Can Trade Agreements Curtail Trade Creation and Prevent Trade Diversion?*

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February 8, 2014

Abstract

Despite recent theoretical literature highlighting the cross effects between preferential trade agreements (PTAs), like the "domino effect" and the "competitive liberalization" theory, little has been done to quantify their impact on bilateral trade flows. This paper investigates how *preexisting* PTAs dilute (shield) the trade creation (diversion) effect of *new* PTAs. Countries having preexisting PTAs enjoy smaller gains in intra-bloc trade because of the dilution effect, and experience smaller losses/ or even gains in extra-bloc trade because of the shielding effect. The findings support the proposition that PTAs could be used to fend off future trade diversion.

JEL Code: F15

Keywords: Preferential Trade Agreements, Trade Creation, Trade Diversion, Gravity Model

*The authors are grateful to Andrew Bernard, James Laurenceson and Volodymyr Lugovskyy for excellent comments and other participants at the 2012 Empirical Investigations in Trade and Investment Conference in Tokyo, the 2012 Midwest International Economic Group Meeting, the 2012 Econometric Society Australasian Meeting, the 14th European Trade Study Group Conference, and a seminar at the University of New South Wales. Any remaining errors are solely the authors' responsibility.

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1 INTRODUCTION

The last two decades has seen a surge in the number of preferential trade agreements (PTAs). A World Trade Organization (WTO) member country would be, on average, a signatory of six PTAs (Saggi and Yildiz, 2010). This has ignited enormous interest in investigating the effects of PTAs on trade flows between members as well as between members and nonmembers. However, most of the previous empirical work, following Viner (1950)'s trade creation/diversion paradigm, focuses singularly on the *individual* effects of PTAs and ignores their *cross* effects. This omission is surprising given the large volume of theoretical literature on the latter issue. The purpose of this paper is to empirically investigate the cross effects of PTAs: how *preexisting* PTAs may affect the impact of *new* PTAs, on both intra-bloc and extra-bloc trade flows.

A "concession erosion effect" noted by Bagwell and Staiger (2004), Goyal and Joshi (2006) and Chen and Joshi (2010), implies that a country's export profits from a new PTA are reduced if its partner country has preexisting PTAs with other countries. The model of Deltas et al. (2012) also shows that an additional PTA with a third country by two member countries of a preexisting PTA, *decreases* the trade between the two members, while an additional PTA by only one of the member countries *increases* it.

A "domino theory" introduced by Baldwin (1993) suggests that the incentives for nonmember countries to join an existing PTA, rise with the expansion of the PTA because of larger trade diversion. Egger and Larch (2008), Bagwell and Staiger (1997) and Baier et al. (2011) argue that the current proliferation of regionalism can be due to "competitive liberalization" and a "tariff complementarity effect", in which countries attempt to use one PTA to prevent or reduce trade diversion from other PTAs.

Egger and Larch (2008), Chen and Joshi (2010), Baier et al. (2011) and Baldwin and Jaimovich (2012) empirically study some of these effects, but they only look at the propensity of PTA formation, and ignore the cross effects between PTAs on *trade flows*. On the contrary, Lee et al. (2008), Hur et al. (2010) and Deltas et al. (2012) study the effects on trade flows. However, unlike the current paper, these studies either focus on trade flows between PTA member countries, thereby omitting trade diversion, or they do not account for important PTA characteristics that can cause estimation bias. Deltas et al. (2012) is the closest to our paper. Still, their analysis focuses solely on Israel, while ours covers more than 160 countries and therefore is much more comprehensive.

The trade creation/diversion paradigm suggests that when country i forms a PTA with country j, it will increase imports from j (the trade creation effect), but potentially reduce imports from other countries (the trade diversion effect). This is largely because of changes in the relative prices of imports from different sources. However, the increase in i's imports from j following their newly formed PTA may be smaller if i has already engaged in PTAs with other countries. We call this the "dilution effect" (on trade creation). The dilution effect may arise because j cannot enjoy shifts of profit or market share in i's market over those countries that already have a PTA with i. This is similar to the concession erosion effect in Chen and Joshi (2010). On the other hand, an existing PTA between i and j may mitigate the reduction of i's imports from j from later PTAs signed by i, with other countries. We call this the "shielding effect" (on trade diversion). The shielding effect may arise because j is less susceptible to losing its cost advantage in i's market due to their preexisting PTA. This is similar to the tariff complementarity effect in Baier et al. (2011).

Accounting for the dilution and shielding effects is important in estimating the PTA effect on trade flows, because otherwise the estimates will overstate the magnitude of changes in intra-bloc and extra-bloc trade flows for countries with one or more preexisting PTAs. Furthermore, evidence of the shielding effect can help explain why the formation of PTAs by some countries seem to prompt even more PTAs, as pointed out by Egger and Larch (2008) and Baier et al. (2011).

Our empirical models are based on the commonly used gravity equation framework. The recent literature identifies several biases in the traditional estimates of the gravity equation. Following that, in our estimations we account for unobserved country-pair heterogeneity using country-pair fixed effects (CPFEs) (Magee, 2003; Baldwin and Taglioni, 2006; Baier and Bergstrand, 2007), and multilateral resistance terms (MRTs) (Anderson and van Wincoop, 2003; Feenstra, 2004). The most common method used to control for MRTs in the literature is to use country-time fixed effects (CTFEs) (Magee, 2008; Eicher et al., 2012; Baier et al., 2013). However, this approach is not feasible in the current paper. Because our focus is on the cross-PTA effects, our models firstly have to incorporate both the trade creation and diversion effects, eventually incorporating the dilution and shielding effects as well. The conventional variables used to capture the trade creation and diversion effects forcountries i and j at time t in the gravity equation are, respectively, a dummy variable for the PTA between i and j (PTA_{ijt}), and the number of "other PTAs" (OPTAs) between i and some third country (or countries) k ($OPTA_{ijt}^{conv} \equiv \sum_{k \neq j} PTA_{ikt}$). Including both these variables in the gravity equation while controlling for MRTs using CTFEs at the same time creates two identification problems.

The first identification problem arises because PTA_{ijt} and $OPTA_{ijt}^{conv}$ sum to the total number of PTAs that i has signed at time t (PTA_{it}), which is perfectly correlated with the importer-time fixed effects (FEs). This multicollinearity problem alone can be addressed by replacing $OPTA^{conv}$ with a GDP-weighted version: $OPTA_{ijt} \equiv \sum_{k \neq j} (Y_{kt}/Y_{Wt}) PTA_{ikt}$, where Y_k and Y_W are the real GDPs of k and the whole world respectively. Using a GDP-weighted measure is conceptually valid because the trade diversion effect of a PTA between i and k is likely to be positively correlated with the economic size of k. This however, still suffers from the second identification problem. The second problem arises from the fact that at least some part of trade diversion is driven by changes in relative national prices. Because MRTs are measures of national prices, their inclusion in the gravity equation will therefore remove some of the trade diversion effect that we try to capture using the $OPTA_{ijt}$ variable, meaning that the coefficient on the variable will be understating the actual trade diversion effect. If the estimation of the trade diversion effect is biased, then so will the associated dilution and shielding effects, because, as shown later, these two effects are essentially interaction effects of trade creation and diversion with lags.

In this paper, we address these two identification problems simultaneously by using the *Bonus vetus* OLS approach of Baier and Bergstrand (2009) to control for MRTs. This solution is based on an observation that the MRTs derived from their approach can be decomposed into $OPTA_{ijt}$ and some other components. Hence we can interpret the coefficient on $OPTA_{ijt}$ as an unbiased measure of the trade diversion effect. To the best of our knowledge, this is the first study that raises and solves these two identification problems in the gravity equation.

Besides using the Ordinary Least Square (OLS) estimator, we also deploy three other additional estimators in light of recent methodological developments on the empirical gravity equation. First, we apply the Helpman et al. (2008) (HMR hereafter) approach with the inclusion of zero trade flows observations. They argue that frequently observed "zeros" in bilateral trade data might be associated with firms' fixed costs of exporting. They note that not accounting for them may cause selection bias in the gravity model. Second, we employ the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Silva and Tenreyro (2006; 2011) argue that the OLS estimator in log-linear models suffers from bias caused by heteroskedastic errors due to the Jensen's inequality, and they suggest using the Poisson Pseudo-Maximum Likelihood (PPML) estimator instead. Because PPML does not control for CPFEs, which is crucial in avoiding bias in estimating the PTA effect, we use the CPPML estimator so that we can account for CPFEs as in Magee (2008) and Liu (2009).

Once we control for both CPFEs and MRTs, we reach the same qualitative conclusion for all the model specifications and estimation methods considered in this paper. First, the dilution effect is both statistically and economically significant. For instance, in the log-linear model, a new PTA is found to increase intra-bloc trade volume by 41.5%, but this is moderated to 30.8% as more PTAs are formed.[1] Second, the shielding effect is statistically significant and a new PTA is even found to increase extra-bloc trade in the presence of preexisting PTAs. For example, in the log-linear model, extra-bloc trade flows between two countries are found to decrease by 0.3% without a preexisting PTA between them, but increase by 0.6% if there is one. Although this figure may seem small, it only refers to a single nonmember country; the aggregate effect in absolute trade volume terms can be substantial when the number of nonmember countries involved is large. Our findings therefore support the proposition of using a PTA as a defensive device to mitigate any adverse effects of other PTAs as argued in Egger and Larch (2008) and Baier et al. (2011).

The rest of the paper is organized as follows. Section 2 explains the empirical methodology. Section 3 describes the data set used for the empirical analysis. Section 4 reports the results and the last section concludes.

[1] Our finding differs from Deltas et al. (2012). They find that the Israel-US trade agreement increases the trade flows between Israel and the EU, which formed a PTA one decade earlier.

2 ECONOMETRIC FRAMEWORK

2.1 Gravity equation

Our empirical tool is the gravity equation. A log-linear gravity equation based on the general equilibrium framework suggested by Anderson and van Wincoop (2003) can be expressed as:

$$\begin{aligned} ln(T_{ijt}) &= \alpha_0 + \alpha_1 lnY_{it} + \alpha_2 lnY_{jt} + \alpha_3 lny_{it} + \alpha_4 lny_{jt} + \mathbf{X}_{ijt} \cdot \beta \\ &\quad + \gamma PTA_{ijt} + \mu_t + \omega_{ij} - lnP_{it}^{1-\sigma} - lnP_{jt}^{1-\sigma} + \varepsilon_{ijt}, \end{aligned} \tag{1}$$

subject to the following N nonlinear market-equilibrium conditions:

$$lnP_{it}^{1-\sigma} = \sum_{k=1}^{N} lnP_{kt}^{1-\sigma} (Y_{kt}/Y_{Wt}) e^{\mathbf{X}_{ijt} \cdot \beta + \gamma_1 PTA_{ijt}}, i = 1, ..., N, \tag{2}$$

Here, T_{ijt} is *import*s by country i from country j at time t. PTA_{ijt} is a dummy taking a value of one if i and j are part of at least one PTA at time t and zero otherwise. This is the conventional measure to capture the trade creation effect.[2] Y is real GDP measured in purchasing power parity (PPP) terms, and y is real per capita GDP (PPP). $\mathbf{X}$ is a vector of trade cost variables such as distance, common language, common colony, common border, common legal origin, country-pair combined land area and GATT/WTO memberships. μ_t represents any unobserved global shocks in each year. ω_{ij} represents the unobserved country-pair heterogeneity (such as cultural, historical or political ties) that affects the likelihood of forming a PTA as well as bilateral trade flows. $P_k^{1-\sigma}$ is an MRT where P_k is the price level of country k and σ is the elasticity of substitution in consumption. Y_{Wt} is world GDP at time t. ε_{ijt} is the error term.

[2] If the two countries are part of more than one PTA at time t, we only count it as one because any extra PTA is redundant as far as the same two countries are concerned.

2.2 Simultaneous estimation of both trade creation and trade diversion

MRTs in equation (1) are not observable, hence Baier and Bergstrand (2009) (hereafter BB) suggests approximating them using the observed explanatory variables:

$$\begin{aligned} ln(T_{ijt}) &= \alpha_0 + \alpha_1 lnY_{it} + \alpha_2 lnY_{jt} + \alpha_3 lny_{it} + \alpha_4 lny_{jt} + (\mathbf{X}_{ijt} - MR\mathbf{X}_{ijt}) \cdot \beta \\ & \quad + \gamma(PTA_{ijt} - MRPTA_{ijt}) + \mu_t + \omega_{ij} + \varepsilon_{ijt}, \end{aligned} \tag{3}$$

$$MR\mathbf{X}_{ijt} = \sum_{k=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) \mathbf{X}_{ikt} + \sum_{m=1}^{N} \left(\frac{Y_{mt}}{Y_{Wt}}\right) \mathbf{X}_{mjt} - \sum_{k=1}^{N} \sum_{m=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) \left(\frac{Y_{mt}}{Y_{Wt}}\right) \mathbf{X}_{mkt}, \tag{4}$$

and

$$MRPTA_{ijt} = \sum_{k=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) PTA_{ikt} + \sum_{m=1}^{N} \left(\frac{Y_{mt}}{Y_{Wt}}\right) PTA_{mjt} - \sum_{k=1}^{N} \sum_{m=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) \left(\frac{Y_{mt}}{Y_{Wt}}\right) PTA_{mkt}, \tag{5}$$

The first term on the right hand side of (5) can be decomposed further:

$$\sum_{k=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) PTA_{ikt} = \left(\frac{Y_{jt}}{Y_{Wt}}\right) PTA_{ijt} + \sum_{k=1, k\neq j}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) PTA_{ikt} \tag{6}$$

One can notice that the second term on the right hand side of (6) is the number of other PTAs, which are GDP weighted, that i has signed with some third country (or countries) $k \neq j$ at time t.

The decomposition of $MRPTA_{ijt}$ as in (5) and (6) is very useful for our particular objective because, to consider the dilution and shielding effects, it is essential to include variables that can capture the trade creation and trade diversion effects separately. This decomposition allows us to do that, while simultanouesly controlling for MRTs. To show that, we rewrite equation (3) as:

$$\begin{aligned} ln(T_{ijt}) &= \alpha_0 + \alpha_1 lnY_{it} + \alpha_2 lnY_{jt} + \alpha_3 lny_{it} + \alpha_4 lny_{jt} + (\mathbf{X}_{ijt} - MR\mathbf{X}_{ijt}) \cdot \beta \\ &\quad + \gamma_1 PTA_{ijt} + \gamma_2 OPTA_{ijt} + \delta resMRPTA_{ijt} + \mu_t + \omega_{ij} + \varepsilon_{ijt}, \end{aligned} \tag{7}$$

where $OPTA = \sum_{k=1,k\neq j}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) PTA_{ikt}$ is the term capturing the trade diversion effect, and $resMRPTA = \left(\frac{Y_{jt}}{Y_{Wt}}\right) PTA_{ijt} + \sum_{m=1}^{N} \left(\frac{Y_{mt}}{Y_{Wt}}\right) PTA_{mjt} - \sum_{k=1}^{N} \sum_{m=1}^{N} \left(\frac{Y_{kt}}{Y_{Wt}}\right) \left(\frac{Y_{mt}}{Y_{Wt}}\right) PTA_{mkt}$ is the rest of $MRPTA_{ijt}$ after subtracting $OPTA_{ijt}$. This is the baseline equation in our empirical analysis.

Equation (7) provides a solution to the challenge of examining the trade creation and trade diversion effects simultaneously in the gravity model while controlling for MRTs. This is because MRTs are commonly controlled for using CTFEs. Howeverthe conventional measure used to capture trade diversion in the gravity model, $OPTA_{ijt}^{conv} \equiv \sum_{k\neq j} PTA_{ikt}$, and PTA_{ijt}, sum to the total number of PTA memberships a country i has at time t, PTA_{it}. This is perfectly correlated to the importer-time FEs. Due to this perfect multicollinearity, previous studies omit either MTRs or trade diversion (e.g. Magee, 2008; Eicher et al., 2012). The GDP-weighted $OPTA_{ijt}$ variable in (7), however, allows us to measure the trade creation and trade diversion effects simultaneously while controlling for MRTs. It is also worth noting that if we use $OPTA_{ijt}$ (instead of $OPTA_{ijt}^{conv}$) in the gravity equation, and account for MRTs using CTFEs, both γ_1 and γ_2 coefficients in equation (7) are technically identifiable. However, as shown in (6), changes in MRTs are a potential major source of trade diversion. Therefore, controlling for MRTs using importer-time FEs will wipe out all the trade diversion effect arising from changes in MRTs, and the estimate of γ_2 will understate the actual trade diversion effect. Using the BB method to control for MRTs as in (7), on the contrary, can avoid this problem. The GDP-weighted $OPTA_{ijt}$ measure is also conceptually sound because the trade diversion effect from a large country is likely to be greater than that from a small one.

2.3 Gravity equation with dilution and shielding effects

To measure the cross-PTA effects, we extend equation (7) by adding two interaction terms:

$$
\begin{aligned}
ln(T_{ijt}) &= \alpha_0 + \alpha_1 lnY_{it} + \alpha_2 lnY_{jt} + \alpha_3 lny_{it} + \alpha_4 lny_{jt} + (\mathbf{X}_{ijt} - MR\mathbf{X}_{ijt}) \cdot \beta \\
&\quad + \gamma_1 PTA_{ijt} + \gamma_2 OPTA_{ijt} + \gamma_3 (PTA_{ijt} \times OPTA_{ij,t-1}) + \gamma_4 (OPTA_{ijt} \times PTA_{ij,t-1}) \\
&\quad + \delta resMRPTA_{ijt} + \mu_t + \omega_{ij} + \varepsilon_{ijt}, \qquad (8)
\end{aligned}
$$

Here, γ_1 is a measure of the trade creation effect of the first PTA (that is, when $OPTA_{ij,t-1} = 0$), $\gamma_3 OPTA_{ij,t-1}$ is the dilution effect of preexisting PTAs between i and some third country (or countries), and $\gamma_1 + \gamma_3 OPTA_{ij,t-1}$ is the net impact on intra-bloc bilateral trade flows after incorporating the dilution effect. Likewise, γ_2 is a measure of the trade diversion effect without a PTA between i and j, $\gamma_4 PTA_{ij,t-1}$ is the shielding effect, and $\gamma_2 + \gamma_4 PTA_{ij,t-1}$ is the net impact on extra-bloc bilateral trade flows after incorporating the shielding effect. Here we expect $\gamma_3 < 0$ and $\gamma_4 > 0$. If the shielding effect is sufficiently large, one may not observe a negative effect on the extra-bloc trade flows.

3 DATA

We employ a panel dataset of 166 countries spanning from 1980 to 2007. Among them 152 countries were WTO members as of 2007. Out of the 27,390 country-pairs, 11,054 pairs had positive bilateral trade in 1980 and by 2007, the number increased to 16,677.[3] Data on nominal bilateral trade flows are drawn from the IMF's Direction of Trade Statistics. Data on nominal GDP, and GDP per capita are drawn from the Penn World Table (PWT) 7.0, and data on GDP deflators are drawn from the U.S. Department of Commerce's Bureau of Economic Analysis. PTA data are constructed from the Regional Trade Agreements Information System (RTA-IS) of the WTO, and data on GATT/WTO membership are drawn from the WTO website. Data on distance, common language, common colony, common border, common legal origin, and country-pair combined land area are drawn from CEPII. Time-varying religion data are obtained from Maoz and Henderson

[3] As we use the unidirectional bilateral import data, each country-pair appears twice a year.

(2013). Since religion data are available only for every five years, we use the data from the closest previous year for an unavailable year. For example, we use the 1980 data for 1981 to 1984.

There are three type of PTAs: customs union (CU), free-trade area (FTA), and partial scope agreements (PSAs). The first two form our measure of PTA.[4] Table 1 reports the summary statistics of several covariates commonly seen in the gravity equation and a few others that are specific to the current study. Common language, common colony, common border and common legal origin are dummies variables. Among the 439,353 (time-specific) country-pairs with positive bilateral trade, 38,606 pairs (8.8%) have at least one PTA. There are substantial differences in the mean and standard deviation of the covariates between country-pairs with and without PTAs. This suggests the formation of a PTA may be closely related to country and country-pair characteristics. As of July 2013, 575 regional trade agreements had been notified to the WTO, and 379 of them were in force.

[Insert Table 1]

4 RESULTS

4.1 Trade creation and diversion effects

We first estimate the log-linear model using the OLS method. For this model, we use only observations with positive trade flows. Columns (1), (2) and (3) in Table 2 report the estimated results. The country-pair subscript ij is omitted from here onwards to ease the notation. The three columns differ in terms of the inclusion of CPFEs and MRTs and, correspondingly, other control variables. All significant variables have signs that are expected.[5] So there are no obvious signs of model misspecifications. Both PTA_t and $OPTA_t$ are significant at the 1% level in all three estimations. A comparison between column (1) and the other two columns shows that not controlling for CPFEs doubles the estimates for the coefficients of PTA_t and $OPTA_t$. This implies that unobserved, time-

[4]We exclude PSAs because PSAs cover only the part of products, unlike CU and FTA. Currently, 35 PSAs have come into force, which is around 7% of the total PTAs.

[5]The negative sign of the WTO membership variable is in accordance with the so-called WTO puzzle (Rose, 2004; Eicher et al., 2012; Roy, 2011).

invariant country-pair heterogeneity (e.g. historical, cultural or political ties) that correlates with both the formation of a PTA and bilateral trade flows, leads to an upward bias in the trade creation estimation and a downward bias in the trade diversion estimation. A comparison between columns (2) and (3) further suggests that not accounting for MRTs as in column (2) causes a downward bias in the estimation of the two effects by about 5 to 10%. The marginal effects of PTA_t and $OPTA_t$ on bilateral trade flows T_t obtained in column (3) with the full set of controls, are illustrated in Figure 1. The first bar on the upper panel shows that the marginal effect of a PTA is equal to 39.9% $(= (e^{0.336} - 1) * 100)$, and the first bar on the lower panel shows that the marginal effect of an OPTA evaluated at the mean value of countries' world GDP shares (0.011) is equal to -0.28% $(= (e^{-0.253*0.011} - 1) * 100)$.

At first glance, the change in extra-bloc trade flows seems to be negligible when compared with the change in intra-bloc trade flows. However, as we account for the changes in imports from all non-PTA countries, the total reduction in extra-bloc trade flows in absolute volume terms for a member country, can be substantial. For instance in our dataset, on average, a country has 128 trading partners with which it does not have a PTA, so the impact from trade diversion due to a new PTA could be comparable to its impact from trade creation.

As 48% of the observations for T_t in our sample have a zero value, their treatment is an important issue. The common practice of using $ln(T_{ijt} + 1)$ is an arbitrary treatment and it does not deal with the self-selection bias associated with zero observations. Instead, we apply a generalized gravity equation following HMR's two-step procedure, which allows us to account for the fixed costs of exporting under the assumption of firm heterogeneity in country-level data. With this two-step procedure, we can properly estimate the individual and cross effects of PTAs on countries that have positive trade flows. The exclusion restrictions of the HMR method requires variables not included in the trade flows equation to be statistically significant in determining whether two countries trade with each other. Following HMR, we use a religious proximity variable as the exclusion restriction.[6]

[6]See Appendix I in HMR(2008) for details about how to construct the common religion index. Our set of religions includes the four most popular religions: Christianity, Judaism, Islam and Buddhism.

As the OLS results show that controlling for CPFEs and MRTs is important for obtaining unbiased estimations, we only focus on the HMR estimations with both controls. The estimation results are reported in column (4) of Table 2 and the marginal effects of PTA_t and $OPTA_t$ are shown in Figure 1. Both PTA_t and $OPTA_t$ are significant at the 1% level. A PTA is estimated to increase the trade flows between two member countries by 42.5% and to decrease the trade flows between a member and a nonmember country by 0.3%. Both these figures are similar to the OLS results.

Silva and Tenreyro (2006) show that, in the presence of heteroskedastic errors, the OLS estimates of log-linear models bias the estimation of the marginal effect of PTAs. They suggest using the PPML method instead. They also show using simulation that the PPML estimator is consistent in large samples as long as the conditional mean is correctly specified. The PPML estimation results are reported in column (5) of Table 2 and the marginal effects of the variables of interests are shown in Figure 1. The PPML method yields a much larger estimate for the trade creation effect than its OLS or HMR counterpart, and it is even more so for the trade diversion effect. A PTA is estimated to increase the trade flows between member countries by 54% and to decrease the trade flows between a member and a nonmember country by 0.9%.

The PPML method, however, does not control for CPFEs, which could cause severe bias if the OLS findings are indicators. To address this potential problem, following Magee (2008) and Liu (2009) we deploy the Conditional PPML method to account for CPFEs using the over-time sum of trade flows for each country pair as the conditioning argument. The results are reported in column (6) of Table 2 and the corresponding marginal effects are shown in Figure 1. Unlike all other estimations in Table 2, $OPTA_t$ is significant 'only' at the 5% level. A PTA is estimated to increase the trade flows between member countries by 21%, less than half of the OLS, HMR, or PPML estimates. The difference in the trade diversion effect is even greater. A PTA is estimated to increase the trade flows between a member and a nonmember country by 0.4%, in contrast to a PTA causing a decrease in the other estimates.[7] We leave the discussion regarding possible explanations

[7]The PPML and CPPML estimates reported here are based on the data of positive trade flows. The results for including zero trade flows are almost identical in that the estimated coefficients for both PTA_t and $OPTA_t$ are the same up to two decimal points.

for the trade diversion effect being positive, till the end of this section.

Overall, the estimation results for the PTA_t variable are qualitatively similar across all four methods, while the estimation results for the $OPTA_t$ variable are qualitatively similar across all but the CPPML method.

[Insert Table 2 and Figure 1]

4.2 Dilution and shielding effects

In this section, we add the two cross-PTA terms, $PTA_t \cdot OPTA_{t-1}$ and $OPTA_t \cdot PTA_{t-1}$, to the regressions in order to investigate, respectively, the dilution and shielding effects. Table 3 presents the estimation results. Again, we apply four estimation methods, namely OLS, HMR, PPML, and CPPML. For the OLS estimation, we only consider the one with CTFs, CPFEs and MRTs. Figure 2 shows the marginal effects of the key variables of interest, evaluated at the mean values of $OPTA_{t-1}$ and $PTA_{t-1} = 1$.[8] As shown in Figure 2, based on the coefficient of the PTA_t stand-alone term from the four estimation methods, a country's *first* PTA increases intra-bloc trade by 40%, 45%, 71%, and 23%, respectively. The magnitudes are roughly comparable to their counterparts in Figure 1. Likewise, the coefficient of the $OPTA_t$ stand-alone term indicates that extra-bloc trade between two nonmember countries decreases by 0.3%, 0.3% and 0.6% according to, respectively, the OLS, HMR, and PPML estimations. However it increases by 0.5% according to the CPPML estimation. The magnitudes are also roughly comparable to their counterparts in Figure 1.

Turning to the cross-PTA effects, the estimated coefficient on $PTA_t \times OPTA_{t-1}$ is statistically significant and yields an expected negative sign in all four estimations. This implies that a country's late coming PTAs will not increase intra-bloc trade flows as much as its first PTA does, confirming the dilution effect. Although the coefficient on $PTA_t \times OPTA_{t-1}$ seems to be small in magnitude, its effect on trade flows can be large as the value of $OPTA_{t-1}$ can be sizeable. For instance, according to the HMR estimation, preexisting PTAs dilute the trade creation effect of a new PTA

[8] In the cases of PPML and CPPML estimations, again, we only report the results obtained when zero observations are excluded. The results are very similar when zero observations are included.

by, on average, 11 percentage points from 45% to 34% (= ($e^{.373+(-.961)\cdot 0.086}$-1)*100, where 0.086 is the mean value of $OPTA_{t-1}$). Comparing this with the 42% estimate in column (4) of Table 2, the result implies that ignoring the cross-PTA effect will overstate the PTA effect on intra-bloc trade flows by as much as one-fourth. Similarly, according to the PPML and CPPML estimations, the first PTA of a country is expected to increase its intra-bloc trade by 71% and 23%, respectively, while preexisting PTAs dilute the effect of a new PTA by, on average, 23 percentage points (one-third) and 5 percentage points (one-fourth), respectively.

The estimated coefficient on $OPTA_t \times PTA_{t-1}$ is statistically significant and yields an expected positive sign in all estimations except for CPPML. This implies that late coming PTAs for a country will not reduce extra-bloc trade flows as much as its first PTA, confirming the shielding effect. According to the HMR estimation, trade flows between a member and a nonmember country decrease by 0.3%. However, the decrease in trade flows would experience a turnaround because of preexisting PTAs by, on average, 0.9% ($= (e^{0.011\cdot(-.292+1\cdot 0.813)} - 1) * 100$), if the net impact is evaluated for a preexisting PTA with an average sized partner country. This means that a preexisting PTA between two countries will generate, on average, an additional 0.6% trade between them when one signs a new PTA with a third country. The PPML and CPPML estimations give qualitatively concordant results in that, preexisting PTAs increase the bilateral trade between a member and a nonmember country by, on average, 1.1% and 0.2%, respectively. As pointed out by Kowalczyk (2000), PTAs may affect extra-bloc trade positively if they increase the income of member countries, or if the imported goods from member and nonmember countries are complementary. An open regional bloc where member countries choose to lower trade barriers against nonmember countries can be another possible explanation. Some previous empirical studies also find positive PTA effects on extra-bloc trade (see Table 2 in Eicher et al. (2012) for a summary). In other words, in the presence of PTA interaction, the traditional trade diversion effect can become an extra trade creation effect.

[Insert Table 3 and Figure 2]

5 CONCLUSION

In this paper, we focus on two cross effects of PTAs on bilateral trade flows—the dilution effect on trade creation and the shielding effect on trade diversion. The dilution effect arises if the home country's preexisting PTAs with third countries moderate the increase of the home country's imports from the member country of a new PTA. The shielding effect arises if the home country's preexisting PTA with another country moderates the decrease of its imports from that country caused by the home country's new PTA with a third country. We test these effects empirically using a dataset of 166 countries spanning from 1980 to 2007.

We base our empirical analysis on the gravity equation and account for various unobserved factors that could have caused estimation bias. We implement the log-linear model, the HMR's (2008) two-stage correction procedure, the PPML, and the CPPML methods. In addition to controlling for CPFEs, we use the BB (2009) method to decompose MRTs into trade diversion and other components. This avoids the multicollinearity problem that derailed previous attempts to estimate the trade creation and diversion effects simultaneously while controlling for MRTs using CTFEs.

All our estimations show that PTAs create more trade between member countries. Despite the strong evidence that the trade creation effect is diluted substantially by preexisting PTAs, the net PTA effect on bilateral trade between member countries remains statistically and economically significant. As for the trade flows between member and nonmember countries, the estimated trade diversion and shielding effects may appear to be small in percentage terms. However as a country, on average, trades with over 100 other countries without a PTA in place, the aggregate effects in absolute trade volume terms could be large. On that note, our empirical findings support the theoretical argument of Egger and Larch (2008) and Baier et al. (2011), that one of the primary incentives to seek a PTA is to avoid trade diversion from other PTAs.

Table 1: Summary statistics of the data: Country-pairs with positive trade

	Whole sample		Pairs with PTA		Pairs w/o PTA	
	Obs=439,353		Obs=38,606		Obs=400,747	
	Mean	S.D	Mean	S.D	Mean	S.D
log T_{ij}	14.58	3.83	16.68	4.09	14.38	3.74
log Real GDP	10.20	2.40	10.24	2.52	10.19	2.39
log Real GDP per capita	8.11	1.61	8.36	1.72	8.08	1.59
log($Distance_{ij}$)	8.68	.81	7.52	.96	8.79	.70
Common language	.202	.401	.360	.480	.187	.390
Common colony	.111	.314	.223	.417	.100	.301
Common border	.026	.159	.142	.349	.014	.120
Common legal origin	.360	.480	.448	.497	.352	.478
log land area	23.64	3.64	22.91	3.67	23.70	3.63
PTA_t	.087	.282	1	1	0	0
$OPTA_t$	.086	.141	.169	.171	.078	.136

*Note: T_{ij} (bilateral trade volume), real GDP and real GDP per capita are in million of constant 2000 US dollars. These variables are used in the benchmark regression.

Table 2: PTA effects: Trade creation and trade diversion

	(1)	(2)	(3)	(4)	(5)	(6)
PTA_{ijt}	.642***	.318***	.336***	.354***	.432***	.190***
	(.053)	(.035)	(.035)	(.035)	(.084)	(.055)
$OPTA_{ijt}$	-.552***	-.232***	-.253***	-.292**	-.819***	.296**
	(.104)	(.082)	(.082)	(.083)	(.227)	(.128)
WTO_{ijt}	-.095***	.027	.024	.023	-.773***	-.201
	(.024)	(.021)	(.051)	(.051)	(.241)	(.188)
$logGDP_{it}$	1.010***	1.112***	1.142***	1.136***	.793***	.597***
	(.009)	(.054)	(.053)	(.052)	(.018)	(.106)
$logGDP_{jt}$	1.183***	.521***	.543***	.534***	.812***	.492***
	(.009)	(.063)	(.062)	(.062)	(.028)	(.113)
$logGDPPC_{it}$	-.012	-.540	-.619	-.623	.153***	.062
	(.012)	(.053)	(.053)	(.053)	(.031)	(.109)
$logGDPPC_{jt}$	.016	.079	.005	.003	.042	.257**
	(.012)	(.063)	(.0632)	(.063)	(.047)	(.116)
$logDistance_{ij}$	-1.165***				-.797***	
	(.020)				(.049)	
$Com.Language_{ij}$	.695***				.292**	
	(.041)				(.121)	
$Com.Colony_{ij}$	.402***				.493**	
	(.055)				(.227)	
$Com.Border_{ij}$	.721***				.422***	
	(.095)				(.108)	
$Com.LegalOrigin_{ij}$	.104***				-.027	
	(.031)				(.093)	
$logLandArea_{ij}$	-.109***				.238***	
	(.006)				(.016)	
$\hat{IMR}_{ijt}$				-.163**		
				(.059)		
$\Phi^{-1}(\hat{IMR}_{ijt})$				-.053***		
				(.016)		
Method	OLS	OLS	OLS	HMR	PPML	CPPML
Time FEs	yes	yes	yes	yes	yes	yes
CPFEs	no	yes	yes	yes	no	yes
MRTs (BB)	no	no	yes	yes	yes	yes
		Year: 1980-2007, Obs: 370,495				Obs: 369,315

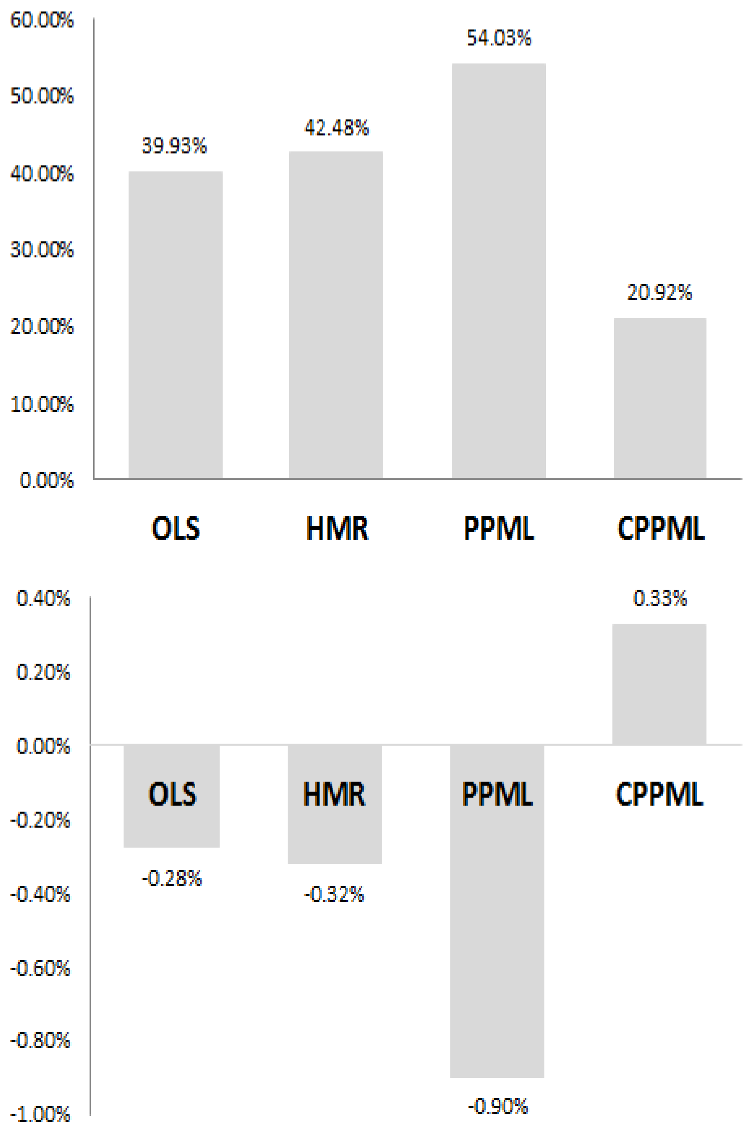
*Note: Cluster (country pairs) robust standard errors are reported in parentheses. $\hat{IMR}$ represents the inverse mills ratio obtained from the first-stage in the HMR estimation and Φ is the cdf of the standard normal distribution. BB represents accounting for time varying unobserved heterogeneity by a first-order log-linear Taylor expansion of the MRTs as suggested by Baier and Bergstrand (2009).

Table 3: Estimates of dilution and shielding effects

	(1)	(2)	(3)	(4)
PTA_{ijt}	.347***	.374***	.527***	.203***
	(.049)	(.049)	(.093)	(.068)
$OPTA_{ijt}$	-.265***	-.292***	-.631*	.427***
	(.086)	(.088)	(.275)	(.119)
$PTA_{ijt} \cdot OPTA_{ijt-1}$	-.907***	-.916***	-1.637***	-.444*
	(.171)	(.172)	(.488)	(.245)
$OPTA_{ijt} \cdot PTA_{ijt-1}$	.824***	.813***	.964**	.177
	(.117)	(.117)	(.460)	(.165)
WTO_{ijt}	.026	.039	-.771**	-.161
	(.053)	(.053)	(.258)	(.189)
$logGDP_{it}$	1.155***	1.157***	.797***	.576***
	(.055)	(.055)	(.019)	(.110)
$logGDP_{jt}$	.602***	.598***	.816***	.599***
	(.065)	(.066)	(.029)	(.115)
$logGDPPC_{it}$	-.632***	-.635***	.151***	.082
	(.055)	(.055)	(.032)	(.114)
$logGDPPC_{jt}$	-.055	-.053	.040	.125
	(.066)	(.066)	(.048)	(.125)
$logDistance_{ij}$			-.806***	
			(.051)	
$Com.Language_{ij}$			.289**	
			(.1222)	
$Com.Colony_{ij}$			.483**	
			(.225)	
$Com.Border_{ij}$			.402***	
			(.111)	
$Com.LegalOrigin_{ij}$			-.030	
			(.093)	
$logLandArea_{ij}$			.237***	
			(.016)	
$I\hat{MR}_{ijt}$		-.029		
		(.075)		
$\Phi^{-1}(I\hat{MR}_{ijt})$		-.059***		
		(.018)		
Method	OLS	HMR	PPML	CPPML
Obs	359,314	359,314	359,314	358,584
Time FEs	yes	yes	yes	yes
CPFEs	yes	yes	no	yes
MRTs(BB)	yes	yes	yes	yes
		Year: 1981-2007		

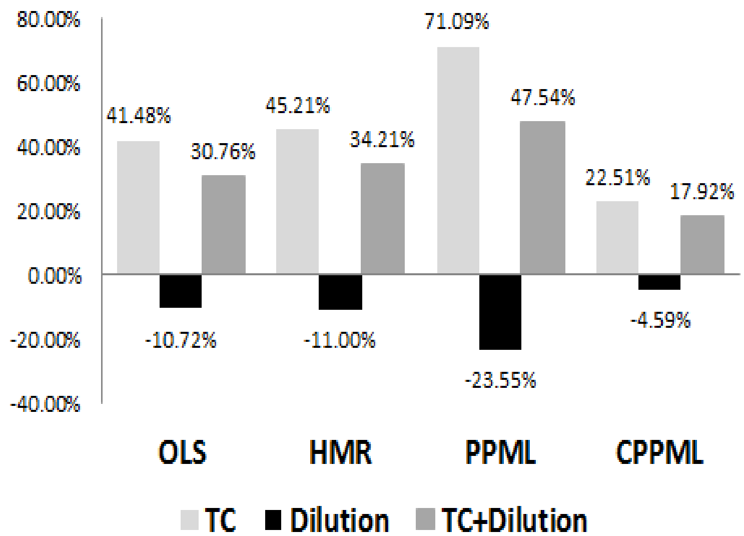
*Note: Cluster (country pairs) robust standard errors are reported in parentheses. $I\hat{MR}$ represents the inverse mills ratio obtained from the first-stage in the HMR estimation and Φ is the cdf of the standard normal distribution. BB represents accounting for time varying unobserved heterogeneity by a first-order log-linear Taylor expansion of the MRTs as suggested by Baier and Bergstrand (2009).

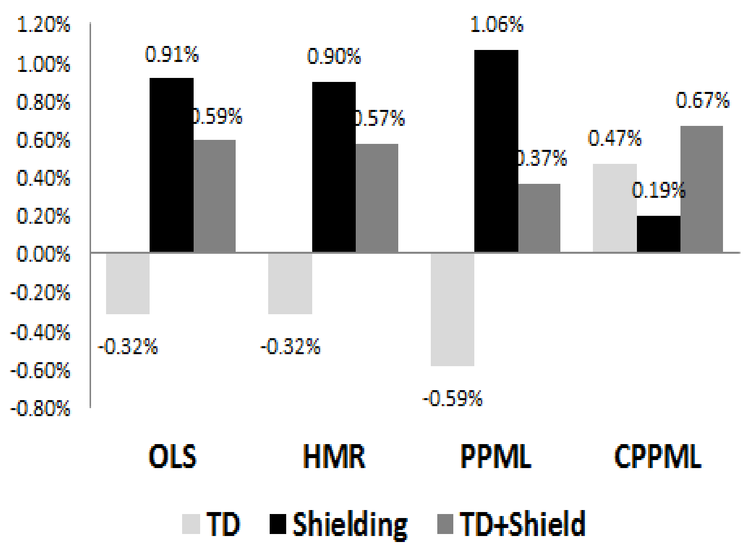
Figure 1: Marginal effects: trade creation and diversion effects



*Note: Trade Creation (TC) = $exp(\gamma_1) - 1$ and Trade Diversion (TD) = $exp(\overline{WYS} \cdot \gamma_2) - 1$ where $\overline{WYS}$ is the average world GDP share, $\frac{Y_j}{Y_W}$, of all country pairs $(= 0.011)$.

Figure 2: Marginal effects: dilution and shielding effects





*Note: Trade Creation (TC) = $exp(\gamma_1) - 1$, Dilution = - Trade Creation + $(exp(\gamma_1 + \gamma_3 \cdot \overline{OPTA}) - 1)$, Trade Diversion (TD) = $exp(\overline{WYS} \cdot \gamma_2) - 1$ and Shielding = -Trade Diversion + $exp(\overline{WYS} \cdot (\gamma_2 + \gamma_4)) - 1$ where $\overline{WYS}$ is the average world GDP share, $\frac{Y_j}{Y_W}$, of all country pairs.

References

Anderson, J. E., van Wincoop, E., 2003. Gravity with gravitas: a solution to the border puzzle. American Economic Review 83 (1), 170–192.

Bagwell, K., Staiger, R. W., 1997. Multilateral tariff cooperation during the formation of free trade areas. International Economic Review 38 (2), 291–319.

Bagwell, K., Staiger, R. W., 2004. Multilateral trade negotiations, bilateral opportunism and the rules of gatt/wto. Journal of International Economics 63 (1), 1–29.

Baier, S. L., Bergstrand, J. H., 2007. Do free trade agreements actually increase members' international trade? Journal of International Economics 71 (1), 72–95.

Baier, S. L., Bergstrand, J. H., 2009. Bonus vetus ols: A simple method for approximating international trade-cost effects using the gravity equation. Journal of In 77, 77–85.

Baier, S. L., Bergstrand, J. H., Feng, M., 2013. Economic integration agreements and the margins of international trade. mimeo.

Baier, S. L., Bergstrand, J. H., Mariutto, R., 2011. Economic determinants of free trade agreements revisited:distinguishing sources of interdependence. Unpublished manuscript.

Baldwin, R., 1993. A domino theory of regionalism. NBER Working Paper Series (4465).

Baldwin, R., Jaimovich, D., 2012. Are free trade agreements contagious? Journal of International Economics 88 (1), 1–16.

Baldwin, R., Taglioni, D., 2006. Gravity for dummies and dummies for gravity equations. NBER Working Paper Series (12516).

Chen, M. X., Joshi, S., 2010. Third-country effects on the formation of free trade agreements. Journal of International Economics 82 (2), 238–248.

Deltas, G., Desmet, K., Facchini, G., 2012. Hub-and-spoke free trade areas: theory and evidecne from israel. Canadian Journal of Economics 45 (3), 942–977.

Egger, P., Larch, M., 2008. Interdependent preferential trade agreement memberships: An empirical analysis. Journal of International Economics 76 (2), 384–399.

Eicher, T., Henn, C., Papageorgiou, C., 2012. Trade creation and diversion revisited: Accounting for model uncertainty and unobserved bilateral heterogeneity. Journal of Applied Econometrics 27 (2), 296–321.

Feenstra, R. C., 2004. Advanced International Trade: Theory and Evidence. Princceton Univ Press, Princeton, NJ.

Goyal, S., Joshi, S., 2006. Bilateralism and free trade. International Economic Review 47 (3), 749–778.

Helpman, E., Melitz, M., Rubinstein, Y., 2008. Estimating trade flows: Trading partners and trading volumes. The Quarterly Journal of Economics 123 (2), 441–487.

Hur, J., Alba, J. D., Park, D., 2010. Effects of hub-and-spoke free trade agreements on trade: A panel data analysis. World Development 38 (8), 1105–1113.

Kowalczyk, C., 2000. Welfare and integration. International Economic Review 41 (2), 483–94.

Lee, J., Park, I., Shin, K., 2008. Proliferating regional trade arrangements: Why and wither? The World Economy 31 (12), 1525–1557.

Liu, X., 2009. Gatt/wto promotes trade strongly: sample selection and model specification. Review of International Economics 17 (3), 428–446.

Magee, C. S., 2003. Endogenous preferential trade agreements: an empirical analysis. Contributions to Economic Analysis and Policy 2 (1), Article 15.

Magee, C. S., 2008. New measures of trade creation and trade diversion. Journal of International Economics 75 (2), 349–362.

Maoz, Z., Henderson, E. A., 2013. The world religion dataset, 1945-2010: Logic, estimates, and trends. International Interactions 39 (3), 265–291.

Rose, A. K., 2004. Do we really know that the wto increases trade? American Economic Review 94, 98–114.

Roy, J., 2011. Is the wto mystery really solved? Economics Letters 113, 127–130.

Saggi, K., Yildiz, H. M., 2010. Bilateralism, multilateralism, and the quest for global free trade. Journal of International Economics 81 (1), 26–37.

Silva, J. S., Tenreyro, S., 2006. The log of gravity. The Review of Economics and Statistics 88 (4), 641–658.

Silva, J. S., Tenreyro, S., 2011. Further simulation evidence on the performance of the poisson pseudo-maximum likelihood estimator. Economics Letters 112 (2), 220–222.

Viner, J., 1950. The customs union issue. Carnegie Endowment for International Peace, New York.