Djibouti	DJI
Dominica	DMA
Dominican Republic	DOM
East Timor	TLS
Ecuador	ECU
Egypt, Arab Rep. of	EGY
Seychelles	SYC
El Salvador	SLV
Equatorial Guinea, Rep. of	GNQ
Eritrea, The State of	ERI
Slovak Republic	SVK
Estonia, Rep. of	EST
Ethiopia, The Federal Dem. Rep. of	ETH
Faroe Islands	FRO
Fiji, Rep. of	FJI
Finland	FIN
Spain	ESP
France	FRA
French Polynesia	PYF
Gabon	GAB
Gambia, The	GMB
Georgia	GEO
Germany	DEU
Swaziland	SWZ
Ghana	GHA
Gibraltar	GIB
Greece	GRC
Greenland	GRL
Tajikistan, Rep. of	TJK

Table 6 (continued)

Country	ISO
Grenada	GRD
Guam	GUM
Guatemala	GTM
Guinea	GIN
Guinea-Bissau	GNB
Guyana	GUY
Haiti	HTI
Honduras	HND
Hungary	HUN
Iceland	ISL
Tuvalu	TUV
India	IND
Indonesia	IDN
Iran, Islamic Rep. of	IRN
Iraq	IRQ
Ireland	IRL
Israel	ISR
Italy	ITA
Jamaica	JAM
Japan	JPN
Jordan	JOR
Kazakhstan, Rep. of	KAZ
Yemen, Rep. of	YEM
Kenya	KEN
Kiribati	KIR
Korea, Dem. People's Rep. of	PRK
Korea, Rep. of	KOR
Kuwait	KWT
Kyrgyz Republic	KGZ
Lao People's Dem. Republic	LAO
Latvia	LVA
Lebanon	LBN
Liberia	LBR
Libya	LBY
Lithuania	LTU
Luxembourg	LUX
Macedonia	MKD
Malawi	MWI
Malaysia	MYS
Maldives	MDV
Mali	MLI
Malta	MLT
Marshall Islands, Rep. of the	MHL

Table 6 (continued)

Country	ISO
Mauritania, Islamic Rep. of	MRT
Mauritius	MUS
Mexico	MEX
Micronesia, Federated States of	FSM
Moldova, Rep. of	MDA
Mongolia	MNG
Montenegro	MNE
Montserrat	MSR
Morocco	MAR
Mozambique, Rep. of	MOZ
Myanmar	MMR
Namibia	NAM
Nauru, Rep. of	NRU
Nepal	NPL
Netherlands, The	NLD
New Caledonia	NCL
New Zealand	NZL
Nicaragua	NIC
Niger	NER
Nigeria	NGA
Norway	NOR
Oman	OMN
Pakistan	PAK
Palau, Rep. of	PLW
Panama	PAN
Papua New Guinea	PNG
Paraguay	PRY
Peru	PER
Philippines	PHL
Poland, Rep. of	POL
Portugal	PRT
Qatar	QAT
Romania	ROU
Russian Federation	RUS
Rwanda	RWA
San Marino, Rep. of	SMR
São Tomé and Príncipe, Dem. Rep. of	STP
Saudi Arabia	SAU
Senegal	SEN
Serbia	SRB
Sierra Leone	SLE
Singapore	SGP
Sint Maarten	SXM

Table 6 (continued)

Country	ISO
Slovenia, Rep. of	SVN
Solomon Islands	SLB
Somalia	SOM
South Africa	ZAF
South Sudan	SSD
Sri Lanka	LKA
St. Kitts and Nevis	KNA
St. Lucia	LCA
St. Vincent and the Grenadines	VCT
Sudan	SDN
Suriname	SUR
Sweden	SWE
Switzerland	CHE
Syrian Arab Republic	SYR
Taiwan	TWN
Tanzania, United Rep. of	TZA
Thailand	THA
Togo	TGO
Tonga	TON
Trinidad and Tobago	TTO
Tunisia	TUN
Turkey	TUR
Turkmenistan	TKM
Turks and Caicos Islands	TCA
Uganda	UGA
Ukraine	UKR
United Arab Emirates	ARE
United Kingdom	GBR
USA	USA
Uruguay	URY
Uzbekistan, Rep. of	UZB
Vanuatu	VUT
Venezuela, Rep. Bolivariana de	VEN
Vietnam	VNM
Western Samoa	WSM
Zambia	ZMB
Zimbabwe	ZWE

Table 7 Estimated average effect of CAFTA-DR

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FTA	0.054*	0.201***	0.041	0.055*	0.015	−0.023	−0.042	−0.023	−0.001
	(0.030)	(0.054)	(0.034)	(0.030)	(0.029)	(0.031)	(0.037)	(0.031)	(0.031)
FTA_{t-5}	0.208***	0.131***	0.157***	0.209***	0.003	0.154***	0.165***	0.154***	0.084***
	(0.046)	(0.036)	(0.042)	(0.046)	(0.036)	(0.038)	(0.045)	(0.038)	(0.031)
FTA_{t-10}									0.132***
									(0.021)
WTO	0.197***	0.041	0.351***	0.197***	−0.010	0.064*	0.066	0.064*	0.069*
	(0.034)	(0.053)	(0.042)	(0.034)	(0.037)	(0.037)	(0.041)	(0.037)	(0.037)
CA-DR	0.667***	0.741***	0.576***	0.589***	0.694***	0.620***	0.469***	0.616***	0.634***
	(0.113)	(0.159)	(0.094)	(0.168)	(0.126)	(0.113)	(0.149)	(0.113)	(0.113)
$CA\text{-}DR_{t-5}$	0.202	0.155	0.339*	0.228	0.191	0.185	0.256*	0.187	0.256
	(0.192)	(0.166)	(0.178)	(0.243)	(0.185)	(0.188)	(0.150)	(0.187)	(0.183)
$CA\text{-}DR_{t-10}$									−0.132
									(0.093)
CAFTA-DR	−0.011	−0.054	0.030	−0.008	−0.133*	−0.066	−0.041	−0.077	−0.064
	(0.064)	(0.079)	(0.111)	(0.066)	(0.071)	(0.072)	(0.073)	(0.080)	(0.072)
$CAFTA\text{-}DR_{t-5}$	−0.011	−0.077	−0.166	−0.007	−0.084	−0.035	−0.031	−0.018	−0.036
	(0.078)	(0.075)	(0.113)	(0.084)	(0.075)	(0.077)	(0.090)	(0.071)	(0.081)
$CAFTA\text{-}DR_{t-10}$									−0.002
									(0.093)
$CAFTA\text{-}DR_{t+5}$								0.022	
								(0.063)	

Table 7 (continued)

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Total effect									
FTA	0.262***	0.333***	0.198***	0.264***	0.018	0.131***	0.123**	0.131***	0.215***
	(0.051)	(0.070)	(0.047)	(0.051)	(0.047)	(0.045)	(0.050)	(0.045)	(0.053)
CA–DR	0.869***	0.896***	0.915***	0.817***	0.885***	1.214***	0.938***	1.231***	0.758***
	(0.220)	(0.259)	(0.197)	(0.263)	(0.224)	(0.225)	(0.297)	(0.227)	(0.227)
CAFTA–DR	−0.021	−0.131	−0.136*	−0.015	−0.218*	−0.100	−0.072	−0.094	−0.102
	(0.103)	(0.094)	(0.076)	(0.109)	(0.111)	(0.114)	(0.120)	(0.111)	(0.133)
Trend effects									
IB×1995					−0.417***				
					(0.049)				
IB×1996					−0.442***				
					(0.048)				
IB×1997					−0.322***				
					(0.044)				
IB×1998					−0.274***				
					(0.046)				
IB×1999					−0.170***				
					(0.024)				
IB×2000					−0.036**				
					(0.016)				
IB×2001					−0.037***				
					(0.013)				

Table 7 (continued)

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IB×2002					−0.033***				
					(0.011)				
IB×2003					−0.072***				
					(0.012)				
IB×2005					0.030***				
					(0.011)				
IB×2006					0.040***				
					(0.012)				
IB×2007					0.062***				
					(0.010)				
IB×2008					0.144***				
					(0.017)				
IB×2009					−0.005				
					(0.020)				
IB×2010					0.072***				
					(0.020)				
IB×2011					0.123***				
					(0.023)				
IB×2012					0.133***				
					(0.026)				
IB×2013					0.131***				
					(0.027)				

Table 7 (continued)

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IB×2014					0.148***				
					(0.028)				
IB×2015					0.130***				
					(0.034)				
IB×2016					0.110***				
					(0.035)				
IB×2017					0.187***				
					(0.033)				
IB×2018					0.216***				
					(0.028)				
Ln(Dist)×1995						−0.136***	−0.136***	−0.136***	−0.137***
						(0.018)	(0.017)	(0.018)	(0.018)
Ln(Dist)×1996						−0.145***		−0.145***	−0.147***
						(0.018)		(0.018)	(0.018)
Ln(Dist)×1997						−0.096***		−0.096***	−0.098***
						(0.016)		(0.016)	(0.016)
Ln(Dist)×1998						−0.091***	−0.091***	−0.091***	−0.092***
						(0.016)	(0.015)	(0.016)	(0.016)
Ln(Dist)×1999						−0.047***		−0.047***	−0.049***
						(0.008)		(0.008)	(0.007)
Ln(Dist)×2000						−0.005		−0.005	−0.005
						(0.005)		(0.005)	(0.005)

Table 7 (continued)

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(Dist)×2001						−0.011**	−0.012**	−0.011**	−0.011**
						(0.005)	(0.005)	(0.005)	(0.005)
Ln(Dist)×2002						−0.019***		−0.019***	−0.018***
						(0.005)		(0.005)	(0.005)
Ln(Dist)×2003						−0.026***		−0.026***	−0.025***
						(0.004)		(0.004)	(0.004)
Ln(Dist)×2005						0.004		0.004	0.001
						(0.005)		(0.005)	(0.005)
Ln(Dist)×2006						0.003		0.003	−0.0003
						(0.007)		(0.007)	(0.007)
Ln(Dist)×2007						0.015**	0.017***	0.015**	0.010
						(0.006)	(0.006)	(0.006)	(0.007)
Ln(Dist)×2008						0.049***		0.049***	0.044***
						(0.008)		(0.008)	(0.007)
Ln(Dist)×2009						−0.007		−0.007	−0.011
						(0.008)		(0.008)	(0.007)
Ln(Dist)×2010						0.018**	0.020**	0.018**	0.013*
						(0.008)	(0.008)	(0.008)	(0.007)
Ln(Dist)×2011						0.039***		0.039***	0.035***
						(0.009)		(0.009)	(0.009)
Ln(Dist)×2012						0.040***		0.040***	0.035***
						(0.011)		(0.011)	(0.010)

Table 7 (continued)

Dependent variable	Trade flow								
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Ln(Dist)×2013						0.043***	0.046***	0.043***	0.039***
						(0.011)	(0.011)	(0.011)	(0.011)
Ln(Dist)×2014						0.045***		0.045***	0.040***
						(0.012)		(0.012)	(0.011)
Ln(Dist)×2015						0.034***		0.034***	0.029**
						(0.013)		(0.013)	(0.013)
Ln(Dist)×2016						0.028**	0.031**	0.028**	0.022*
						(0.013)	(0.013)	(0.013)	(0.013)
Ln(Dist)×2017						0.055***		0.055***	0.049***
						(0.012)		(0.012)	(0.012)
Ln(Dist)×2018						0.070***		0.070***	0.064***
						(0.010)		(0.010)	(0.010)
Fixed effects									
Exp/Imp-year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	940,211	937,077	941,291	717,243	940,211	938,235	298,857	938,235	928,623
R^2	0.9995	0.9965	0.9997	0.9995	0.9995	0.9995	0.9995	0.9995	0.9996
Wald test, p value	$2.8e-17$	$3.5e-8$	$8.7e-25$	$6.5e-12$	$8.3e-191$	$1.5e-159$	$3.7e-21$	$1.3e-158$	$3.5e-157$

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: all estimates obtained using the PPML method. *Note 3*: fixed effect estimates omitted for brevity *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed as missing

Table 8 Estimated effect of CAFTA-DR on members by trade flow type

Dependent variable	Trade flow						
Model	Exports		Imports		Exports		Imports	
	(1)		(2)		(3)		(4)	
	β	s.e	β	s.e	β	s.e	β	s.e
Total effects by member								
CAFTA-DR: CRI	−0.678***	(0.249)	0.236	(0.290)	−0.229	(0.326)	−0.421	(0.309)
CAFTA-DR: HND	0.235	(0.228)	−0.143	(0.229)	−0.100	(0.251)	0.356*	(0.206)
CAFTA-DR: SLV	0.747***	(0.199)	−0.348*	(0.197)	0.077	(0.141)	0.345**	(0.163)
CAFTA-DR: GTM	0.243	(0.207)	−0.152	(0.197)	−0.217*	(0.118)	0.324*	(0.127)
CAFTA-DR: NIC	0.797**	(0.342)	−0.088	(0.286)	0.606*	(0.327)	0.592*	(0.304)
CAFTA-DR: DOM	−0.403**	(0.194)	−0.346*	(0.155)	−1.110***	(0.168)	−0.141	(0.120)
CAFTA-DR: USA	−0.093	(0.113)	−0.089	(0.166)	0.088	(0.130)	−0.304**	(0.137)
Regular coefficients								
FTA	−0.023	(0.031)	−0.023	(0.031)	−0.024	(0.032)	−0.024	(0.032)
FTA$_{t-5}$	0.154***	(0.038)	0.154***	(0.038)	0.150***	(0.038)	0.150***	(0.038)
WTO	0.064*	(0.037)	0.064*	(0.037)	0.064*	(0.037)	0.064*	(0.037)
CA-DR	0.649***	(0.120)	0.597***	(0.115)	0.709***	(0.120)	0.711***	(0.122)
CA-DR$_{t-5}$	0.233	(0.171)	0.274	(0.209)	0.350*	(0.180)	0.032	(0.144)
CAFTA-DR: CRI	−0.596***	(0.206)	0.739***	(0.212)	−0.159	(0.218)	0.126	(0.203)
CAFTA-DR: CRI$_{t-5}$	−0.083	(0.229)	−0.503***	(0.141)	−0.070	(0.236)	−0.547***	(0.143)
CAFTA-DR: HND	0.151	(0.177)	−0.211	(0.183)	−0.093	(0.112)	0.219	(0.141)
CAFTA-DR: HND$_{t-5}$	0.085	(0.178)	0.068	(0.162)	−0.006	(0.196)	0.138	(0.183)
CAFTA-DR: SLV	0.641***	(0.190)	−0.506**	(0.209)	0.006	(0.084)	0.188	(0.162)
CAFTA-DR: SLV$_{t-5}$	0.106	(0.077)	0.158	(0.115)	0.071	(0.088)	0.158	(0.123)

Table 8 (continued)

Dependent variable	Exports (1) β	s.e	Imports (2) β	s.e	Exports (3) β	s.e	Imports (4) β	s.e
Model	Trade flow							
CAFTA-DR: GTM	0.335**	(0.165)	−0.397*	(0.209)	−0.107	(0.115)	0.077	(0.158)
CAFTA-DR: GTM$_{t-5}$	−0.092	(0.092)	0.245**	(0.103)	−0.110	(0.089)	0.247**	(0.112)
CAFTA-DR: NIC	0.309	(0.241)	−0.549***	(0.186)	0.229**	(0.095)	0.011	(0.158)
CAFTA-DR: NIC$_{t-5}$	0.488*	(0.275)	0.461**	(0.210)	0.377	(0.309)	0.582***	(0.217)
CAFTA-DR: DOM	−0.061	(0.174)	−0.261*	(0.143)	−0.749***	(0.194)	−0.064	(0.105)
CAFTA-DR: DOM$_{t-5}$	−0.342***	(0.126)	−0.085	(0.079)	−0.361***	(0.130)	−0.077	(0.072)
CAFTA-DR: USA	0.043	(0.132)	−0.064	(0.139)	0.189***	(0.068)	−0.134	(0.104)
CAFTA-DR: USA$_{t-5}$	−0.136	(0.104)	−0.025	(0.098)	−0.101	(0.098)	−0.170**	(0.082)
Trend effects								
Ln(Dist)×1995	−0.136***	(0.018)	−0.136***	(0.018)	−0.136***	(0.018)	−0.136***	(0.018)
Ln(Dist)×1996	−0.145***	(0.018)	−0.145***	(0.018)	−0.146***	(0.018)	−0.146***	(0.018)
Ln(Dist)×1997	−0.096***	(0.016)	−0.096***	(0.016)	−0.097***	(0.016)	−0.097***	(0.016)
Ln(Dist)×1998	−0.091***	(0.016)	−0.091***	(0.016)	−0.091***	(0.016)	−0.091***	(0.016)
Ln(Dist)×1999	−0.047***	(0.008)	−0.047***	(0.008)	−0.048***	(0.008)	−0.048***	(0.008)
Ln(Dist)×2000	−0.005	(0.005)	−0.005	(0.005)	−0.006	(0.005)	−0.006	(0.005)
Ln(Dist)×2001	−0.011**	(0.005)	−0.011**	(0.005)	−0.012**	(0.005)	−0.012**	(0.005)
Ln(Dist)×2002	−0.019***	(0.005)	−0.019***	(0.005)	−0.019***	(0.005)	−0.019***	(0.005)
Ln(Dist)×2003	−0.026***	(0.004)	−0.026***	(0.004)	−0.026***	(0.004)	−0.026***	(0.004)
Ln(Dist)×2005	0.004	(0.005)	0.004	(0.005)	0.005	(0.005)	0.005	(0.005)
Ln(Dist)×2006	0.003	(0.007)	0.003	(0.007)	0.003	(0.007)	0.003	(0.007)
Ln(Dist)×2007	0.015**	(0.006)	0.015**	(0.006)	0.016**	(0.007)	0.016**	(0.007)

Table 8 (continued)

Dependent variable	Trade flow							
Model	Exports		Imports		Exports		Imports	
	(1)		(2)		(3)		(4)	
	β	s.e	β	s.e	β	s.e	β	s.e
Ln(Dist)×2008	0.049***	(0.008)	0.049***	(0.008)	0.049***	(0.008)	0.049***	(0.008)
Ln(Dist)×2009	−0.007	(0.008)	−0.007	(0.008)	−0.006	(0.008)	−0.006	(0.008)
Ln(Dist)×2010	0.018**	(0.008)	0.018**	(0.008)	0.020**	(0.008)	0.020**	(0.008)
Ln(Dist)×2011	0.039***	(0.009)	0.039***	(0.009)	0.041***	(0.009)	0.041***	(0.009)
Ln(Dist)×2012	0.040***	(0.011)	0.040***	(0.011)	0.043***	(0.011)	0.043***	(0.011)
Ln(Dist)×2013	0.043***	(0.011)	0.043***	(0.011)	0.046***	(0.011)	0.046***	(0.011)
Ln(Dist)×2014	0.045***	(0.012)	0.045***	(0.012)	0.049***	(0.012)	0.049***	(0.012)
Ln(Dist)×2015	0.034***	(0.013)	0.034***	(0.013)	0.039***	(0.013)	0.039***	(0.013)
Ln(Dist)×2016	0.028**	(0.013)	0.028**	(0.013)	0.033**	(0.013)	0.033**	(0.013)
Ln(Dist)×2017	0.055***	(0.012)	0.055***	(0.012)	0.059***	(0.013)	0.059***	(0.013)
Ln(Dist)×2018	0.070***	(0.010)	0.070***	(0.010)	0.074***	(0.011)	0.074***	(0.011)
Fixed effects								
Country pair	Yes		Yes		No		No	
Exp/Imp-year	Yes		Yes		Yes		Yes	
Country pair Asym	No		No		Yes		Yes	
# of observations	938,235		938,235		895,470		895,470	
R^2	0.9995		0.9995		0.9997		0.9997	
Wald test (p value)	1.7e−166		7.1e−166		5.98e−170		9.4e−167	

Signif. codes: ***0.01; **0.05; *0.1. *Note 1:* standard errors clustered by country pair are reported in parentheses. *Note 2:* all estimates obtained using the PPML method. *Note 3:* fixed effect estimates omitted for brevity. *Note 4:* the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed missing

Table 9 Estimated directional effect of CAFTA-DR by country pair

Dependent variable:			Trade flow		
Variables	β	s.e	Variables	β	s.e
CRI⇒DOM	−0.822***	(0.219)	NIC⇒SLV	−0.075	(0.112)
CRI⇒DOM$_{t-5}$	0.227	(0.192)	NIC⇒SLV$_{t-5}$	0.205	(0.297)
CRI⇒GTM	−0.806***	(0.190)	NIC⇒USA	0.285***	(0.093)
CRI⇒GTM$_{t-5}$	0.795***	(0.183)	NIC⇒USA$_{t-5}$	0.331	(0.277)
CRI⇒HND	−0.617***	(0.200)	SLV⇒CRI	−0.213	(0.207)
CRI⇒HND$_{t-5}$	0.688***	(0.207)	SLV⇒CRI$_{t-5}$	−0.088	(0.152)
CRI⇒NIC	−0.423**	(0.209)	SLV⇒DOM	−0.049	(0.173)
CRI⇒NIC$_{t-5}$	0.569***	(0.217)	SLV⇒DOM$_{t-5}$	−0.116	(0.093)
CRI⇒SLV	−0.821***	(0.190)	SLV⇒GTM	0.027	(0.135)
CRI⇒SLV$_{t-5}$	0.511***	(0.184)	SLV⇒GTM$_{t-5}$	0.273**	(0.112)
CRI⇒USA	−0.022	(0.165)	SLV⇒HND	0.372***	(0.117)
CRI⇒USA$_{t-5}$	−0.14	(0.171)	SLV⇒HND$_{t-5}$	0.106	(0.179)
DOM⇒CRI	−0.760***	(0.267)	SLV⇒NIC	0.089	(0.130)
DOM⇒CRI$_{t-5}$	−0.564***	(0.200)	SLV⇒NIC$_{t-5}$	0.513***	(0.188)
DOM⇒GTM	−0.017	(0.244)	SLV⇒USA	−0.084	(0.097)
DOM⇒GTM$_{t-5}$	−0.270*	(0.146)	SLV⇒USA$_{t-5}$	−0.062	(0.090)
DOM⇒HND	−0.917***	(0.242)	USA⇒CRI	0.169	(0.190)
DOM⇒HND$_{t-5}$	−0.118	(0.194)	USA⇒CRI$_{t-5}$	−0.596***	(0.142)
DOM⇒NIC	−0.181	(0.244)	USA⇒DOM	0.086	(0.109)
DOM⇒NIC$_{t-5}$	0.264	(0.208)	USA⇒DOM$_{t-5}$	−0.061	(0.067)
DOM⇒SLV	−0.374	(0.237)	USA⇒GTM	0.231**	(0.095)
DOM⇒SLV$_{t-5}$	0.083	(0.167)	USA⇒GTM$_{t-5}$	0.146**	(0.070)
DOM⇒USA	−0.725***	(0.201)	USA⇒HND	0.366***	(0.070)
DOM⇒USA$_{t-5}$	−0.373***	(0.136)	USA⇒HND$_{t-5}$	0.059	(0.156)
GTM⇒CRI	−0.278	(0.207)	USA⇒NIC	0.114	(0.088)
GTM⇒CRI$_{t-5}$	−0.243	(0.161)	USA⇒NIC$_{t-5}$	0.350**	(0.169)
GTM⇒DOM	−0.373**	(0.178)	USA⇒SLV	0.384***	(0.070)
GTM⇒DOM$_{t-5}$	−0.194*	(0.101)	USA⇒SLV$_{t-5}$	0.056	(0.116)
GTM⇒HND	0.273*	(0.141)	FTA	−0.024	(0.032)
GTM⇒HND$_{t-5}$	−0.105	(0.182)	FTA$_{t-5}$	0.150***	(0.038)
GTM⇒NIC	−0.187	(0.150)	WTO	0.064*	(0.037)
GTM⇒NIC$_{t-5}$	0.400**	(0.192)	CA-DR	0.728***	(0.129)
GTM⇒SLV	0.002	(0.141)	CA-DR$_{t-5}$	0.474***	(0.169)
GTM⇒SLV$_{t-5}$	0.051	(0.150)	Ln(Dist)×1995	−0.136***	(0.018)
GTM⇒USA	−0.095	(0.121)	Ln(Dist)×1996	−0.146***	(0.018)
GTM⇒USA$_{t-5}$	−0.167*	(0.093)	Ln(Dist)×1997	−0.097***	(0.016)
HND⇒CRI	0.147	(0.231)	Ln(Dist)×1998	−0.091***	(0.016)
HND⇒CRI$_{t-5}$	−0.499***	(0.168)	Ln(Dist)×1999	−0.048***	(0.008)
HND⇒DOM	0.225	(0.181)	Ln(Dist)×2000	−0.006	(0.005)
HND⇒DOM$_{t-5}$	0.305**	(0.149)	Ln(Dist)×2001	−0.012**	(0.005)
HND⇒GTM	0.153	(0.145)	Ln(Dist)×2002	−0.019***	(0.005)
HND⇒GTM$_{t-5}$	0.263	(0.181)	Ln(Dist)×2003	−0.026***	(0.004)
HND⇒NIC	−0.034	(0.141)	Ln(Dist)×2005	0.005	(0.005)
HND⇒NIC$_{t-5}$	1.100***	(0.236)	Ln(Dist)×2006	0.003	(0.007)

Table 9 (continued)

Dependent variable:			Trade flow		
Variables	β	s.e	Variables	β	s.e
HND⇒SLV	0.434***	(0.131)	Ln(Dist)×2007	0.016**	(0.007)
HND⇒SLV$_{t-5}$	0.343*	(0.203)	Ln(Dist)×2008	0.049***	(0.008)
HND⇒USA	−0.187*	(0.108)	Ln(Dist)×2009	−0.006	(0.008)
HND⇒USA$_{t-5}$	−0.085	(0.165)	Ln(Dist)×2010	0.020**	(0.008)
NIC⇒CRI	0.067	(0.280)	Ln(Dist)×2011	0.041***	(0.009)
NIC⇒CRI$_{t-5}$	−0.292	(0.193)	Ln(Dist)×2012	0.043***	(0.011)
NIC⇒DOM	−0.291	(0.179)	Ln(Dist)×2013	0.046***	(0.011)
NIC⇒DOM$_{t-5}$	−0.36	(0.221)	Ln(Dist)×2014	0.049***	(0.012)
NIC⇒GTM	0.152	(0.129)	Ln(Dist)×2015	0.039***	(0.013)
NIC⇒GTM$_{t-5}$	0.363	(0.280)	Ln(Dist)×2016	0.033**	(0.013)
NIC⇒HND	0.084	(0.112)	Ln(Dist)×2017	0.059***	(0.013)
NIC⇒HND$_{t-5}$	−0.327	(0.312)	Ln(Dist)×2018	0.074***	(0.011)
Fixed effects			Observations		895,471
Country pair Asym		Yes	Goodness of fit statistics		
Exporter-year		Yes	R^2		0.9997
Importer-year		Yes	Wald test (p value)		$2.2e-16$

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: estimates obtained using the PPML method. *Note 3*: fixed effect estimates omitted for brevity. *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed missing

Table 10 Estimated auxiliary regression on trade costs

Dependent variable	Country-pair fixed effects	
Variable	β	s.e
lnDIST	−0.636***	(0.048)
ComLang	1.260***	(0.097)
CNTG	0.604***	(0.122)
ComCol	0.593***	(0.153)
ComLeg	0.379***	(0.145)
IB	−4.06***	(0.174)
Fixed effects		
Exporter	Yes	
Importer	Yes	
Observations	38,701	
Goodness of fit statistics		
R^2	0.99328	
Wald test (p value)	$2.2e-16$	

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: estimates obtained using the PPML method. *Note 3*: fixed effect estimates omitted for brevity. *Note 4*: the dependent variable, country-pair fixed effects, was taken from estimation of Eq. (6)

Table 11 Estimated general equilibrium effects of CAFTA-DR

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
ABW	0.18	0.15	0.15	−0.06	0.09
AFG	−0.01	0.00	−0.01	0.01	−0.01
AGO	0.00	0.01	0.00	0.00	0.00
AIA	0.00	−0.05	0.12	−0.16	−0.04
ALB	−0.01	−0.00	−0.00	−0.00	−0.00
AND	−0.02	−0.03	−0.01	−0.02	−0.02
ARE	−0.00	0.01	0.00	0.00	0.00
ARG	−0.05	−0.04	−0.00	−0.01	−0.02
ARM	−0.01	−0.00	0.00	−0.00	−0.00
ASM	−0.00	0.01	−0.01	0.01	0.00
ATG	−0.02	−0.01	0.03	−0.07	−0.05
AUS	−0.01	0.01	0.00	0.00	0.01
AUT	−0.00	0.00	0.00	0.00	0.00
AZE	−0.00	0.00	0.00	0.00	0.00
BDI	−0.02	0.00	−0.00	0.00	0.00
BEL	−0.00	−0.00	0.00	−0.01	−0.00
BEN	0.01	0.00	0.00	−0.01	−0.01
BFA	−0.00	0.01	0.00	−0.00	−0.00
BGD	−0.00	0.01	0.00	0.00	0.01
BGR	−0.01	0.00	0.00	−0.00	−0.00
BHR	−0.00	0.01	0.00	0.00	0.01
BHS	−0.12	−0.01	−0.47	0.09	−0.38
BIH	−0.01	0.00	0.00	0.00	0.00
BLR	−0.01	0.00	0.00	0.00	0.00
BLZ	0.07	0.18	0.03	−0.03	0.00
BMU	−0.00	−0.03	−0.01	−0.01	−0.02
BOL	−0.02	−0.01	−0.00	−0.01	−0.01
BRA	−0.04	−0.03	−0.00	−0.01	−0.01
BRB	−0.08	−0.58	−0.17	−0.17	−0.34
BRN	−0.00	0.01	−0.00	0.01	0.01
BTN	−0.01	0.00	−0.00	−0.00	−0.01
BWA	−0.01	−0.00	0.00	0.00	0.00
CAF	0.00	−0.08	−0.00	−0.04	−0.04
CAN	0.03	0.04	0.01	−0.00	0.01
CHE	0.00	0.01	0.01	−0.00	0.00
CHL	0.01	0.01	0.00	−0.01	−0.00
CHN	−0.02	0.01	0.00	0.00	0.00
CIV	−0.00	0.01	0.00	−0.00	0.00
CMR	−0.00	0.01	0.00	−0.00	−0.00
COD	−0.00	0.01	0.00	0.00	0.00
COG	0.00	0.02	0.01	−0.00	0.00
COK	0.00	0.01	0.00	−0.00	−0.00
COL	−0.09	−0.20	−0.02	−0.05	−0.07
COM	−0.00	−0.01	−0.00	0.00	−0.00

Table 11 (continued)

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
CPV	−0.11	−0.08	−0.01	−0.02	−0.04
CRI	−4.23	−3.86	−4.46	5.18	0.49
CUB	−0.03	−0.15	−0.03	−0.10	−0.12
CUW	−0.36	−0.46	−0.34	−0.08	−0.42
CYP	−0.01	0.00	0.00	−0.00	−0.00
CZE	−0.01	0.00	0.00	0.00	0.00
DEU	−0.01	0.00	0.00	0.00	0.00
DJI	−0.01	−0.01	−0.00	−0.00	−0.00
DMA	0.03	−0.10	0.12	−0.22	−0.10
DNK	−0.01	−0.01	−0.00	−0.00	−0.01
DOM	−24.61	−18.62	−8.66	−2.29	−12.04
DZA	−0.00	0.01	0.00	0.00	0.00
ECU	−0.08	−0.15	−0.02	−0.05	−0.07
EGY	−0.01	0.01	0.00	0.00	0.00
ERI	−0.03	0.01	−0.00	0.01	0.00
ESP	−0.02	−0.03	−0.01	−0.01	−0.01
EST	−0.01	−0.01	−0.00	−0.01	−0.01
ETH	−0.02	0.01	−0.00	0.00	0.00
FIN	0.00	0.00	0.00	−0.01	−0.01
FJI	−0.05	−0.03	−0.03	0.00	−0.03
FRA	−0.01	0.00	0.00	−0.00	−0.00
FRO	−0.00	0.00	0.00	−0.00	0.00
FSM	−0.01	0.01	−0.02	0.01	−0.01
GAB	0.01	−0.02	0.00	−0.00	−0.00
GBR	−0.00	0.01	0.00	−0.00	0.00
GEO	−0.00	−0.00	0.00	−0.00	−0.00
GHA	−0.01	0.01	0.00	0.00	0.00
GIB	−0.01	−0.02	−0.00	−0.00	−0.01
GIN	−0.01	0.01	0.00	0.00	0.00
GMB	−0.02	−0.02	−0.01	−0.00	−0.01
GNB	0.25	0.02	0.12	−0.20	−0.08
GNQ	−0.00	−0.01	−0.00	−0.00	−0.00
GRC	−0.01	0.00	0.00	−0.00	−0.00
GRD	0.19	−0.08	0.06	−0.14	−0.09
GRL	−0.00	−0.00	0.00	−0.00	−0.00
GTM	4.40	2.27	1.54	−2.96	−1.49
GUM	0.00	0.00	0.01	−0.00	0.01
GUY	0.01	−0.04	0.08	−0.15	−0.07
HKG	−0.00	−0.01	−0.01	0.00	−0.01
HND	2.06	2.10	3.97	−3.60	0.23
HRV	−0.01	0.01	0.00	0.00	0.00
HTI	3.39	0.40	1.08	−2.20	−1.16
HUN	−0.00	0.00	0.00	0.00	0.00
IDN	−0.01	0.01	0.00	0.00	0.01

Table 11 (continued)

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
IND	−0.00	0.01	0.00	−0.00	−0.00
IRL	0.01	0.02	0.01	0.00	0.01
IRN	−0.01	0.01	0.00	0.00	0.00
IRQ	0.00	0.01	0.01	0.00	0.01
ISL	−0.01	0.01	0.00	0.00	0.00
ISR	0.01	0.02	0.01	0.00	0.01
ITA	−0.01	0.00	0.00	−0.00	−0.00
JAM	0.17	0.01	0.07	−0.14	−0.07
JOR	−0.00	0.01	0.00	0.00	0.01
JPN	−0.01	0.01	0.00	0.00	0.01
KAZ	−0.01	0.01	0.00	0.00	0.00
KEN	−0.01	0.01	0.00	0.00	0.01
KGZ	−0.01	−0.00	−0.00	0.00	0.00
KHM	0.00	0.02	0.00	0.01	0.01
KIR	−0.01	0.00	0.00	−0.01	−0.00
KNA	0.04	−0.04	0.14	−0.14	−0.00
KOR	−0.00	0.00	0.00	0.00	0.00
KWT	−0.00	0.01	0.00	0.00	0.01
LAO	−0.01	0.01	0.00	0.01	0.01
LBN	−0.00	0.01	0.00	0.00	0.00
LBR	−0.01	−0.00	−0.00	0.00	0.00
LBY	−0.00	0.00	0.00	−0.00	0.00
LCA	−0.21	−0.09	−0.33	−0.01	−0.34
LKA	0.00	0.01	0.00	0.00	0.01
LTU	−0.01	−0.01	−0.00	−0.00	−0.00
LUX	−0.00	−0.00	−0.00	0.00	−0.00
LVA	−0.00	−0.02	−0.00	−0.00	−0.01
MAC	0.01	0.01	0.01	−0.00	0.01
MAR	−0.01	0.00	0.00	−0.00	−0.00
MDA	−0.00	0.00	0.00	0.00	0.00
MDG	−0.00	0.01	0.00	0.00	0.01
MDV	0.00	0.01	0.00	0.00	0.01
MEX	−0.01	−0.04	−0.01	−0.00	−0.02
MHL	−0.01	0.00	−0.02	0.01	−0.01
MKD	−0.00	0.01	0.00	−0.00	0.00
MLI	−0.01	0.01	0.00	0.00	0.00
MLT	−0.00	0.00	−0.00	0.00	−0.00
MMR	−0.01	0.01	0.00	0.00	0.00
MNE	−0.01	−0.01	−0.00	−0.00	−0.00
MNG	−0.00	0.01	0.00	0.00	0.00
MOZ	−0.01	0.00	0.00	0.00	0.00
MRT	−0.02	−0.03	−0.00	−0.01	−0.01
MSR	−0.01	−0.03	−0.01	−0.04	−0.05
MUS	0.00	0.01	0.01	0.00	0.01

Table 11 (continued)

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
MWI	−0.01	0.01	0.00	0.00	0.00
MYS	−0.00	0.01	0.00	0.01	0.01
NAM	−0.00	−0.00	0.00	−0.00	0.00
NCL	−0.00	0.00	0.00	−0.00	0.00
NER	−0.01	0.01	0.00	0.00	0.00
NGA	−0.00	0.01	0.00	−0.00	0.00
NIC	10.07	8.14	3.76	−2.68	0.97
NLD	−0.00	0.00	0.00	−0.00	−0.00
NOR	−0.01	−0.00	−0.00	−0.00	−0.00
NPL	0.00	0.01	0.00	0.00	0.00
NRU	−0.00	0.01	0.00	−0.00	0.00
NZL	−0.01	−0.01	−0.00	0.00	−0.00
OMN	−0.00	0.01	0.00	0.00	0.01
PAK	−0.01	0.00	0.00	0.00	0.00
PAN	−0.06	−0.69	−0.28	−0.11	−0.40
PER	−0.02	−0.03	−0.00	−0.02	−0.02
PHL	−0.00	0.01	0.00	0.01	0.01
PLW	0.00	0.01	0.00	0.00	0.01
PNG	−0.00	0.01	0.00	0.00	0.00
POL	−0.01	0.00	0.00	−0.00	0.00
PRK	−0.01	−0.02	−0.00	−0.01	−0.01
PRT	−0.01	0.00	0.00	−0.00	−0.00
PRY	−0.01	−0.01	−0.00	−0.01	−0.01
PYF	0.00	0.00	0.01	0.00	0.01
QAT	−0.01	0.00	−0.00	0.00	0.00
ROU	−0.01	0.00	0.00	0.00	0.00
RUS	−0.01	0.00	0.00	0.00	0.00
RWA	−0.01	0.01	0.00	0.00	0.00
SAU	−0.00	0.01	0.00	0.00	0.01
SDN	−0.00	0.01	0.00	0.00	0.00
SEN	−0.02	0.00	−0.00	−0.00	−0.00
SGP	0.00	0.00	−0.00	0.00	0.00
SLB	−0.00	0.01	−0.00	0.00	0.00
SLE	−0.01	−0.01	−0.00	−0.00	−0.00
SLV	4.53	2.06	3.49	−2.97	0.41
SMR	−0.00	−0.00	0.00	−0.00	0.00
SOM	−0.00	0.01	−0.00	0.00	0.00
SRB	−0.00	0.01	0.00	0.00	0.00
SSD	−0.00	0.00	0.01	−0.01	0.00
STP	−0.03	−0.02	−0.09	−0.01	−0.10
SUR	0.00	0.01	0.14	−0.16	−0.02
SVK	−0.00	0.00	0.00	0.00	0.00
SVN	−0.00	0.00	0.00	0.00	0.00
SWE	−0.01	−0.00	0.00	−0.00	−0.00

Table 11 (continued)

Country	Total exports $X_i^T, \Delta\%$	Total imports $M_i^T, \Delta\%$	Welfare (real income) $ToT_i, \Delta\%$	Inward MRT $P_{j=i}, \Delta\%$	Factory-gate price $p_i, \Delta\%$
SWZ	− 0.01	− 0.01	− 0.00	0.00	− 0.00
SXM	− 0.04	− 0.21	− 0.06	− 0.03	− 0.09
SYC	− 0.01	− 0.01	− 0.00	− 0.00	− 0.00
SYR	− 0.01	0.01	0.00	0.00	0.00
TCA	0.04	− 0.09	0.26	− 0.28	− 0.02
TCD	0.02	0.08	0.01	0.00	0.01
TGO	− 0.01	− 0.00	− 0.00	− 0.00	− 0.01
THA	− 0.00	0.00	0.00	0.00	0.00
TJK	0.09	− 0.02	0.01	− 0.03	− 0.03
TKM	− 0.00	0.01	0.00	0.00	0.00
TLS	0.01	0.01	0.01	− 0.01	− 0.00
TON	− 0.01	− 0.05	− 0.01	− 0.01	− 0.02
TTO	− 0.08	− 0.01	− 0.26	0.01	− 0.24
TUN	− 0.01	0.01	0.00	− 0.00	0.00
TUR	− 0.01	0.00	− 0.00	0.00	0.00
TUV	− 0.01	0.00	0.00	− 0.00	− 0.00
TWN	− 0.00	0.00	− 0.00	0.00	0.00
TZA	− 0.01	0.00	− 0.00	0.00	0.00
UGA	− 0.01	0.00	− 0.00	0.00	0.00
UKR	− 0.01	− 0.00	− 0.00	− 0.00	− 0.00
URY	− 0.05	− 0.13	− 0.03	− 0.03	− 0.06
USA	− 0.17	− 0.09	− 0.01	0.03	0.02
UZB	− 0.01	− 0.00	− 0.00	0.00	0.00
VCT	0.07	− 0.02	0.08	− 0.12	− 0.04
VEN	− 0.02	0.01	− 0.06	− 0.01	− 0.06
VNM	− 0.00	0.01	0.00	0.00	0.01
VUT	0.00	− 0.04	− 0.01	− 0.01	− 0.01
WSM	− 0.00	0.01	0.00	0.01	0.01
YEM	− 0.01	0.01	0.00	0.00	0.00
ZAF	− 0.00	0.01	0.00	0.00	0.00
ZMB	− 0.01	0.00	0.00	0.00	0.00
ZWE	− 0.01	0.01	0.00	0.00	0.00

Note 1: Percentage change with respect to the counterfactual scenario. *Note 2*: Elasticity of trade, σ, equal to 4.46. *Note 3*: All values represent the full endowment general equilibrium effects. *Note 4*: Coefficients used for the baseline scenario come from Appendix Table 9

Table 12 Estimated average effect of CAFTA-DR without selected members

Dependent variable	Trade flow							
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excluded member	CRI	SLV	GTM	HND	NIC	DOM	USA	CRI, DOM
FTA	−0.022	−0.023	−0.023	−0.023	−0.023	−0.023	−0.017	−0.022
	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)	(0.031)
FTA$_{t-5}$	0.155***	0.154***	0.154***	0.154***	0.154***	0.154***	0.155***	0.155***
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.043)	(0.038)
WTO	0.064*	0.064*	0.064*	0.064*	0.064*	0.064*	0.053	0.063*
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)	(0.034)	(0.037)
CA-DR	0.604***	0.603***	0.620***	0.643***	0.625***		0.549***	
	(0.142)	(0.110)	(0.150)	(0.111)	(0.117)		(0.157)	
CA-DR$_{t-5}$	0.344**	0.139	0.171	0.149	0.188		0.049	
	(0.167)	(0.206)	(0.248)	(0.196)	(0.195)		(0.134)	
CAFTA-DR	−0.067	−0.083	−0.072	−0.074	−0.079	0.017	−0.188	0.086*
	(0.070)	(0.079)	(0.079)	(0.080)	(0.076)	(0.076)	(0.127)	(0.046)
CAFTA-DR$_{t-5}$	0.015	−0.055	−0.066	−0.049	−0.082	0.017	0.300***	0.106*
	(0.064)	(0.085)	(0.087)	(0.085)	(0.073)	(0.098)	(0.105)	(0.064)
Total effect								
FTA	0.133***	0.131***	0.131***	0.131***	0.131***	0.131***	0.138***	0.133***
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.049)	(0.045)
CA-DR	0.948***	0.742***	0.790***	0.792***	0.813***		1.009***	
	(0.216)	(0.224)	(0.280)	(0.226)	(0.226)		(0.314)	
CAFTA-DR	−0.052	−0.138	−0.138	−0.123	−0.162	0.034	0.112	0.192**
	(0.116)	(0.124)	(0.126)	(0.125)	(0.111)	(0.136)	(0.147)	(0.083)

Table 12 (continued)

Dependent variable	Trade flow							
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excluded member	CRI	SLV	GTM	HND	NIC	DOM	USA	CRI, DOM
Trend effects								
Ln(Dist)×1995	−0.135***	−0.136***	−0.136***	−0.136***	−0.136***	−0.136***	−0.166***	−0.135***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Ln(Dist)×1996	−0.144***	−0.145***	−0.146***	−0.145***	−0.145***	−0.145***	−0.180***	−0.145***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)	(0.018)
Ln(Dist)×1997	−0.095***	−0.096***	−0.096***	−0.096***	−0.096***	−0.096***	−0.117***	−0.096***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.016)
Ln(Dist)×1998	−0.090***	−0.091***	−0.091***	−0.091***	−0.091***	−0.091***	−0.113***	−0.091***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Ln(Dist)×1999	−0.046***	−0.047***	−0.047***	−0.047***	−0.047***	−0.047***	−0.061***	−0.046***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Ln(Dist)×2000	−0.005	−0.005	−0.005	−0.005	−0.005	−0.005	−0.017***	−0.005
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ln(Dist)×2001	−0.011**	−0.011**	−0.011**	−0.011**	−0.011**	−0.011**	−0.017***	−0.011**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ln(Dist)×2002	−0.019***	−0.019***	−0.019***	−0.019***	−0.019***	−0.019***	−0.026***	−0.018***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ln(Dist)×2003	−0.026***	−0.026***	−0.026***	−0.026***	−0.026***	−0.026***	−0.030***	−0.026***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ln(Dist)×2005	0.004	0.004	0.004	0.004	0.004	0.004	0.008	0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.005)

Table 12 (continued)

Dependent variable	Trade flow							
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excluded member	CRI	SLV	GTM	HND	NIC	DOM	USA	CRI, DOM
Ln(Dist)×2006	0.003	0.003	0.003	0.003	0.003	0.003	0.005	0.003
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.007)
Ln(Dist)×2007	0.015**	0.015**	0.015**	0.015**	0.015**	0.015**	0.016**	0.015**
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.006)
Ln(Dist)×2008	0.049***	0.049***	0.049***	0.049***	0.049***	0.049***	0.056***	0.049***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Ln(Dist)×2009	−0.007	−0.007	−0.007	−0.007	−0.007	−0.007	−0.006	−0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Ln(Dist)×2010	0.018**	0.018**	0.018**	0.018**	0.018**	0.018**	0.021**	0.018**
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
Ln(Dist)×2011	0.039***	0.039***	0.039***	0.039***	0.039***	0.039***	0.046***	0.039***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.010)	(0.009)
Ln(Dist)×2012	0.040***	0.040***	0.040***	0.040***	0.040***	0.040***	0.045***	0.040***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)
Ln(Dist)×2013	0.043***	0.043***	0.043***	0.043***	0.043***	0.043***	0.050***	0.043***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.011)
Ln(Dist)×2014	0.045***	0.045***	0.045***	0.045***	0.045***	0.045***	0.052***	0.045***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.012)
Ln(Dist)×2015	0.035***	0.034***	0.034***	0.034***	0.034***	0.034***	0.032**	0.035***
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.013)

Table 12 (continued)

Dependent variable	Trade flow							
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Excluded member	CRI	SLV	GTM	HND	NIC	DOM	USA	CRI, DOM
Ln(Dist)×2016	0.029**	0.028**	0.028**	0.028**	0.028**	0.028**	0.024*	0.029**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.015)	(0.013)
Ln(Dist)×2017	0.056***	0.055***	0.055***	0.055***	0.055***	0.055***	0.055***	0.056***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.013)
Ln(Dist)×2018	0.071***	0.070***	0.070***	0.070***	0.070***	0.070***	0.071***	0.071***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)
Fixed effects								
Exp/Imp-year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
# of observations	928,537	928,549	928,641	928,597	928,549	928,543	928,613	918,893
Squared correlation	0.9995	0.9965	0.9997	0.9995	0.9995	0.9995	0.9996	0.9995
Wald test, *p* value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Signif. codes: ***0.01; **0.05; *0.1. *Note 1*: standard errors clustered by country pair are reported in parentheses. *Note 2*: all estimates obtained using the PPML method. *Note 3*: fixed effect estimates excluded for brevity. *Note 4*: the number of total observations included in our regressions differs from our total sample size for three main reasons: (1) missing intranational trade flows for some countries; (2) drop in trade observations due to perfect prediction of fixed effects (countries with only zero trade flows in specific years or with specific trading partners); and (3) countries that only existed for some years of the sample period and whose trade observations were assumed as missing

Declarations

Consent to participate All the authors have approved and consented to the manuscript submission.

Consent for publication All authors have given their consent for the publication of the manuscript.

Conflict of interest The authors declare no competing interests.

References

Anderson JE, van Wincoop E (2003) Gravity with gravitas: a solution to the border puzzle. Am Econ Rev 93(1):170–192

Baier SL, Bergstrand JH (2007) Do free trade agreements actually increase members' international trade? J Int Econ 71(1):72–95

Baier SL, Yotov YV, Zylkin T (2019) On the widely differing effects of free trade agreements: lessons from twenty years of trade integration. J Int Econ 116(C):206–226

Bergé LR (2018) Efficient estimation of maximum likelihood models with multiple fixed-effects: the R package Fenmlm. CREA Discussion Paper Series 18–13. Center for Research in Economic Analysis, University of Luxembourg. https://wwwfr.uni.lu/content/download/110162/1299525/file/2018_ 13%20Efficient%20estimation%20of%20maximum%20likelihood%20models%20with%20mul tiple%20fixed-effects%20-%20the%20R%20package%20FENmlm.pdf. Accessed 1 Jul 2020

Bergstrand JH, Larch M, Yotov YV (2015) Economic integration agreements, border effects, and distance elasticities in the gravity equation. Eur Econ Rev 78:307–327

Borchert I, Larch M, Shikher S, Yotov Y (2022) The International Trade and Production Database for Estimation – Release 2(ITPD-E-R02)." Economics Working Paper Series 2022–07-A. U.S. International Trade Commission

Breinlich H, Novy D, Santos Silva JMC (2022) Trade, gravity and aggregation. Rev Econ Stat: 1-29. https://doi.org/10.1162/rest_a_01234

Campos, Rodolfo G, Jacopo Timini and Elena Vidal. 2021. "Structural gravity and trade agreements: does the measurement of domestic trade matter?" Working Papers 2117. Banco de España. https:// www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSeriadas/DocumentosTrabajo/ 21/Files/dt2117e.pdf. Accessed 14 Jan 2022

Carrère C (2006) Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model. Eur Econ Rev 50(2):223–247

Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua (1998) Tratado de Libre Comercio entre Centroamérica y República Dominicana." http://www.sice.oas.org/Trade/camdrep/CARdo_2s.asp#1.01. Accessed 19 Dec 2021

Cruz Rodríguez A, Calvo Clúa R (2016) "Implicancias del DR-CAFTA sobre el comercio intraindustrial de la República Dominicana." MPRA Paper 73009. University Library of Munich, Germany

Dypski MC (2002) The Caribbean Basin Initiative: an examination of structural dependency, good neighbor relations, and American investment. J Transnatl Law Policy 12(1):96–136

Eaton J, Kortum S (2002) Technology, geography, and trade. Econometrica 70(5):1741–1779

El Dahrawy Sánchez-Albornoz A, Timini J (2021) Trade agreements and Latin American trade (creation and diversion) and welfare. The World Economy 44(7):2004–2040

Fally T (2015) Structural gravity and fixed effects. J Int Econ 97(1):76–85

Granados J, Cornejo R (2006) Convergence in the Americas: some lessons from the DR-CAFTA process. World Econ 29(7):857–891

Gurevich T, Herman P (2018) The dynamic gravity dataset: 1948–2016." Economics Working Paper Series 2018–02-A. U.S. International Trade Commission

Head K, Mayer T (2014) Gravity equations: workhorse, toolkit, and cookbook." In *Handbook of International Economics*, edited by G. Gopinath, E. Helpman, and K. Rogoff, 4: 131–195. Elsevier

Hicks R, Milner HV, Tingley D (2014) Trade policy, economic interests, and party politics in a developing country: the political economy of CAFTA-DR. Int Stud Quart 58(1):106–117

Hornbeck JF (2012) The Dominican Republic-Central America-United States Free Trade Agreement (CAFTA DR): developments in trade and investment." CRS Report for Congress R42468. Congressional Research Service (CRS). https://digital.library.unt.edu/ark:/67531/metadc85400/?q=R42468. Accessed 28 Jun 2020

Huegel F, Kostrzewa B (2013) Tenth Report to Congress on the Operation of the Caribbean Basin Economic Recovery Act." 10. Office of the United States Trade Representative

Koehler-Geib F (Fritzi), Sanchez SM (2015) *Costa Rica five years after CAFTA-DR: assessing early results*. Edited by Friederike Koehler-Geib and Susana M. Sanchez. Directions in Development - Trade. Washington, DC: The World Bank

Larch M, Monteiro J-A, Piermartini R, Yotov YV (2019) On the effects of GATT/WTO membership on trade: they are positive and large after all." CESifo Working Paper Series 7721. CESifo

Nguyen DB (2019) A new examination of the impacts of regional trade agreements on international trade patterns. J Econ Integr 34(2):236–279

Organization of American States OAS (2005) US President George W. Bush Discusses CAFTA-DR. http://www.oas.org/en/media_center/speech.asp?sCodigo=05-0163. Accessed 27 Dec 2021

Pacheco A, Valerio F (2007) DR-CAFTA: aspectos relevantes seleccionados del Tratado y reformas legales que deben realizar a su entrada en vigor los países de Centroamérica y la República Dominicana." Estudios y Perspectivas - Sede Subregional de la CEPAL en México 76. Naciones Unidas Comisión Económica para América Latina y el Caribe (CEPAL). https://repositorio.cepal.org/handle/11362/5001. Accessed 11 Sep 2020

Paggi MS, Lynn Kennedy P, Yamazaki F, Josling TE (2005) Regional trade agreements and implications for US agriculture: the case of CAFTA-DR. Choices: Mag Food Farm Resour Issues 20(2):137–41

Poggio V, Calderon C (2010) Trade and economic growth: evidence on the role of complementarities for CAFTA-DR countries. Policy Research Working Paper Series 5426. The World Bank

Redwood S (2015) Dominican Republic: on the mining map. Min J 1:12–18. https://www.miningjournal.com/central-south-america/news/1169701/dominican-republic-mining-map. Accessed 19 Dec 2021

Reyes Peguero IM, Hansen A (2019) Did DR-CAFTA affect the exports of the Dominican Republic to the United States? Int J Interdiscip Glob Stud 14(3):19–49

Sandoval LA, Malaga JE, Carpio CE (2015) Analysis of the impact of dollarization and CAFTA-DR on El Salvador's trade flows. 2015 Annual Meeting, January 31-February 3, 2015, Atlanta, Georgia 196817. Southern Agricultural Economics Association

Santos Silva JMC, Tenreyro S (2006) The log of gravity. Rev Econ Stat 88(4):641–658

Santos Silva JMC, Tenreyro S (2022) The log of gravity at 15. Port Econ J: 1617–9838.

Simonovska I, Waugh ME (2014) The elasticity of trade: estimates and evidence. J Int Econ 92(1):34–50

Sistema de la Integración Centroamericana SICA (2013) Comunicado Conjunto de la Reunión de Jefes de Estado y de Gobierno de los Países Miembros del SICA y el Presidente de la Comisión Europea. https://www.sica.int/download/?83306. Accessed 10 Oct 2020

Spilker G, Bernauer T, Kim IS, Milner H, Osgood I, Tingley D (2018) Trade at the margin: estimating the economic implications of preferential trade agreements. Rev Int Organ 13(2):189–242

Storrs KL, Ribando C, Sek L, Sullivan MP, Taft-Morales M, Veillette C (2004) Central America and the Dominican Republic in the context of the free trade agreement (DR-CAFTA) with the United States." CRS Report for Congress RL32322. Congressional Research Service (CRS). https://digital.library.unt.edu/ark:/67531/metadc809076/?q=RL32322. Accessed 12 Oct 2020

United States, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua (2004) Dominican Republic - Central America - United States Free Trade Agreement (CAFTA-DR). https://ustr.gov/trade-agreements/free-trade-agreements/cafta-dr-dominican-republic-central-america-fta/final-text. Accessed 18 Dec 2021

Wooldridge JM (1999) Appendix B: Fundamentals of probability. In: *Introductory Econometrics: A Modern Approach*, 1st edition, US: Thomson Learning / South-Western College Publishing

World Bank (2005) Dominican Republic, Central American Free Trade Agreement (CAFTA-DR): challenges and opportunities for Central America. Document of the World Bank 32288-LAC. World Bank, Washington, DC

World Trade Organization (2016a) Free trade agreement between the Dominican Republic and Central America (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua), goods and services. Note on the Meeting of 27 September 2016a." WT/REG305/M/1 16–5742. World Trade Organization. https://docsonline.wto.org/dol2fe/Pages/FE_Search/FE_S_S006.aspx?Query=@Symbol=%20wt/reg305*&Language=ENGLISH&Context=FomerScriptedSearch&languageUIChanged=true#. Accessed 12 Oct 2020

World Trade Organization (2016b) Free trade agreement between the Dominican Republic, Central America (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua), and the United States, goods and services. Note on the Meeting of 27 September 2016b. WT/REG211/M/1 16–5734. World Trade Organization. https://docsonline.wto.org/dol2fe/Pages/FE_Search/FE_S_S006.aspx?Query=@Symbol=%20wt/reg211*&Language=ENGLISH&Context=FomerScriptedSearch&languageUIChanged=true#. Accessed 3 Nov 2020

Yotov YV, Piermartini R, Monteiro J-A, Larch M (2016) An advanced guide to trade policy analysis: the structural gravity model. World Trade Organization, Geneva

Yotov YV (2022) On the role of domestic trade flows for estimating the gravity model of trade. Contemp Econ Policy 40:526–540

Zylkin T (2016) Beyond tariffs: quantifying heterogeneity in the effects of free trade agreements." Working Paper Drexel University, Department of Economics. http://www.tomzylkin.com/uploads/4/1/0/4/41048809/beyondtariffs__web_.pdf. Accessed 28 May 2020