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The Impact of Trade Agreements in Latin America using the Synthetic Control Method

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The Impact of Trade Agreements in Latin America using the Synthetic Control Method[1]

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Abstract

The paper employs synthetic control method (SCM) to determine the impact of trade agreements for 64 Latin American country pairs in the period 1989-1996. The results suggest that trade agreements have markedly boosted exports in Latin America, on an average by 76.4 percentage points over ten years. However, there is variation across countries and agreements. The export gains due to trade agreements are lower than the world average comprising 104 country pairs in the period 1983-1995.

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I. INTRODUCTION

In line with the global effort of increasing trade integration by engaging in trade agreements, Latin America has participated in numerous trade agreements in the past four decades. Have these agreements boosted trade?

The paper employs synthetic control method (SCM) – currently very popular in micro and macro studies – to determine the impact of trade agreements in Latin America. SCM is an econometric tool for comparative studies where the control unit is determined by a systematic, data-driven procedure. A synthetic (artificial) control unit is a weighted average or linear combination of the untreated units. The weights are chosen such that both the outcome variable and its observable covariates/determinants are matched with the treated unit *before treatment*. The evolution of the actual outcome of the treated unit *post-treatment* is then compared against the outcome of the synthetic unit, and the difference is interpreted as the treatment effect. Intuitively, synthetic controls use a weighted average of the outcome of the control units to estimate the counterfactual outcome of the treated unit. Previous studies have used this approach on a range of issues, including the effect of tobacco control programmes on tobacco consumption in California and the impact of German reunification on the economic growth of West Germany.

The key advantage of employing SCM in understanding the impact of trade agreements is that it is a novel way of addressing the endogeneity problem associated with trade agreements. One of the perennial issues in academic literature related to understanding the impact of trade agreements is how to deal with the endogeneity problem. It is now a well-documented fact in academic literature that trade agreements are not exogenous random variables, but countries are likely to select endogenously into trade agreements for reasons not observable but correlated with the level of trade, hence biasing the results. SCM can be a better way of addressing this endogeneity issue. Since both the outcome variable and its observable covariates match over the specified period before treatment, the unobserved variables automatically match in the periods before treatment if one thinks of a simple factor loading model where the dependent variable is explained by its observed and unobserved covariates. The method thus allows the effect of unobserved confounders to vary with time, as opposed to traditional econometric methods that can deal with time-invariant unobserved country characteristics only. This feature is particularly useful as the benefits of trade agreements can take few years to materialize, and hence there can be potential econometric issues if the unobserved confounders are not allowed to vary with time.

Using SCM approach to the gravity model for each country pair separately, this paper looks at sixty-one Latin American country pairs, predominantly representing major trade agreements like NAFTA, Mercosur, Group of Three, Andean Community, and Central American Common Market, in the period 1989-1996. The results suggest that trade agreements have boosted exports in Latin America, on an average by 76.4 percentage points over ten years. However, there is substantial variation across countries and across agreements. Of the 61 country pairs considered, only 31 cases have positive export gains, indicating that not all countries have benefitted from trade agreements. Comparing the average treated to the average synthetic across trade agreements, NAFTA has generated the highest export gain of 80.9 percentage points over ten years, followed by Mercosur (23.7 percentage points) and Group of Three (9.5 percentage points). Comparing each country pair's treated unit to its corresponding synthetic unit, Mercosur has generated the highest average export gain, at 152.4 percentage points over ten years, followed by Group of Three (114.0 percentage points) and NAFTA (86.8 percentage points). Interestingly, all the countries participating in NAFTA have benefitted from the agreement, with the USA increasing exports on an average by 44.5 percentage points over ten years, and Canada and Mexico by 71.6 and 144.3 percentage points, respectively. The results also suggest that countries with lower income have received higher export boost owing to trade agreements.

Using both the measures of average treated relative to average synthetic across trade agreements and individual country pair's treated versus its corresponding synthetic counterpart, the export gains due to trade agreements are lower than the world average comprising 104 country pairs in the period 1983-1995, as derived in Hannan (2016). The proportion of countries that have benefitted from trade agreements are also substantially lower. The overall conclusion from this analysis is thus that, while trade agreements have substantially boosted exports in Latin America, the gains are less than that experienced in the rest of the world around the same time. The comparatively less gains are possibly due to relative weakness in factors like trade openness, export diversification, participation in global value chains, and structural reforms.

The rest of the paper is organized as follows. Section II briefly describes the main trade agreements in the data sample. Section III discusses the theoretical details underlying SCM methodology. Section IV discusses the results on trade creation, including the placebo tests. Section V concludes.

II. Trade Agreements in Latin America

The negotiation of regional and bilateral trade agreements has been a distinctive feature of international trade landscape since the formulation of General Agreement on Tariffs and Trade (GATT), signed by 23 countries in 1947, with the aim to promote international trade by substantially reducing tariffs and other trade barriers. In line with the international trend, Latin America's desire for regional integration began in the late 1950s. The first attempt towards regional integration resulted in the creation of Latin America Free Trade Association (LAFTA) in 1962, comprising Mexico and all South American countries (except Guyana, Surinam and French Guyana). The objective of this agreement was to create a free trade area by 1972 through the gradual reduction of tariffs and the elimination of non-tariff barriers hurting intraregional trade. In 1980, LAFTA reorganized into Latin American Integration Association (LAIA). It maintained the creation of Latin American common market as a final goal but without adhering to any fixed timetable.

Though the process of regional integration started in Latin America from late 1950s, it was not until the mid-1980s that the process of regional integration progressed at a rapid pace with the formation of multiple trade agreements across various countries of the region (table 1). This paper studies some of the major trade agreements in the region since 1980. Before proceeding to the analysis, the rest of this section, mostly based on Indart and Lengyel (1995), briefly describes most of the trade agreements covered in this study.

Table 1

Trade Agreements
Mercado Comun del Sur, or Mercosur (1991): Argentina, Brazil, Paraguay, Uruguay (formed in 1991 and a free trade area in 1995)
Central American Common Market (1961-1975, 1993-present): El Salvador, Guatemala, Honduras, Nicargua, Costa Rica (1965)
Andean Community (1993): Bolivia, Columbia, Ecuador, Peru, Venezuela, Peru (1997)
North American Free Trade Agreement, or NAFTA (1994): Canada, Mexico, United States
Bolivia-Mexico (1995)
Costa Rica-Mexico (1995)
Group of Three (1995): Columbia, Mexico, Venezuela
Mercosur-Chile (1996)
Mercosur-Bolivia (1996)

Source: Condensed version of Table 3 (Baier and Bergstrand, 2007).
Years in parentheses denote date of entry, except where noted otherwise.

Central American Common Market, comprising Costa Rica, Guatemala, El Salvador, Honduras, and Nicaragua, is one of the oldest integration projects in Latin America, with efforts starting in the early 1950s and culminating in a treaty in 1960 with the objective of creating a custom union within a decade. The political turmoil in the 1970s and 1980s left the treaty ineffective. However, the agreement was revived in early 1990s. One of the important features of this agreement was the introduction of a common external tariff for third-country imports. The countries also made efforts to reduce nontariff barriers like reducing red tape at the borders.

Mercosur, comprising Argentina, Brazil, Uruguay, and Paraguay, was formed in March, 1991, with the goal of the formation of the Common Market of the South (MERCOSUR) by December 31, 1994. The treaty facilitated the free movement of goods, services and factors of production. The members set a common external tariff for third parties and adopted a common trade policy towards third parties. The treaty also included the adoption of tariff reductions and NTB elimination, which would not benefit other LAIA members.

Andean Community, comprising Bolivia, Colombia, Ecuador, Peru[2] and Venezuela, was formed in 1969 with the aim to liberalize interregional trade and eventually form a custom union. The trade crisis following the debt crisis of 1982 made the members realize that the existing institutional arrangement would not allow the group to reach their objectives. This

[2] Left the group in 1992 and joined again in 1997.

prompted the members to make a major revision of foreign investment rules, trade measures, and joint development programs in 1988. Finally, the Summit of La Paz (November 1990), the Andean group agreed to form a custom union by the end of 1993 among the three major countries and by 1995 for others. In 1992, the group agreed to reach full liberalization of intraregional trade by January 1993 and to adopt a common external tariff by the end of that year.

North American Free Trade Agreement (NAFTA), comprising Canada, Mexico, and the U.S., came into force on January 1, 1994, superseding the Canada-United States Free Trade Agreement between Canada and the United States. The goal of the agreement was to eliminate trade and investment barriers amongst the signatory countries. NAFTA was formed to eliminate non-tariff trade barriers and to protect the intellectual property rights on traded products. NAFTA has two supplements: the North American Agreement on Environmental Cooperation (NAAEC) and the North American Agreement on Labor Cooperation (NAALC).

Group of Three, comprising Colombia, Mexico, and Venezuela, was formed in 1990, with the aim of promoting trade and eventually forming a free trade area by January 1, 1995. The agreement was not only limited to liberalizing trade, but also included issues such as investment, services, government purchases, regulations to fight unfair competition, and intellectual property rights.

III. Empirical Strategy[3]

> "Given that many policy interventions and events of interest in social science take place at an aggregate level (countries, regions, cities, etc.) and affect a small number of aggregate units, the potential applicability of synthetic control methods to comparative case studies is very large, especially in situation where traditional regression methods are not appropriate."
>
> Abadie, Diamond and Hainmueller (2010)

Synthetic control method (SCM) is a recent econometric tool for comparative studies developed by Abadie and Gardeazabal (2003) and later extended by Abadie, Diamond and

[3] The description of methodology is mostly taken from Hannan (2016), with some modifications.

Hainmueller (2010). SCM provides a systematic way of choosing comparison units in comparative studies as the choice of comparison unit is a data driven procedure. As highlighted in Hosny (2012), SCM is close in spirit to the matching estimators and difference-in-differences models, but rest on weaker identification assumptions that allows the effects of unobserved confounders to vary with time. SCMs create synthetic (artificial) control or comparison units based on their similarity to the treated country before the treatment actually takes place. This is done based on a weighted average of past observable covariates and past realizations of the outcome variables. The evolution of the actual outcome of the treated unit post-treatment is then compared against the outcome of the synthetic unit, and the difference is interpreted as the treatment effect.

Since the publication of Abadie, Diamond and Hainmuller (2010)'s seminal study of the effect of tobacco control programmes on tobacco consumption in California, the SCM approach has been very popular in micro and macro studies. The range of applications is very wide, from studies of natural disasters and political conflict through to social and economic policy interventions, as is the range of spatial scales, from whole countries to school districts. Abadie, Diamond and Hainmueller (2014) uses SCM to look at the impact of German reunification on economic growth in West Germany, while Lee (2011) uses the approach to evaluate the effect of inflation-targeting policies on inflation rates in emerging markets. A comprehensive list of studies using SCM during the period 2003-2015 can be found in Craig (2015).

While SCM has been a very popular approach in many micro and macro studies, there are relatively very few studies in international trade using this approach. Billmeier and Nannicini (2007) and Nannicini and Billmeier (2011) use SCM to look at trade openness and growth relationship. Hosny (2012) looks at Algeria's trade with GAFTA countries. Hannan (2016) uses the methodology across a large number of trade agreements, involving 104 country pairs from multiple income groups. As far as the author is aware, this paper is the first attempt to employ SCM across a large number trade agreement in Latin America.

A. SCM Methodology

This section summarizes the technical details underpinning the SCM methodology, following the exposition of Abadie, Diamond and Hainmueller (2010). The authors propose a simple model to provide the rationale for the use of SCM in comparative case study research. The model assumes that there are *J+1* regions and that the first region is exposed to the intervention of interest, so that the remaining *J* regions are potential controls, or, as is known in statistical matching literature, “donor pool”.

The authors make the following assumptions while building the model:

- Y_{it}^N is the outcome that would be observed for region i at time *t* in the absence of intervention, for units *i*=1,….,*J+1*, and time periods *t*=1,….,*T*.
- T_0 is the number of pre-intervention periods, with $1 \leq T_0 \leq T$.
- Y_{it}^1 is the outcome that would be observed for unit *i* at time *t* if unit *i* is exposed to the intervention in periods T_0+1 to *T*.
- The intervention has no effect on the outcome before the implementation period. Hence for $t \in [1, \dots, T_0]$ and all $i \in [1, \dots, N]$, $Y_{it}^1 = Y_{it}^N$.
- The observed outcome for unit *i* at time *t* is then $Y_{it} = Y_{it}^N + \alpha_{it} D_{it}$, where $\alpha_{it} = Y_{it}^1 - Y_{it}^N$ is the effect of the intervention for unit *i* at time *t*, and D_{it} is an indicator that takes value one if unit *i* is exposed to the intervention at time *t*, and value zero otherwise. Since only the first region is exposed to the intervention and only after period T_0:

$$D_{it} = \begin{cases} 1, & i = 1 \; and \; t > T_0 \\ 0, & otherwise \end{cases} \qquad (1)$$

In this set-up, the aim is to estimate $(\alpha_{1T0+1}, + \cdots + \alpha_{1T})$.

$$\alpha_{1t} = Y_{1t}^1 - Y_{1t}^N = Y_{1t} - Y_{1t}^N \qquad for\ t > T_0 \qquad (2)$$

Y_{1t} is observed. Hence, to estimate α_{1t}, the only variable that needs to be estimated is Y_{1t}^N. The idea of synthetic control is introduced here by Abadie, Diamond and Hainmueller (2010), in the process of estimating Y_{1t}^N. The authors assume that Y_{it}^N is given by a factor model:

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it}, \qquad (3)$$

where δ_t is an unknown common factor with constant factor loadings across units, Z_i is a vector of observed covariates (not affected by the intervention), λ_t is a vector of unobserved common factors, μ_i is a vector of unknown factor loadings, and the error terms ε_{it} are unobserved transitory shocks at the region level with zero mean.

Abadie, Diamond and Hainmueller (2010) show that the equation (3) is a generalization of the difference-in-differences (fixed-effects) approach. However, a key difference is that the impact of unobservable common factor representing, in this example, region heterogeneity, λ_t, is allowed to vary with time. In difference-in-difference models, the unobserved heterogeneity is assumed to be constant across time, and can therefore be eliminated by taking differences.

Abadie, Diamond and Hainmueller (2010) further define the following $(J \times 1)$ vector of weights:

$$W = \left(w_2, \dots\dots, w_{J+1}\right) \; such \; that \; w_j \geq 0 \; and \; \sum w_j = 1 \; for \; j = 2, \dots\dots, J+1 \qquad (4)$$

Each particular value of W represents a potential synthetic control for the treated unit, that is, a particular weighted average of control units. The value of the outcome variable for each synthetic control indexed by W is:

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt} \qquad (5)$$

Suppose that there is an optimal vector $\left(w_2^*, \dots\dots, w_{J+1}^*\right)$ such that

$$\sum_{j=2}^{J+1} w_j^* \, Y_{j1} = Y_{11}, \qquad \sum_{j=2}^{J+1} w_j^* \, Y_{j2} = Y_{12}, \quad \dots, \; \sum_{j=2}^{J+1} w_j^* \, Y_{jT0} = Y_{1T0} \quad and \quad \sum_{j=2}^{J+1} w_j^* \, Z_j = Z_1, \qquad (6)$$

then the following could be used as an estimator of the treatment effect,

$$\widehat{\alpha_{1t}} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* \, Y_{jt} \qquad for \;\; t \in (T_0 + 1, \dots, T) \qquad (7)$$

In practice, the synthetic control $\left(w_2^*, \dots\dots, w_{J+1}^*\right)$ is selected so that equation (6) holds approximately. The vector $\left(w_2^*, \dots\dots, w_{J+1}^*\right)$ is optimally chosen to minimize the following pseudo-distance:

$$\|X_1 - X_0W\| \text{ such that } w_j \geq 0 \text{ and } \sum w_j = 1 \text{ for } j = 2, \dots, J+1, \qquad (8)$$

where X_1 represents a vector of pre-intervention characteristics of the treated region, while X_0 is a matrix containing the same pre-intervention variables of the control regions.

In simple words, the SCM essentially uses a weighted average of the outcome of potential control units to estimate the counterfactual outcome of the treated unit. The weights are chosen in such a way that, on average, the estimated pre-intervention outcome and observed characteristics of the synthetic control are very close to those actually observed in the treated unit. One of the novelties of this approach is that, unlike difference-in-difference models, it allows the impact of unobservable confounding factors to be time-variant.

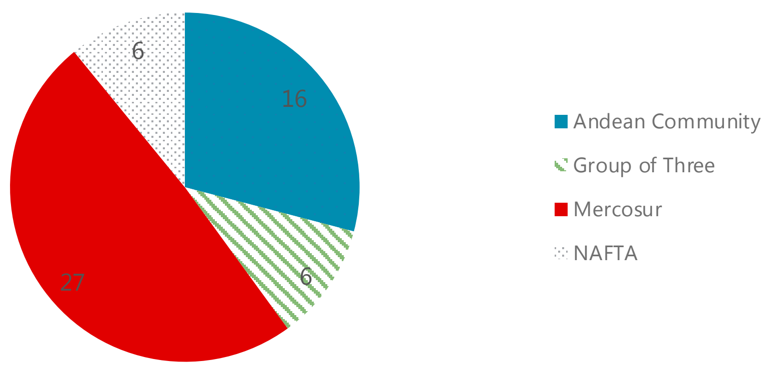
While SCM approach has been extremely popular in recent studies to address endogeneity concerns, some of the disadvantages should be borne in mind, well summarized in Craig (2015). First, since the method relies on comparisons between a real region and a synthetic control unit, standard methods of statistical inference are inappropriate. Instead, Abadie, Diamond and Hainmueller (2010) propose to use placebo or 'falsification' tests described in Section IV. Hence, inference is less formal compared to other econometric methods and is based on weaker assumptions. Second, the effect of the intervention can only be estimated accurately if there were no other events that affect only the intervention area, such as additional policy changes. Third, SCM assumes that the intervention should affect outcomes only in the intervention area. If the other areas comprising the synthetic unit are also affected, the impact could be potentially underestimated. Fourth, a good fit is needed between the pre-intervention trends in the intervention area and the synthetic control. Finally, for the method to work well, some weighted combinations of regions in the donor or control pool must be similar to the intervention area. If the treated region is at the extreme end of the range of observed characteristics, it might be difficult to find an appropriate synthetic.

B. Application of SCM to Bilateral Trade Pairs

This section discusses how SCM can be used to determine the impact of trade agreements. First, the trade agreements – the treatment in SCM approach – are discussed.

Second, the gravity model is used to determine the covariates that are used to form the synthetic pair.

Figure 1: Number of Country Pairs in Sample for Each Trade Agreement



The Trade Agreements

This paper looks at the impact of regional trade agreements in Latin America over the period 1989-1996. The regional trade agreements are taken from Head, Mayer and Ries (2010). Figure 1 shows the number of country pairs belonging to the major trade agreements. Each agreement between two countries, for example Country A and Country B, would translate into two pairs, one representing the exports from Country A to Country B, the other representing the exports from Country B to Country A. Of the 61 pairs studied[4], there are 27 pairs representing Mercosur, 16 representing Andean Community, 6 representing NAFTA, and 6 representing Group of Three. The sixty-one country pairs are listed in table 2.

From Gravity Model to SCM

This paper employs SCM approach to understand bilateral exports of countries for the ten years following a trade agreement. The trade agreement is the 'treatment' undergone while the country pair with the trade agreement can be regarded as the 'treated' unit. To construct the synthetic that would represent the counterfactual, the donor pool (or the control group) should naturally not include the same treatment. Consequently, the donor pool for

[4] Initially, the study considered 64 country pairs. However, due to data constraints, three pairs were removed.

each treated unit excludes all the country pairs in the sample that had a trade agreement in the same year. In addition, the donor pool excludes all other trade agreements that the exporting country has with any other country in the entire sample.

Table 2: Country Pairs

Exporting Country	Importing country	Entry into force	Exporting Country	Importing country	Entry into force
CAN	USA	1989	CRI	MEX	1995
USA	CAN	1989	ECU	BOL	1995
ARG	BRA	1991	ECU	COL	1995
ARG	PRY	1991	ECU	PER	1995
ARG	URY	1991	ECU	VEN	1995
BRA	ARG	1991	MEX	BOL	1995
BRA	PRY	1991	MEX	CRI	1995
BRA	URY	1991	MEX	VEN	1995
PRY	ARG	1991	PER	BOL	1995
PRY	BRA	1991	PER	ECU	1995
PRY	URY	1991	PER	VEN	1995
URY	ARG	1991	VEN	COL	1995
URY	BRA	1991	VEN	ECU	1995
URY	PRY	1991	VEN	MEX	1995
CRI	NIC	1993	VEN	PER	1995
NIC	CRI	1993	ARG	BOL	1996
CAN	MEX	1994	ARG	CHL	1996
MEX	CAN	1994	BOL	ARG	1996
MEX	USA	1994	BOL	BRA	1996
USA	MEX	1994	BOL	PRY	1996
COL	MEX	1995	BOL	URY	1996
COL	PER	1995	BRA	BOL	1996
MEX	COL	1995	BRA	CHL	1996
PER	COL	1995	CHL	ARG	1996
BOL	COL	1995	CHL	BRA	1996
BOL	ECU	1995	CHL	PRY	1996
BOL	MEX	1995	CHL	URY	1996
BOL	PER	1995	PRY	BOL	1996
COL	BOL	1995	PRY	CHL	1996
COL	ECU	1995	URY	BOL	1996
COL	VEN	1995			

As discussed in the previous section, the synthetic variable is constructed based on a weighted average of past observable covariates and past realizations of the outcome variable. For our purpose, in order to obtain the covariates, we need a model that can be useful in explaining bilateral trade between two country pairs. We can then use the determinants of trade (or regressors/covariates) from that model and the exports between two country pairs (or outcome variable) to create the synthetic counterfactual outcome. For the regressors or covariates of the SCM approach, we resort to the gravity model that has been widely used in the last four decades in empirical analysis to understand patterns and potential of trade. Feenstra, Markusen and Rose (2001) argue that simple gravity equation explains a great deal about the data on bilateral trade flows and is consistent with several theoretical models of trade.

The gravity model is essentially a simple equation to predict the trade on a bilateral basis between any two countries. The name is derived from the similarity to the law of gravity in physics, with the attraction (trade) depending on mass (economic size) and distance. Recent studies have augmented the simple model to include dummy variables incorporating some characteristics common between two countries that may be useful determinants of bilateral flows. As discussed in Head, Mayer and Ries (2010), all the well-known empirical and theoretical formulations of the gravity equation can be represented in the following equation for the value of x_{ijt}, the exports from exporting country *i* to importing country *j* in year *t*:

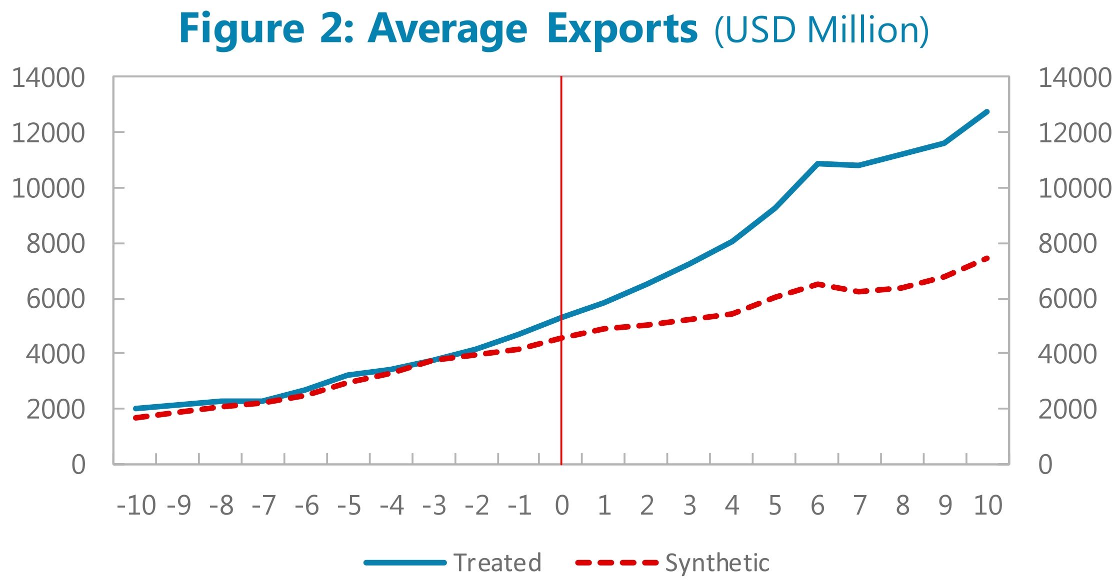
$$x_{ijt} = G_t M_{it}^{ex} M_{jt}^{im} \emptyset_{ijt} \qquad (9)$$

where M_{it}^{ex} and M_{jt}^{im} are indexes of the attributes of exporter *i* and importer *j* in a specific year. As highlighted in UNCTAD/WTO (2012), M_{it}^{ex} comprises export-specific factors (such as the exporter's GDP) that represent the total amount exporters are willing to supply and M_{jt}^{im} denotes all importer-specific factors that make up the total importer's demand (such as the importing country's GDP). G_t is a common year-specific factor determining trade that does not depend on *i* or *j* such as the level of world liberalization. Finally, variation in bilateral trade intensity enters through $\emptyset_{ijt}$, a variable that represents the ease of exporter *i* to access of market *j* (that is, the inverse of bilateral trade costs). In literature, M_{it}^{ex} and M_{jt}^{im} are referred to as monadic effects while $\emptyset_{ijt}$ as the dyadic effect. In practice, the gravity equation relates the monetary value of trade between two countries to their respective GDPs, composite terms measuring barriers and incentives to trade between them, and terms measuring barriers to trade between each of them and the rest of the world. UNCTAD/WTO (2012) has a detailed exposition on this.

In line with literature on the determinants of trade, the paper uses the following variables for covariates in the SCM approach:

- Distance between the bilateral pairs
- GDP of each country in the bilateral pair
- GDP per capita of each country in the bilateral pair
- Population of each country in the bilateral pair
- Bilateral Real Exchange Rate
- Remoteness of each country in the bilateral pair, proxy for multilateral trade resistance (MTR) term (remoteness due to physical distance and/or policy).
- Dummy variables:
    - Colonial history = 1 if pair ever in colonial relationship
    - Col to = 1 if export from hegemon to colony
    - Col from = 1 if export from colony to hegemon
    - Contig = 1 for contiguity
    - Comleg = 1 for common legal origins
    - Comcur = 1 for common currency
    - Common language = 1 for common official language
- Exports, lagged by three years

The data comes mostly from the underlying gravity dataset used in Head, Mayer and Ries (2010), available at http://econ.sciences-po.fr/thierry-mayer/data. The authors note that the trade data in the dataset comes from IMF DOTS database. The trade agreements are taken from three sources: Baier and Bergstrand (2007), supplemented with information from WTO and qualitative information contained in Frenkel (1997). The gravity controls are taken mainly from World Bank's Development Indicators, national sources, and Angus Maddison dataset. The authors also use data from Andrei Shleifer and Glick at http://post.economics.harvard.edu/faculty/shleifer/Data/qgov_web.xls and Glick and Rose (2002) for common legal origins and common currency, respectively. Bilateral distances and common (official) language come from the CEPII distance database (http://www.cepii.fr/anglaisgraph/bdd/distances.htm). Outside the dataset by Head, Mayer and Ries (2010), bilateral real exchange rate is calculated using data from World Development Indicators.



All the variables are self-explanatory. However, multilateral trade resistance (MTR) warrants some discussion. This term arises from the seminal work of Anderson and van Wincoop (2003), who show that bilateral trade is determined by related trade costs. The propensity of country *j* to import from country *i* is determined by country's trade cost toward *i* relative to its overall resistance to imports (weighted average trade costs) and to the average "resistance" facing exporters in country *i*; not simply by the absolute trade costs between countries *i* and *j*. Following the practice of a lot of studies in literature (UNCTAD/WTO, 2012), this paper incorporates MTR terms for exporting and importing countries by including a proxy for these indexes called "remoteness":

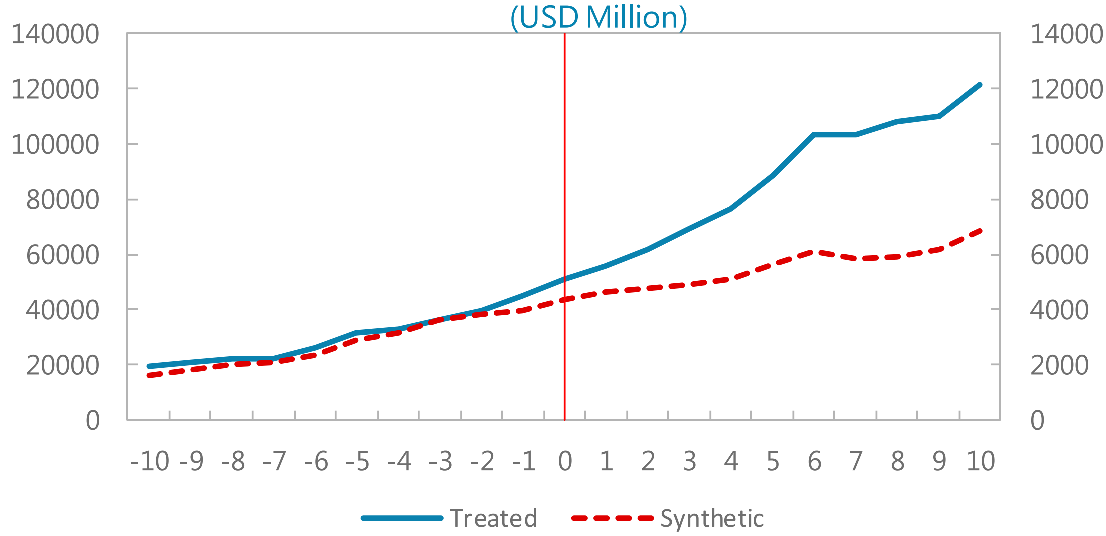
$$Rem_i = \sum_j \frac{dist_{ij}}{GDP_j / GDP_w} \qquad (10)$$

This formula measures a country's average weighted distance from its trading partners (Head, 2003), where weights are the partner countries' shares of world GDP (denoted by GDP_w).

IV. RESULTS

The synthetic control methodology is employed to each of the sixty-one country pairs separately using the approach described in the previous section. There is no panel dimension to this exercise. The results are then reported both in terms of averages (the average treated is compared to the average synthetic) as well as individual countries (each country's treated is

Figure 3: Average Exports in NAFTA



compared to each country's synthetic). Since SCM is employed on each country pair separately, the results on individual countries highlight the diversity and variation across countries in terms of the export gains achieved. On the other hand, the results reported as averages are useful in obtaining a broader perspective about the overall importance of trade agreements in boosting trade in Latin America.

A. Average of Countries

Figure 2 shows the results for the average of the 61 country pairs, while figure 3 looks specifically at the NAFTA trade agreement.[5,6] The outcome variable, gross exports, is plotted against the time to trade agreements, with t=0 referring to the period when the

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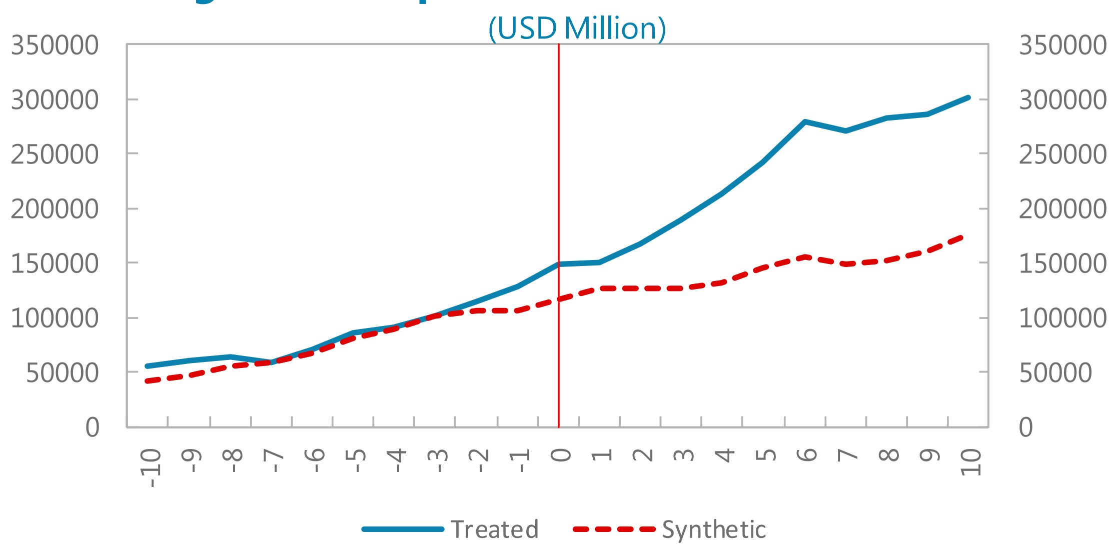
[5] The synthetic usually diverges the treated unit before t=0 when the trade agreement is in effect. This is due to the anticipation effect. This fact has been acknowledged in literature related to synthetic controls.

[6] For NAFTA, bilateral country pairs corresponding to Canada and USA trade has t=0 in 1989, reflecting the Canada-United States Free Trade Agreement that was superseded by NAFTA. Hannan (2016) discusses that taking t=0 in 1994 for these pairs yields similar overall results for NAFTA.

agreement was enacted, t=-1, -2,…,-10 showing the outcome variable until ten years before the trade agreement, and t=+1, +2, …,+10 showing the outcome variable until ten years after the trade agreement. The blue line shows the average gross exports of countries undergoing the trade agreement, while the red dotted line shows their synthetic counterparts. The divergence between the treated and synthetic lines in these figures post trade agreement indicates substantial gains from trade. The average gross exports of Latin American countries with trade agreements is 76.4 percentage points higher over the next ten years on a cumulative basis, compared to the average synthetic counterparts.[7]

Fig 4: U.S. Exports to Canada and Mexico



Looking at some specific trade agreements, one key finding for NAFTA is that the treated unit is larger than the synthetic unit for all the possible bilateral pairs involving the USA, Canada and Mexico, indicating that the exports have increased for all the participating countries (figures 4, 5, and 6). The exports due to NAFTA increased by 80.9 percentage points over ten years.

In terms of other major trade agreements considered in this study, Figure 7 shows the impact of Mercosur and Group of Three. Compared to NAFTA, the export gains of Mercosur and Group of Three are smaller at 23.7 and 9.5 percentage points respectively over ten years on a cumulative basis. This indicates that the export gains in Latin America due to trade

[7] For export gains over ten years, export growth of treated unit using t=10 and t=0 is computed. This is then compared to the export growth of the synthetic over the same time frame.

agreements are predominantly driven by NAFTA when the average treated unit is compared to the average synthetic unit. This implies that, from a global perspective, the export gains in Mercosur and Group of Three have been small compared to that of NAFTA.

Fig 5: Canada Exports to Mexico and U.S.
(USD Million)

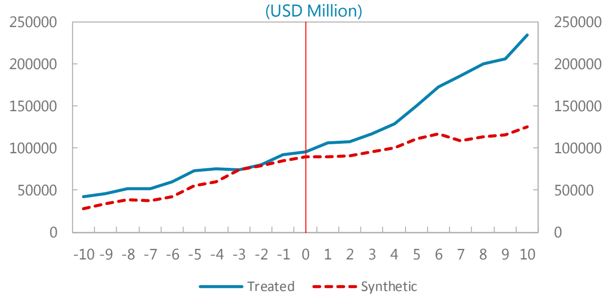


Fig 6: Mexico Exports to Canada and U.S.
(USD Million)

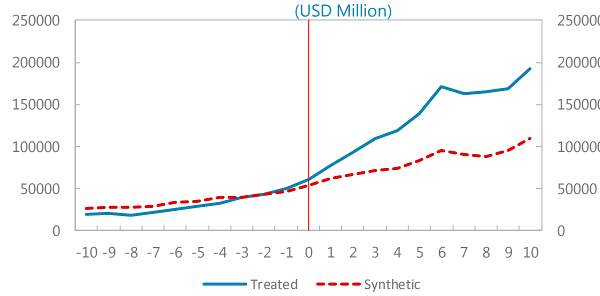


Figure 7: Export Growth of Average Treated over Ten Years, Relative to Average Synthetic
(cumulative, percentage points)

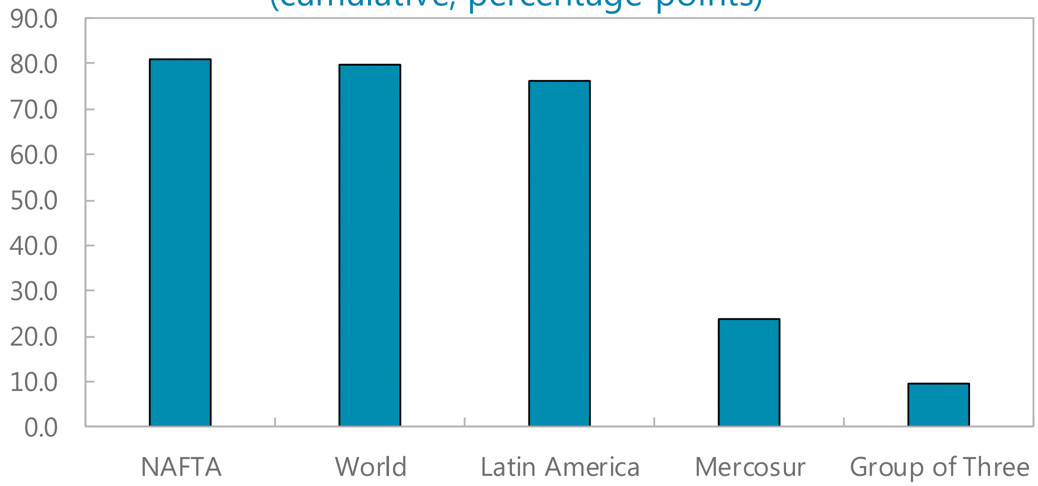
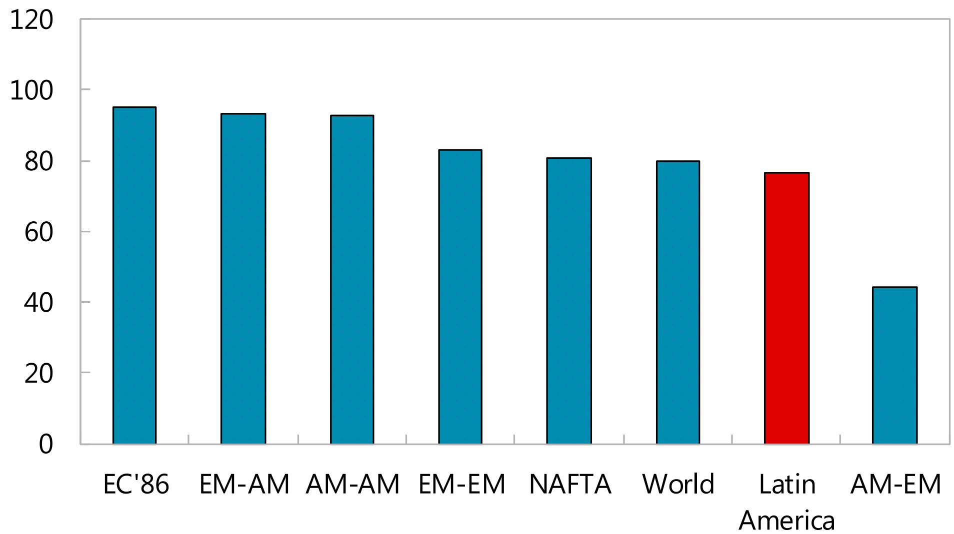


Figure 7 also compares the results of Latin America to the export gains of world average. Hannan (2016), using the same methodology of synthetic controls on 104 country pairs, argues that the cumulative export gains over ten years is 79.7 percentage points due to trade agreements. Our results suggest that the export gains of Latin America are lower than the average export gains of world, by 3.4 percentage points. The export gains of NAFTA over ten years are comparable to world average, while the export gains of Mercosur and Group of Three are much lower than world average.

Figure 8 compares the results to the export gains achieved by different income groups in the world. A country pair EM-AM in the figure denotes the export gains by the emerging market when it has a trade agreement with an advanced country. The computed numbers suggest that the export gains in Latin America are much lower than the export gains achieved by other income groups, except AM-EM.

Figure 8: Export Growth of Average Treated in Ten Years, Relative to Average Synthetic
(Cumulative, Percentage Points)



B. Individual Countries

This section discusses the individual export gains of the 61 country pairs studied. Figure 9 plots the export gains over ten years for each country against the goodness of fit between treated and synthetic for the ten years prior to the trade agreement. The export gains are computed as the export growth of treated over ten years (after trade agreement) on a cumulative basis relative to the export growth of the synthetic over the same period, expressed in percentage points. The x-axis of figure 9 reports the normalized root-mean-square deviation (NRMSD)[8] of each country, with a lower number indicating better goodness

[8] The root-mean-square deviation (RMSD) or root-mean-square-error (RMSE) is a frequently used measure of the differences between values predicted by a model and the values actually observed. RMSD is the square root of the mean of the squares of deviations. Normalizing the RMSD facilitates the comparison between different

(continued…)

of fit. Figure 10 shows a truncated version of figure 9, representing country pairs that have goodness of fit less than 1.

Figure 9: Export Gains versus Goodness of Fit

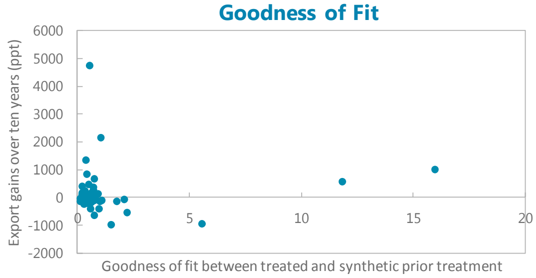
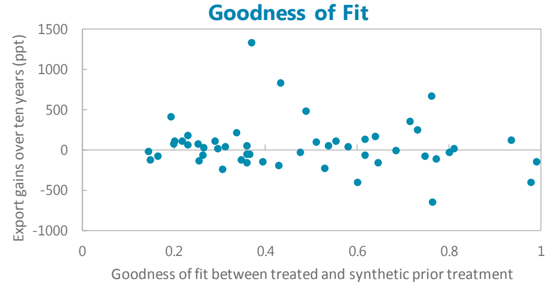


Figure 10: Export Gains versus Goodness of Fit



Export gains are export growth of treated over ten years relative to synthetic, in cumulative percentage points. Goodness of fit is the normalized root-mean-square deviation between treated and synthetic for the ten years prior to treatment. A smaller number of goodness of fit indicates a better fit.

The results in figure 9 indicate the export gains can be substantial for most countries, however there is immense variation. The average of individual country gains is 132.6 percentage points, while the median is 9.9 percentage points. The highest export gain is 4755.5 percentage points for the country pair CRI-MEX (Costa Rica's exports to Mexico following the trade agreement in 1995). When the export gains for cases with less than NRMSD of 2 are considered, the average export increase is 144.6 percentage points. When pairs with export gains less than 1000 percentage points are considered, the average export gain is -2.7 percentage points. Not all countries gain from trade agreements: of the 61 country pairs considered, 31 countries show positive gains from trade agreements. The highest loss is -967.7 percentage points (representing Bolivia's exports to Ecuador following the trade agreement in 1995). Overall, these results suggest that, while trade agreements can boost exports, there is considerable variation amongst countries and not all countries have benefitted from trade agreements. In particular, the proportion of countries that have gained due to trade agreements is at 51 percent, significantly lower than the world average of 77 percent.

Figures 11 and 12 report the export gains by size and income per capita of the exporting country, respectively. The export gains are higher for countries with smaller size, indicating that smaller countries can get a disproportionately higher boost from trade agreements,

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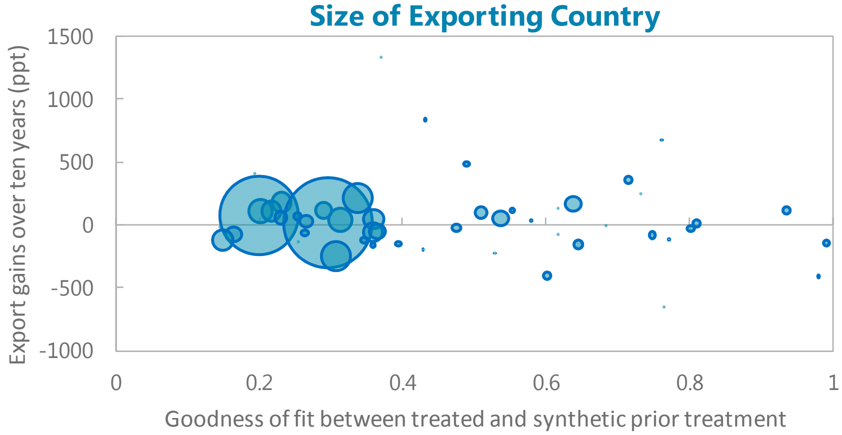
units. The normalized root-mean-square deviation (NRMSD) is computed by dividing the RMSD of each country pair by the average exports over ten years prior to intervention.

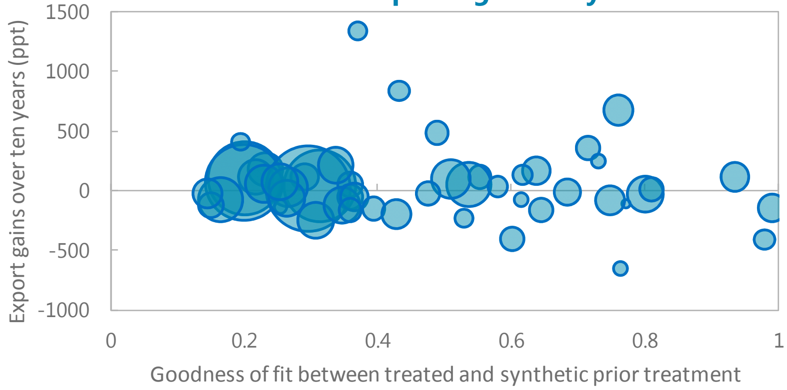
possibly due to the greater opportunity of trade integration and lower base effect. The relationship between the exporting country's income per capita and export gains is less clear-cut. Having said that, there seems to be some suggestive evidence that the larger export gains have come from countries with lower income per capita. These results are in line with the global trends.

Figure 11: Export Gains by Size of Exporting Country



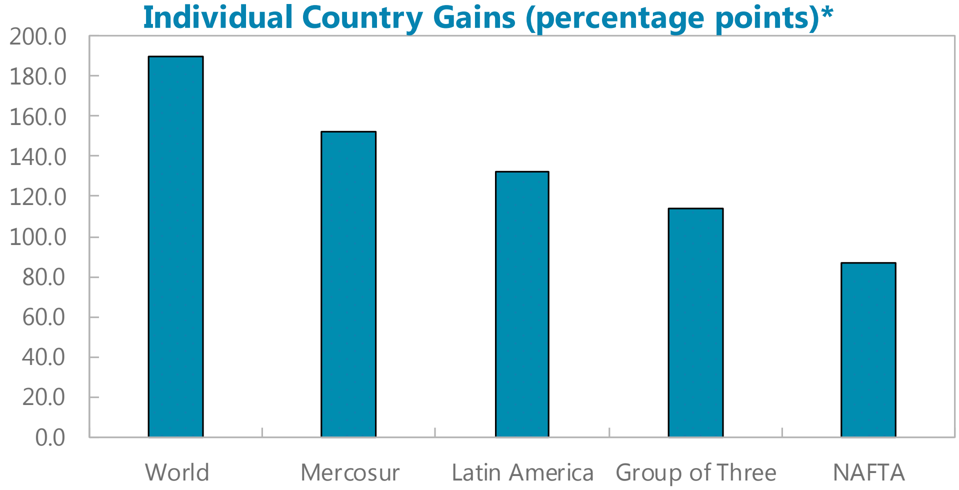
Size of bubles represents nominal GDP (USD million) of exporting country during the year of trade agreement. Export gains are export growth of treated over ten years relative to synthetic, in cumulative percentage points. Goodness of fit is the normalized root-mean-square deviation between treated and synthetic for the ten years prior to treatment. A smaller number of goodness of fit indicates a better fit.

Figure 12: Export Gains by Income per Capita of Exporting Country



Size of bubles represents nominal GDP per capita (USD) of exporting country during the year of trade agreement. Export gains are export growth of treated over ten years relative to synthetic, in cumulative percentage points. Goodness of fit is the normalized root-mean-square deviation between treated and synthetic for the ten years prior to treatment. A smaller number of goodness of fit indicates a better fit.

Figure 13: Export Gains over Ten Years, Average of Individual Country Gains (percentage points)*



Exports gains over ten years for each country is export growth of treated over ten years relative to export growth of synthetic over ten years.

Figure 13 computes the average of individual country gains over ten years across the major trade agreements studied in this paper. The export gains are the highest for Mercosur (152.4 percentage points), followed by Group of Three (114.0 percentage points), and then

NAFTA (86.8 percentage points). The average of export gains of trade agreements in Latin America is 132.6 percentage points. The individual country gains are markedly lower than the world average of 190.2 percentage points over ten years.

Comparing the results to literature

Recent literature shows that, once endogeneity bias is corrected, the impact of trade agreements can be substantial. For example, Baier and Bergstrand (2007) use instrumental variables with cross section data while Baier and Bergstrand (2009) use nonparametric (matching) econometric techniques. Both the papers find that trade agreements increase trade by around 100 percent in the long run. The sample in these studies is not limited to Latin American countries. When the synthetic control method (SCM) is used across a broader number of trade agreements not restricted to Latin American countries, the results are similar to these studies (see Hannan 2016).

In terms of the performance of NAFTA and Mercosur, the results in literature are mixed. One of the famous papers, Kehoe (2003) evaluates the performances of three of the most prominent multisectoral static applied general equilibrium models used to predict the impact of NAFTA. The author finds that these models drastically underestimated the impact of NAFTA on North American trade. This paper begs the question that more work needs to be done to capture the accurate impact of NAFTA. Table 1 of Coulibaly (2009) summarizes previous literature on the impact of Mercosur, showing studies with both positive and negative trade creation. The author then uses a semi-parametric approach to show a positive impact. Broadly speaking, it seems that literature is finding more positive results with the recent initiative of addressing the endogeneity concern with parametric approaches.

C. Placebo (or Falsification) Tests[9]

This section assesses whether the effect estimated by the synthetic control method for a country pair affected by the trade agreement is large relative to the effect estimated for a country pair chosen at random. For SCM studies, Abadie, Diamond and Hainmueller (2010)

[9] The description of placebo tests in this section is taken from Hannan (2016).

propose exact inferential techniques, akin to permutation tests, to perform inference. The idea is to apply the synthetic control method to the controls in the sample and determine if the effect estimated by the synthetic control for the country pair with trade agreement (that is, affected by intervention) is large relative to the effect estimated for a country pair chosen at random that did not go through the trade agreement.

The process of performing placebo tests is as follows: ten treated units are randomly chosen from the sample. Let A be the exporting country of a treated unit chosen randomly. The idea is then to randomly select five country pairs showing the exports of A to a country that does not have a trade agreement with A. These five country pairs are known as placebos. This process of choosing ten random treated units and five control units per treated unit should thus generate fifty control units (placebos). SCM is then applied to these control units. The evolution of treated unit relative to synthetic unit is then compared to the evolution of the placebo units relative to their synthetics.

Figure 14: Export Gains over Ten Years
(cumulative, percentage points)

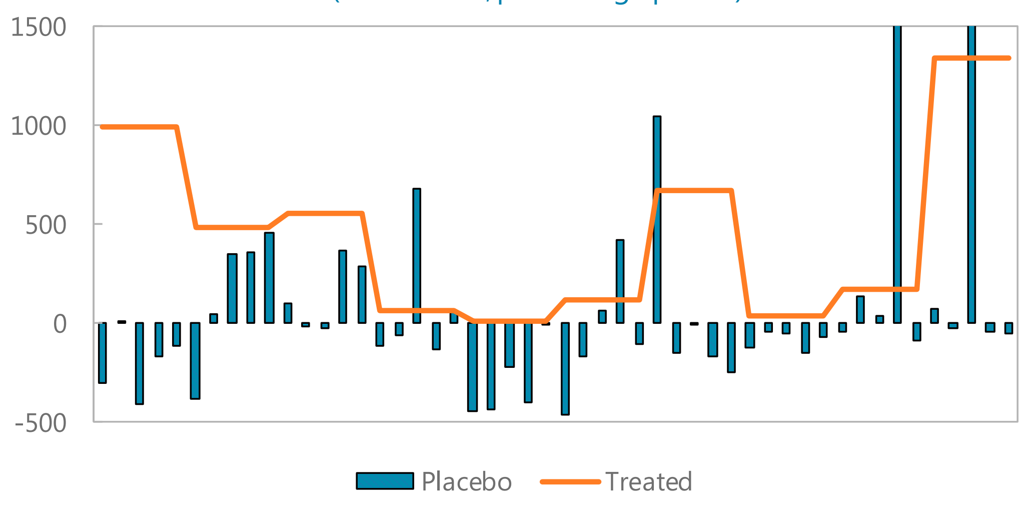


Figure 14 shows the results of this exercise, where the bold orange line represents the export gains over ten years due to the trade agreements for the treated unit and the blue bars represent the same measures for the placebo units. For each blue bar, a higher value for the corresponding orange line would indicate that the gains from the treated unit is higher than that implied by the placebo unit. For the fifty placebo units considered, there are only five cases where the placebo unit shows a higher gain than the treated unit. There is thus around 10 percent probability that the placebo test shows that the export gains suggested by the treated unit is also manifested in other units chosen at random. This indicates that the placebo test has been successful and the inferential technique, as implied by placebo tests using the approach suggested by Abadie, Diamond and Hainmueller (2010), is strong. The effect estimated by the synthetic control method for a country pair affected by the trade agreement is large relative to the effect estimated for a country pair chosen at random.

V. CONCLUDING THOUGHTS – WHY ARE EXPORT GAINS LESS THAN WORLD?

This paper employs a novel approach – synthetic control method – to determine how trade agreements have influenced trade in Latin America. The results suggest that the export gains have been substantial in Latin America but less than the world average. Moreover, not all countries have benefitted from trade agreements with a significant amount of countries showing negative export gains owing to such agreements.

There can be many factors responsible for the lower export gains in Latin America. As discussed in IMF (2015), trade agreements are not a magic wand for boosting trade. They need to be accompanied by *structural reforms* and reduction of nontariff barriers in order to reap the benefits of the trade agreements. Without the accompanying structural reforms, trade agreements cannot serve as a tool of improving competitiveness and thereby raising exports. Compared to other parts of the world, particularly Asian and Eastern European emerging markets, Latin America remains a comparatively *less trade open* region, with *less export diversification, product sophistication* and *product complexity*. Latin America is also *less integrated in global value chains,* one of the main reasons for increased trade volumes in several Asian and European emerging countries. Finally, larger economies in Latin America are not playing the role of *dynamic emerging market trade hubs*, as China is in emerging Asia. Latin America needs to thus increase efforts to penetrate large markets, both through advanced economies and regional market trade hubs. The region can also boost exports by undertaking structural reforms, improving infrastructure, quality of education, lowering average tariffs and taking initiatives to participate in global value chains where feasible.

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