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The Impact of Preferential Trade Agreements on the Margins of International Trade

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The Impact of Preferential Trade Agreements on the Margins of International Trade

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Abstract

In this paper we consider the trade creating effects of Preferential Trade Agreements (PTAs) for a large sample of countries within the period 1962-2000. The paper builds upon existing literature by examining whether any significant effects of PTAs occur through a change in the variety of exports (the extensive margin) or through a change in the volume of existing products (the intensive margin). To address this issue we employ the commonly used gravity equation as well as a matching approach to deal with potential self-selection problems. Our results indicate that exports respond positively to the formation of a PTA between countries, and that much of this increase in exports occurs along the extensive margin. We also show that the extensive margin responds more strongly to the formation of a PTA in larger exporters and for larger country-pairs.

Keywords: *preferential trade agreements, intensive and extensive margin, matching econometrics, difference-in-difference*

JEL classifications: *F10, F15*

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The impact of Preferential Trade Agreements on the margins of international trade

1 Introduction

In the last two decades there has been a proliferation in the number of Preferential Trade Agreements (PTAs).[1] According to Urata and Okabe (2007) the number of PTAs reported to the WTO was 25 in 1990, 91 in 2000 and 194 in 2007. For a long time most PTAs were regional in focus with members being geographically close to each other (e.g. EU, NAFTA). More recently however countries or regional blocs have signed PTAs with diverse and geographically distant partners.[2] Moreover, regional groupings have become more diverse (e.g. ASEAN).

As discussed in the literature (e.g. Viner, 1950) there is a trade-off involved when discussing the benefits of PTA membership. On the one hand, there is a *trade creation* effect that comes from the elimination in distortions between the relative prices of domestic goods and those of other members. On the other hand, there exists the potential for a *trade diversion* effect due to the introduction of distortions between the relative prices of members and non-member goods. A large number of empirical papers have addressed the issue of whether membership in a PTA creates trade between members and whether trade diversion is an outcome of the presence of a PTA. The gravity equation has developed as the standard tool to estimate the effects of PTAs on trade between members. To account for PTA membership a dummy variable is included in the model which equals one if a country-pair are both members of a PTA and zero otherwise. The coefficient on the PTA variable is then used as an indicator of the effect of PTA membership on trade flows between member countries (i.e. trade creation effects). Studies have also attempted to examine the potential trade diversion effects of PTAs by including binary variables that take the value one if only one member of a country pair belongs to a PTA (see for example Frankel, Stein and Wei, 1996). The results of such studies are mixed depending upon the sample, the time period, the specification of the gravity equation and the particular PTAs considered.

An extension of this literature has been to consider specific PTAs rather than bundling them all into one dummy variable, by constructing PTA dummies for each of a number of

[1] In what follows we take Preferential Trade Agreements (PTAs) to mean any preferential access for members of such an agreement.

[2] For example, the US has signed agreements with Israel (1985), Jordan (2002), Australia (2004), Morocco (2005) and Peru (2009), while the EU has signed agreements with Turkey (1996), the Faroe Islands (1997), the Palestinian Authority (1997), Tunisia (1999), South Africa (2000), Morocco (2000), Israel (2000), Mexico (2000), Chile (2004), Algeria (2006) and Cote d'Ivoire (2008).

specific PTAs. This allows one to examine the impact on trade flows of specific PTAs. Using such an approach has lead to mixed results. Aitken (1973), Abrams (1980) and Brada and Mendez (1983) for example found membership in the European Community to have a positive and significant effect on trade flows among members, while Bergstrand (1985) and Frankel, Stein and Wei (1995) found insignificant effects. Frankel (1997) finds a positive impact from MERCOSUR membership, insignificant effects from membership in the Andean pact, and occasionally negative effects from membership in the European Community.

One important issue that has recently been addressed is the issue of endogeneity: membership in PTAs is likely to be endogenous as countries self-select into PTAs for reasons related to the level of trade. To account for endogeneity studies have used panel models with fixed effects and Heckman control functions, examples including Baier and Bergstrand (2002), Magee (2003), and Baier et al (2008). A couple of recent papers (Egger et al, 2008; Baier and Bergstrand, 2009) employ matching techniques to control for endogeneity. Both studies find evidence in favour of the trade-creating effects of PTAs. The study of Egger et al (2008) concentrates on the trade-structure effects of PTAs, though they do report results for the volume of trade. In particular, Egger et al (2008) consider panel data and concentrate on the contemporaneous effects of PTA formation on trade comparing trade performance between two small windows prior to and post PTA membership. The more recent paper of Baier and Bergstrand (2009) concentrates on the effect of PTAs on the volume of trade. Different to Egger et al (2008), they employ cross-section data and an alternative matching procedure that allows them to identify the *long-run* impact of PTAs on trade volume.

The empirical literature on the trade effects of PTAs largely ignores the two margins of trade, namely the extent to which countries trade different volumes (i.e. the intensive margin) or a wider variety (i.e. the extensive margin) of goods. This is despite the fact that a great deal of attention has been paid to the margins of trade in recent empirical and theoretical contributions in international trade. Part of the reason for this interest is the increasing availability of highly disaggregated trade data as well as product-level export data at the firm level, along with advances in the measurement of product variety (e.g. Feenstra, 1994). A further reason however relates to developments in the theory of international trade and economic growth, with a number of models emphasising the benefits of international trade in providing access to new products or new varieties of existing products (see for example the seminal contributions of Rivera-Batiz and Romer, 1991; and Grossman and Helpman, 1991). In these models, a country's access to foreign inputs raises productivity levels thereby generating static gains from trade. New foreign inputs also lower the cost of innovation, enabling the creation of new varieties, and this generates dynamic gains from trade. Recently, Feenstra and Kee (2008) have shown that the variety of exports is also related to country productivity in a sample of 48 countries.

Their theoretical model relates to the recent literature on heterogeneous firms (e.g. Melitz, 2003), with firms self-selecting into exporting markets. Since more productive firms self-select into export markets and are thus more productive than the average domestic firm, an increase in the number of firms exporting and therefore an increase in export variety is associated with rising productivity.

In response to improvements in the extent and accessibility of data and to advances in economic theory recent empirical research has examined the importance of and the extent of trade in variety (e.g. Hummels and Klenow, 2005; Schott, 2004; Funke and Ruhwedel, 2002).[3] A number of papers within this literature examine the impact of trade liberalisation on the volume and variety of traded goods. Klenow and Rodriguez-Clare (1997) consider the liberalisation of Costa Rica between 1986 and 1992 and show that liberalisation was accompanied by a surge in import variety. In particular, a 1% decrease in tariffs is associated with an increase in import variety of around 0.5%. Feenstra and Kee (2007) consider the effects of US tariff reductions on the variety of exports of Mexico to the US and find evidence supporting the view that tariff liberalisation due to NAFTA has increased export variety from Mexico. Goldberg et al (2008a and b) consider the liberalisation experience of India during the 1990s, and find that trade liberalisation dramatically increased Indian firms' access to new imported inputs; two-thirds of the surge in imported inputs occurred in products not imported prior to the reforms. Goldberg et al (2009) find that trade reform in India spurred imports of previously unavailable products and varieties in many products that arguably can be characterised as important inputs for manufacturing firms. Debaere and Mostashari (2010) examine whether changing tariffs and tariff preferences affect the variety of products imported to the US over the period 1989-2000. Using a Probit model to explain the probability that a good is exported to the US at the end of the sample they show that tariff reductions influence the extensive margin by increasing the variety of goods exported to the US. In addition, the authors find that tariff preferences have a trade diverting effect on the extensive margin by reducing the variety of products exported to the US for excluded countries. Hillberry and McDaniel (2002) examine whether the increased trade of the US with its NAFTA partners since 1993 is due to an increasing volume of existing products or to trading new products. The results provide evidence of both, though a substantial portion of US trade growth since 1993 can be explained by increases in the variety of products the US imports from Mexico.

While most of the above studies consider the effects on a single country or a specific liberalisation episode, others have considered the impact of liberalisation on a broader

[3] Hummels and Klenow (2005) for example decompose the exports of 126 countries into the contribution of the intensive (volume of goods traded) and extensive (variety of goods traded) margin and then relate each margin to country size (GDP) and its components (workers and GDP per worker). They find that the extensive margin accounts for about 60 percent of the greater exports of larger economies. Other examples include Schott (2004) who finds that richer countries export higher quality goods, and Funke and Ruhwedel (2002) who find a positive association between the variety of exports and total export volumes.

sample of countries. Kehoe and Ruhl (2003) consider the impact of six major trade liberalisations in 18 countries on the extensive margin of trade using bilateral data. They find using detailed trade data that the goods that were traded least before liberalisation account for a disproportionate share in trade following the reduction of trade barriers. They further show that large increases in the extensive margin of trade coincide with trade liberalisation. More recently, Frensch (2010) examines the relationship between import margins and trade liberalisation for 36 countries in a gravity framework. The results again indicate that the main effect of liberalisation occurs along the extensive margin of imports, with the effects on intermediate and capital imports being stronger than those on consumer goods.

In this paper we examine the effect of PTA membership on the volume and variety of a country's exports for a large number of countries. In particular, we use data from Feenstra et al (2005) over the period 1962-2000 to construct the two margins of exports for up to 174 exporters[4]. In the first stage of our analysis we employ the gravity model and a difference-in-difference analysis to examine the trade creating effects of PTAs, and decompose the change in trade following entry into a PTA along the intensive and extensive margin. We further test for the possibility of a non-linear relationship between PTA membership and the margins of trade, examining whether the impact of PTAs on exports and the two margins is affected by either the size of the exporter or of the bilateral-pair. In a second stage, we account for the possible endogeneity of PTA membership using a matched difference-in-difference approach. The approach we adopt is very similar to that adopted by Egger et al (2008) in that we concentrate on the contemporaneous effects of PTA formation by considering two small windows either side of PTA formation. The obvious difference from Egger et al (2008) is that we concentrate on the effect of PTAs on the margins of trade and not on the trade structure effects. Our results indicate that PTA formation is trade-creating and that much of this trade creation occurs along the extensive margin. These results are confirmed by our matching analysis. We further show that while the trade creating effects of PTAs are stronger for smaller countries and smaller bilateral-pairs, the impact on the extensive margin is stronger in larger exporters and larger bilateral-pairs, a result consistent with theory.

The remainder of the paper is set out as follows. Section 2 discusses our main hypotheses, our empirical approach and the data used. Section 3 discusses our main results, Section 4 reports the results from our robustness analysis using matching techniques and Section 5 concludes.

[4] This number includes countries no longer in existence (e.g. Czechoslovakia, ex-Yugoslavia) along with the countries that replaced them (e.g. Czech Republic, Slovakia).

2. Method and Data

2.1. Model Specification

The approach we adopt to identify the impact of PTAs on both the volume and variety of bilateral exports is to consider a standard gravity-type regression of the form,

$$\ln EXP_{ijt} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln POP_{it} + \beta_4 \ln POP_{jt} + \beta_5 \ln DIST_{ij} + \beta_6 LANG_{ij} + \beta_7 ADJ_{ij} + \beta_8 LOCK_{ij} + \beta_9 PTA_{ijt} + \varepsilon_{ijt} \quad (\mathbf{1})$$

where $\ln EXP$ is (the natural log of) our measure of exports from country i to country j in time t, GDP refers to Gross Domestic Product, POP to population, $DIST$ is the great circle distance between capital cities of countries i and j, $LANG$ is a dummy taking the value if i and j share a common language, ADJ is a dummy taking the value one if i and j share a common border, $LOCK$ is a variable taking the value 0,1,2 depending on whether none, one or both of i and j are landlocked respectively, and PTA is a dummy taking the value one if i and j are members of the same PTA.[5]

In our analysis we follow the approach of Egger et al (2008) and concentrate on the contemporaneous effects of joining a PTA on exports and the margins of exports. As such, we consider the gravity equation in difference form. In particular, our dependent variable is calculated as the difference between average log exports in the three years after the formation of a PTA and average logged exports in the three years prior to PTA formation, i.e. $\Delta \ln EXP_{ijt} = \ln EXP_{ij,t:t+2} - \ln EXP_{ij,t-3:t-1}$.[6] We calculate the corresponding differences for our other variables, and write the gravity equation in difference form as,

$$(\ln EXP_{ij,t:t+2} - \ln EXP_{ij,t-3:t-1}) = \beta_1 (\ln GDP_{i,t:t+2} - \ln GDP_{i,t-3:t-1}) + \beta_2 (\ln GDP_{j,t:t+2} - \ln GDP_{j,t-3:t-1}) + \beta_3 (\ln POP_{i,t:t+2} - \ln POP_{i,t-3:t-1}) + \beta_4 (\ln POP_{j,t:t+2} - \ln POP_{j,t-3:t-1}) + \beta_9 (PTA_{ij,t:t+2} - PTA_{ij,t-3:t-1}) + \varepsilon_{ijt} \quad (\mathbf{2})$$

which we write as,

$$\Delta \ln EXP_{ijt} = \beta_1 \Delta \ln GDP_{it} + \beta_2 \Delta \ln GDP_{jt} + \beta_3 \Delta \ln POP_{it} + \beta_4 \Delta \ln POP_{jt} + \beta_9 \Delta PTA_{ijt} + \varepsilon_{ijt} \quad (\mathbf{3})$$

where ΔPTA_{ijt} will equal one if the bilateral-pair entered a PTA in year t and zero otherwise. Time-invariant variables such as distance and other geography variables will

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[5] While the vast majority of empirical studies considering the trade creating effects of PTAs use a binary variable for PTA presence it should be kept in mind that such a variable doesn't account for the breadth and depth of such PTAs. Accounting for this however, would require one to identify which products are covered by PTAs and track any changes in tariff rates applied for each PTA. A couple of recent papers make some progress towards this goal. Vicard (2009) for example considers four different categories of PTAs whose depth differs, and finds that the impact on trade is not significantly different between the four different categories, while Medvedev (2010) uses a comprehensive database on PTAs and considers only trade in products where preferences are likely to matter and finds that using total trade biases downwards the coefficient on the PTA variable.

[6] We also tried comparing just the year before the formation of the PTA with the year after, but the results tended to be weaker. This may result from variation in export volumes due to business cycle effects and other shocks not related to PTA formation, or because adjustment to the formation of a new PTA takes some time. These results are available upon request.

drop out of this specification.[7] We construct the relevant differences in equation (3) for all country-pairs and for each year (over the period 1962-2000) in which new PTAs were formed. This gives us a set of data for 19 years for which we have observations on new PTAs[8], which is then pooled to form our final dataset. This is the starting point for our empirical analysis below. It should be noted that in all of our regressions we also include a set of time dummies.[9]

2.2. Data

Data on our explanatory variables comes from a variety of sources. The GDP and population of the importer and exporter are taken from the World Development Indicators (2008) dataset. Data on distance, common language and adjacency are from CEPII[10]. Data on PTAs is taken from the WTO website[11] (accessed at various dates) and complemented with information from Baier et al (2008).[12] The PTA dummy variable is defined as equal to one if exporter and importer were in any one of the PTAs listed on either the WTO website or by Baier et al (2008).

Finally, the trade data is taken from the dataset of Feenstra et al (2005), which reports data on imports and exports at the SITC four-digit level over the period 1962-2000. From this dataset we use data on up to 174 exporting countries. It should be noted that this number includes countries that are no longer in existence (e.g. Czechoslovakia) along with the countries that replaced them (e.g. Czech Republic and Slovakia). In our analysis we treat these countries as different countries, which is a valid approach since data on these different countries never overlaps.

We follow the approach of Kehoe and Ruhl (2002) in adapting the decomposition of Hummels and Klenow (2005) to apply to a single bilateral trade relationship. In particular, the extensive margin (EM) is defined as[13],

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7 Adopting such a difference specification has the further advantage that we don't need to concern ourselves with which time-invariant country dummies to include. In the literature it has been suggested that importer and exporter dummies (Egger, 2000) and bilateral-pair dummies (Baldwin and Taglioni, 2006) be included in the gravity specification, both of which would drop out in our difference specification.

8 In total we have data on 1025 country pairs forming a PTA in our dataset.

9 In all regressions the time dummies are jointly significant. Excluding the time dummies are not found to change the results a great deal. These results are available upon request.

10 http://www.cepii.fr/anglaisgraph/bdd/distances.htm

11 http://rtais.wto.org/UI/PublicAllRTAList.aspx

12 The reason for considering alternative sources is that the WTO dataset only includes PTAs in force, thus excluding a number of PTAs that are no longer in force, but that would have been in the period of interest, examples being the PTAs agreed between the EU-15 and Romania, Bulgaria and others in the 1990s, but which are no longer in force now that these countries are now members of the EU.

13 We drop time subscripts where they are not necessary for the explanation. It should be kept in mind however that these variables are calculated for each year in the sample.

$$EM_{ij} = \frac{\sum_{n \in N_{im}} p_{kjn} x_{kjn}}{\sum_{n \in N} p_{kjn} x_{kjn}}, \quad (\mathbf{4})$$

where N_{ij} is the set of observable categories in which exporting country i has positive exports to j, p_{kjn} is the price of a unit of good n exported from reference country k to country j, and x_{kjn} is the quantity of good n exported from reference country k to country j. Reference country k has positive exports to j in all N categories. Following the approach of Frensch (2010) we define a reference "country" that does not vary across time or countries. In particular, x_{kjn} is the quantity of exports of the world to country j in good n averaged across the years 1962-2000, with p_{kjn} defined similarly.

The extensive margin can be thought of as a weighted count of i's categories relative to k's categories, where the goods are weighted by their importance in world exports to importing country j. If all categories are of equal importance then the extensive margin is simply the fraction of categories in which i exports to j. Hummels and Klenow (2005) discuss a number of advantages and disadvantages of this measure of the extensive margin. In particular, they note that by measuring the extensive margin without reference to i's exports it prevents a category appearing important solely because i (and no other country) exports a lot of that product to j. They note that a disadvantage of the approach is that a country may appear to have a large extensive margin because it exports a small amount in categories in which k exports a lot, an outcome that could also arise we were to use a simple count of the categories of goods exported.

The intensive margin (IM) compares nominal shipments for country i and k in a common set of goods, and is given by,

$$IM_{ij} = \frac{\sum_{n \in N_{ij}} p_{ijn} x_{ijn}}{\sum_{n \in N_{ij}} p_{kjn} x_{kjn}} \quad (\mathbf{5})$$

IM_{ij} equals i's nominal exports relative to k's nominal exports in those categories in which i exports to $j (N_{ij})$.

It can be shown that the ratio of country i to country k exports to j equals the product of the two margins, that is,

$$EXPRAT_{ij} = \frac{\sum_{n \in N_{ij}} p_{ijn} x_{ijn}}{\sum_{n \in N} p_{kjn} x_{kjn}} = IM_{ij} EM_{ij} \quad (\mathbf{6})$$

In the regression analysis that follows we use the natural log of this ratio as our dependent variable, rather than the natural log of exports of country i to country j, which is commonly included in gravity regressions. The reason for employing this ratio as one of our dependent variables is that since OLS is a linear operator it will decompose the effects of PTAs on the export ratio along the extensive and intensive margins, allowing us to quantify the contribution of the two margins to the change in this ratio following PTA membership.

Moreover, given the difference specification for the gravity equation that we adopt and given our approach of having a reference country whose trade doesn't vary across countries or time the coefficient on the PTA variable in our (differenced) gravity model will provide an estimate of the trade-creating effects of PTAs on our sample of countries[14], that is,

$$\Delta \ln EXPRAT_{ijt} = \Delta \ln EXP_{ijt} - \Delta \ln EXP_{world,j} = \Delta \ln EXP_{ijt} \quad (\mathbf{7})$$

where $\Delta \ln EXP_{world,j}$ is the change in the natural log of exports of the world, which by definition is zero.

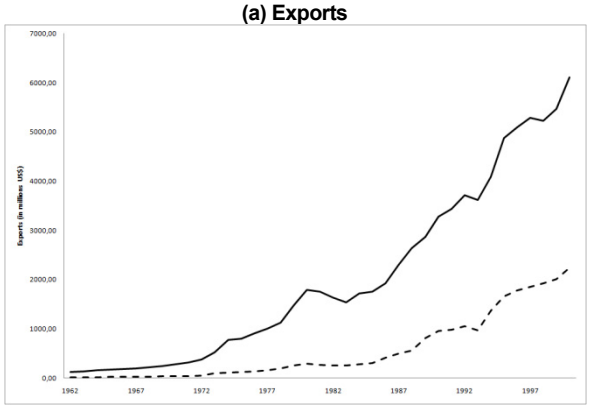
To give some indication of the increasing importance of international trade and its expansion along the two margins we report in Figure 1 (panels a-c) the world exports and the sum of the two margins across all countries for each year (the solid lines). Also reported are the sum of exports and the two margins for country-pairs involved in a PTA in each year (the dashed lines). Panel (a) of this figure shows the rapid increase in world exports from the early 1980s onwards, as well as the rapid increase in exports that took place within PTAs. Panels (b) and (c) indicate that this increase in exports has been due to an increase in both the extensive and intensive margin. These figures also indicate that for much of the period under consideration, and especially since the early 1980s, the growth of the extensive margin has outpaced that of the intensive margin. Moreover, the growth of the extensive margin for trade within PTAs has also exceeded that of the intensive margin, particularly towards the end of the period, which may indicate that much of the trade-creating effect of PTAs occurs along the extensive margin.

[14] If the value of exports of the reference country were to vary across time and countries we would not be able to use this ratio to obtain an estimate of the trade-creating effects of PTAs. In such a case, the finding of a positive effect of PTAs on the above ratio could be the result of the partner country exporting more supplanting production in the importing country (trade creation) or because the partner country exported more at the expense of non-member countries not receiving preferential tariffs (trade diversion). By forcing the reference country's value of exports to be constant across time and countries we eliminate this latter possibility.

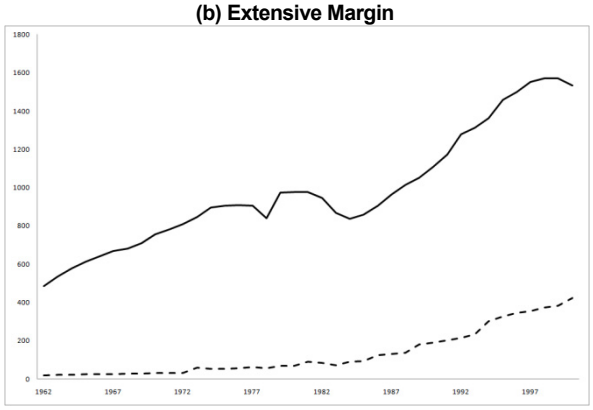
Figure 1

World Exports and the Margins of Exports

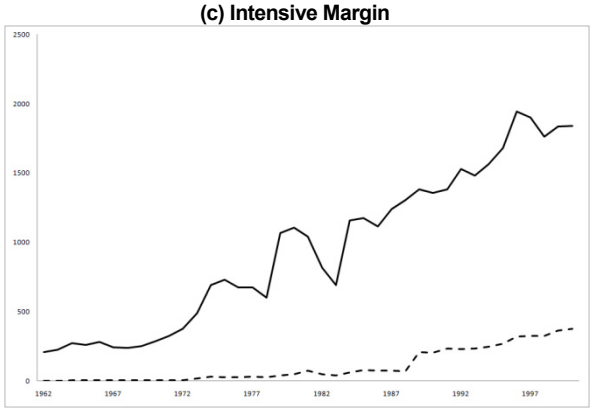
(a) Exports



(b) Extensive Margin



(c) Intensive Margin



3. Results

3.1. PTAs and the Margins of Trade

Table 1 reports our initial results from estimating equation (3). The dependent variable in our estimation of equation (3) is the difference in the logged value of one of (a) $EXPRAT_{ijt}$; (b) EM_{ijt}; or (c) IM_{ijt}. Column (1) of Table (1) reports results when considering the difference in the logged ratio of exports ($\Delta lnEXPRAT$) as our dependent variable. Here, we find coefficients on the change in GDP of the importer and exporter that are positive and significant.[15] The coefficients have a value of around 1.0, which is consistent with other findings from gravity models estimated in levels. The coefficients in the final two columns allow us to decompose the effects of the explanatory variables on changes in exports along the extensive and intensive margins. For the change in the log of the GDP of the exporter ($\Delta \ln GDP_i$) we find that around 53 percent (i.e. 0.561/1.053) of the larger exports of exporters with a higher growth of GDP is due to an increase in the extensive margin, a result similar to that found using data on the aggregate margins and a level specification by Hummels and Klenow (2005). The decomposition for the importer ($\Delta \ln GDP_j$) is similar, with around 60 percent (i.e. 0.635/1.054) of the higher level of imports of importers with higher GDP growth due to an increase in the extensive margin. In Column (1) the coefficients on the population variables are found to be relatively small, negative and significant, a result again in line with existing literature on the gravity model. Decomposing these coefficients into an effect along the extensive and intensive margin, we find in the case of the exporter that the lower level of exports of faster growing exporters is driven by a lower intensive margin, with the coefficient on the extensive margin being positive, albeit insignificant. In the case of the lower imports of faster growing importers however, we find that this is driven by a negative coefficient on the extensive margin, with the coefficient on the intensive margin being positive and significant. Finally, and most importantly, we find in Column (1) that establishing a PTA between two countries is trade creating. The coefficients on the PTA variable in columns (2) and (3) further indicate that the majority of this trade creation is due to an expansion along the extensive margin, with the extensive margin accounting for 78 percent (0.0831/0.1064) of the increase in exports.

3.2. Non-Linear Effects of PTAs

In this sub-section we consider whether the impact of PTAs on exports and the margins of trade differs depending upon the trade partners considered. To date there has been very little empirical research addressing such issues, though non-linear effects are likely pervasive with the effect of a PTA on two members' trade likely influenced by the economic size, per capita incomes and even distance between the two countries.

[15] It is interesting to note that while an R-squared of above 0.6 is often found in panel gravity models estimated in levels, the R-squared from this regression is less than 0.1. This suggests that much of the variation in exports is explained by geography and omitted country-pair specific effects.

Table 1

Linear Results

	(1) $\Delta lnEXPRAT$	(2) $\Delta lnEM$	(3) $\Delta lnIM$
$\Delta \ln GDP_i$	1.053***	0.561***	0.492***
	(0.0365)	(0.0255)	(0.0326)
$\Delta \ln GDP_j$	1.054***	0.635***	0.419***
	(0.0313)	(0.0279)	(0.0289)
$\Delta \ln POP_i$	-0.632***	0.0506	-0.683***
	(0.0877)	(0.0631)	(0.0820)
$\Delta \ln POP_j$	-0.400***	-0.455***	0.0543
	(0.0757)	(0.0580)	(0.0660)
ΔPTA	0.106***	0.0831***	0.0233
	(0.0239)	(0.0187)	(0.0222)
Constant	0.0287*	0.0226*	0.00610
	(0.0173)	(0.0129)	(0.0160)
Observations	106,621	106,621	106,621
R^2	0.071	0.035	0.057
F-Statistic	276.0***	134.0***	240.8***

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; All regressions include a full set of unreported time dummies.

In this paper we concentrate on non-linear effects related to the economic size of the trade partners. Frankel, Stein and Wei (1995, 1996) show that the formation of a PTA between two large partners creates trade in more varieties than a PTA between two small partners, improving utility more in large countries relative to small countries. To address this issue we begin by examining whether the coefficient on the PTA dummy depends upon the size of the exporting country, measured using the level of GDP of the exporting country. To do this we split the sample of exporting countries into large and small exporters, with large (small) exporters having a level of GDP greater (smaller) than the median.[16] In the table below we refer to these as PTA_L and PTA_S, with L referring to the coefficient in large exporters and S in small exporters. In addition, we also consider non-linearities by examining whether the coefficient on the PTA dummy depends upon the product of the exporter's and importer's GDP. This latter method allows us to examine whether it is trade between two large partners that is an important determinant of the benefits of PTAs. To achieve this we split countries based on the product of the log of the trading partners GDP, with the product of the log of the trading partners GDP for large (small) trading-pairs being above (below) the median. Once again, we refer to these two groups as PTA_L and PTA_S in the table below.

[16] It would be possible to endogenously split the sample using the threshold techniques of Hansen (1999). We choose not to adopt this approach however, since the method would allow for different threshold values for our different dependent variables, which would make interpretation more difficult, in particular the decomposition of the effects along the intensive and extensive margins.

The results of our non-linear model are reported in Table 2, with the first three columns reporting results for non-linearities based on the GDP of the exporter and the final three columns for non-linearities based on the product of the exporter's and importer's GDP. The results on the gravity determinants in Columns (1) and (4) are largely consistent with those in Table 1, so we turn immediately to the results on the PTA variables. The coefficient on the PTA variable when considering the ratio of exports (i.e. Columns (1) and (4)) indicate that the trade creating effects of PTA formation are larger in smaller exporters, Column (1), and for smaller country pairs, Column (4), though none of the coefficients are significantly different from each other at standard significance levels. Interestingly however, we find that PTAs have a significantly larger effect on the extensive margin in larger country pairs, Column (5). More generally, we find that the trade creating effects of PTAs are driven to a greater extent by the extensive margin in larger exporters and larger country pairs. In particular, when considering non-linearities based on exporter size we find that the extensive margin accounts for 97 percent of the increase in exports following the formation of a PTA in larger exporters, while the figure is 203 percent when considering non-linearities based on the product of the exporter's and importer's GDP.

Table 2

Non-Linear Effects of PTAs

	(1) $\Delta lnEXPRAT$	(2) $\Delta lnEM$	(3) $\Delta lnIM$	(4) $\Delta lnEXPRAT$	(5) $\Delta lnEM$	(6) $\Delta lnIM$
$\Delta \ln GDP_i$	1.053***	0.561***	0.492***	1.053***	0.561***	0.492***
	(0.0365)	(0.0255)	(0.0326)	(0.0365)	(0.0255)	(0.0326)
$\Delta \ln GDP_j$	1.054***	0.635***	0.419***	1.054***	0.636***	0.418***
	(0.0313)	(0.0279)	(0.0289)	(0.0313)	(0.0279)	(0.0289)
$\Delta \ln POP_i$	-0.631***	0.0494	-0.681***	-0.630***	0.0479	-0.678***
	(0.0878)	(0.0632)	(0.0821)	(0.0877)	(0.0631)	(0.0820)
$\Delta \ln POP_j$	-0.400***	-0.456***	0.0555	-0.398***	-0.458***	0.0593
	(0.0758)	(0.0581)	(0.0660)	(0.0758)	(0.0581)	(0.0660)
PTA_S	0.113***	0.0728***	0.0403*	0.130***	0.0522***	0.0779***
	(0.0240)	(0.0231)	(0.0238)	(0.0237)	(0.0182)	(0.0216)
PTA_L	0.0985**	0.0950***	0.00350	0.0666	0.135***	-0.0683
	(0.0433)	(0.0299)	(0.0392)	(0.0498)	(0.0391)	(0.0467)
Constant	0.0287*	0.0227*	0.00595	0.0286*	0.0228*	0.00578
	(0.0173)	(0.0130)	(0.0160)	(0.0173)	(0.0129)	(0.0160)
Observations	106,621	106,621	106,621	106,621	106,621	106,621
R^2	0.071	0.035	0.057	0.071	0.035	0.057
F-Statistic	265.1***	128.5***	231.0***	265.2***	128.5***	232.0***

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; All regressions include a full set of unreported time dummies.

4. Robustness

One issue – mentioned above – when estimating the effects of PTAs on trade using gravity models is a potential endogeneity problem, with countries potentially self-selecting into PTAs for reasons related to the level of trade. In the literature to date this has mainly been addressed through the use of fixed effects in a panel context, with a smaller number of studies using alternatives such as Heckman control functions or matching techniques. In this paper we follow the approach of Egger et al (2008) and use matching techniques to solve this potential endogeneity problem.

The problem is as follows: let $\Delta \ln EXP^{1}_{ijt} = \ln EXP^{1}_{ij,t:t+2} - \ln EXP_{ij,t-3:t-1}$ be the change in the (three-year) average level of logged exports or the margins for country-pair ij after the formation of a PTA between the two, and $\Delta \ln EXP^{0}_{ijt} = \ln EXP^{0}_{ij,t:t+2} - \ln EXP_{ij,t-3:t-1}$ be the change in the (three-year) average level of logged exports or the margins for this country-pair if they had not joined a PTA. The causal effect of joining a PTA is then defined as the change in exports (or the margins) if a PTA were formed in time t minus the change in exports (or the margins) if a PTA were not formed in time t. The average expected effect can thus be written as,

$$E\{\Delta \ln EXP^{1}_{ijt} - \Delta \ln EXP^{0}_{ijt} | PTA_{ijt} = 1\} = E\{\Delta \ln EXP^{1}_{ijt} | PTA_{ijt} = 1\} - E\{\Delta \ln EXP^{0}_{ijt} | PTA_{ijt} = 1\} \quad (\mathbf{8})$$

It is obviously the case however that the change in exports (or the margins) if the country-pairs had not formed a PTA is not observable. Causal inference therefore relies on the construction of this counterfactual, and this is where matching can be useful. The purpose of matching is to pair a country-pair that forms a PTA to a similar country-pair that did not form a PTA in time t based on a set of observable characteristics.[17] Once a country-pair has been matched we replace $E\{\Delta \ln EXP^{0}_{ijt} | PTA_{ijt} = 1\}$ in (8) with $E\{\Delta \ln EXP^{0}_{ijt} | PTA_{ijt} = 0\}$.

Since matching involves comparing country-pairs joining a PTA and those not across a number of observable characteristics it is difficult to decide along which dimension to match the countries or what type of weighting scheme to use. We use propensity score matching (Rosenbaum and Rubin, 1983), which uses the probability of receiving a given treatment, conditional on the pre-entry characteristics of the country-pairs to reduce the dimensionality problem. In our analysis these probabilities are obtained from a Probit regression model.

To identify the probability of forming a PTA we follow Baier and Bergstrand (2004) who develop and test a model identifying the determinants of PTAs. They find that pairs of countries tend to form PTAs: (i) the closer together geographically they are, (ii) the more remote a pair of natural trading partners are away from the rest of the world (ROW), (iii) the

[17] For more details on matching econometrics see Blundell and Costas Dias (2000) and Heckman, Ichimura and Todd (1998).

larger and more similar in economic size the countries are, (iv) the greater the difference in the capital-labour ratio between countries, and (v) the smaller the difference in the capital-labour ratio with respect to the ROW. We therefore include in our Probit analysis the following variables employed by Baier and Bergstrand:

- $NATURAL_{ij}$ is the natural logarithm of the inverse of the distance between the centres of i and j. The authors argue that the welfare gains from a PTA increase as the distance between them decreases[18]
- $REMOTE_{ij} = DCONT_{ij}\left\{\left[\ln\left(\sum_{k=1,k\neq i,j}^{N}\frac{DIST_{ik}}{N-1}\right) + \ln\left(\sum_{k=1,k\neq i,j}^{N}\frac{DIST_{jk}}{N-1}\right)\right]/2\right\}$, where $DCONT_{ij}$ is a dummy taking the value one if countries i and j share a common continent. This variable captures how far two countries on the same continent are from other countries. The authors show that the welfare gains from a PTA for two natural trading partners increases as their remoteness from the rest of the world increases
- $RGDP_{ijt}$ measures the sum of the log of the real GDP of countries i and j
- $DGDP_{ijt}$ measures the absolute value of the difference between the log of the real GDP of countries i and j. Baier and Bergstrand (2004) find that the probability of an PTA is higher the larger and more similar economically are the trading partners
- $ROWGDP_{ijt}$ is the average of the logs of the two countries Rest of the World (ROW) real GDP, where each country's ROW real GDP is the sum of the other country's GDP (divided by the number of other countries)[19]. Baier and Bergstrand (2004) argue that the probability of a PTA is lower the larger the ROW's economic size, since the potential for trade diversion is higher.

To perform the propensity score matching we estimate a Probit model of the following form,

$$P(PTA_{ij} = 1) = F(REMOTE_{ij}, NATURAL_{ij}, RGDP_{ij}, DGDP_{ij}, ROWGDP_{ij}) \qquad (\mathbf{9})$$

where PTA_{ij} is equal to one for country-pair ij in the year in which they formed a PTA and is zero otherwise. The matching strategy we employ is only valid on a cross-section by cross-section basis, hence the lack of a t subscript in equation (9). When implementing the matching estimator therefore we perform the matching on each cross-section and then pool the matched observations to form a panel. The matched observations are obtained using nearest neighbour matching where a country-pair that formed a PTA in time t is matched to the five closest country-pairs[20] that didn't form a PTA in time t in terms of the

[18] The abbreviation $NATURAL$ is used since countries that are close to each other and form PTAs are said to form natural PTAs (see Frankel, Stein and Wei, 1995).

[19] Note, in their analysis Baier and Bergstrand (2004) exclude this variable since it lacks variation. Given however our use of a panel there is more variation and so we include this variable. Baier and Bergstrand (2004) also included a measure of the difference in the capital stocks of the two countries (and a measure of the ROW capital stock) since they argue that the probability of a PTA is higher the larger the difference in the country's relative factor endowments. Given the lack of good quality time-series data on capital stocks for most countries we cannot include this variable in our analysis.

[20] A country-pair that didn't form a PTA can be matched to more than one country-pair that did form a PTA.

propensity score.[21] Once we have the matched sample we repeat the estimation of equation (3) above on the matched sample.

Before reporting the results from estimating equation (3) on the matched sample we report in Table 3 results from estimating the Probit model on the full panel of observations. We report these results for the full panel to give some insight into whether the model is a useful predictor of PTAs. The results reported in Table (3) do not directly relate to those used in the matching analysis however, since the matching analysis is done on a cross-section by cross-section basis, meaning that we have a different set of Probit results for each year in which a new PTA was formed. In addition, the Probit model is only estimated for those years in which a new PTA was formed.

Table 3

Determinants of PTA Participation

	(1) PTA	**(2)** PTA	**(3)** PTA	**(4)** PTA
$NATURAL$	0.136***	0.206***	0.195***	0.244***
	(0.0162)	(0.0182)	(0.0220)	(0.0250)
$REMOTE$	4.989***	5.349***	4.969***	5.710***
	(0.424)	(0.477)	(0.518)	(0.587)
$GDPROW$	0.201***	0.688***	0.297***	0.347*
	(0.0308)	(0.0939)	(0.0553)	(0.201)
$RGDP$	0.0728***	0.0822***	-0.187***	-0.285***
	(0.0172)	(0.0200)	(0.0482)	(0.0577)
$DGDP$	-0.0981***	-0.0886***	-0.0113	9.63e-05
	(0.0126)	(0.0145)	(0.0180)	(0.0209)
Constant	-6.824***	-21.77***	-4.276***	-3.395
	(0.936)	(2.974)	(1.272)	(6.337)
Year Dummies	No	Yes	No	Yes
Importer / Exporter Dummies	No	No	Yes	Yes
Observations	102,686	102,686	63,293	63,293
χ^2	736.0***	2594***	1269***	3032***

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The coefficient on $NATURAL$ – the inverse distance measure – is positive and significant, suggesting that a decrease in distance between two countries (i.e. an increase in $NATURAL$) is associated with an increase in the probability of these countries joining a PTA as expected. Similarly, an increase in remoteness is also associated with an increase in the probability of two countries joining a PTA as expected. The coefficients on the difference in

[21] We also tried using just one nearest neighbour. The results are very similar to those reported in the paper and are available upon request.

GDPs ($DGDP$) of two countries tend to be negative and significant across specifications as expected: Baier and Bergstrand (2004) note that the probability of two countries joining a PTA is larger the more similar they are economically. Given this statement of Baier and Bergstrand (2004) we would also expect a positive coefficient on the sum of the two countries GDP ($RGDP$). Here however we find that the coefficient differs in size, becoming negative and significant when time-invariant importer and exporter effects are included. According to Baier and Bergstrand (2004) we would expect a negative coefficient on the GDPs of the rest of the world, which is inconsistent with what we find. It should be noted however that in their analysis they exclude the GDP of the rest of the world from their model, while including a measure of the capital stock of the rest of the world, which we don't include because of a lack of long time-series data on this variable. Despite this latter result, overall the results are fairly consistent with those found by Baier and Bergstrand (2004).

Table 4

Results using a Matched Sample

	(1) $\Delta lnEXPRAT$	**(2)** $\Delta lnEM$	**(3)** $\Delta lnIM$
$\Delta \ln GDP_i$	0.707***	0.488***	0.218
	(0.154)	(0.114)	(0.137)
$\Delta \ln GDP_j$	1.303***	0.761***	0.542***
	(0.134)	(0.114)	(0.116)
$\Delta \ln POP_i$	0.169	0.678**	-0.509
	(0.375)	(0.306)	(0.345)
$\Delta \ln POP_j$	-0.483	-0.411	-0.0718
	(0.317)	(0.260)	(0.294)
ΔPTA	0.0656**	0.0698***	-0.00427
	(0.0265)	(0.0208)	(0.0246)
Constant	0.123	-0.0934	0.217
	(0.300)	(0.326)	(0.471)
Observations	4,931	4,931	4,931
R^2	0.103	0.043	0.077
F-Statistic	19.58***	8.975***	16.47***

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; All regressions include a full set of unreported time dummies.

Using the same specification for the Probit model as described above we performed matching on a cross-section by cross-section basis for each year in our sample in which new PTAs were formed and pooled the data to give us a panel of matched countries. Using this dataset we re-ran the estimation of equation (3). Table 4 reports the results. The results on the additional gravity variables in Column (1) are largely consistent with those in Tables 1 and 2 – the main exception being the lack of significant coefficients on the population variables – and so we skip over these results and turn to the coefficients on the PTA variable for which results are also very similar to those reported in Table 1. In

particular, we find a positive impact of the establishment of a PTA on exports, albeit with the coefficient being somewhat smaller than that in Table 1. Once again, the majority of this increase is due to an expansion in exports along the extensive margin, and in this case we find that the extensive margin accounts for 106 percent of the increase in exports, with a small (insignificant) decrease in the intensive margin.

5 Conclusions

In this paper we examine the effects of PTAs on exports in general and the extensive and intensive export margins in particular. Initially, we report results using a simple gravity framework. We further address the issue of potential non-linear effects of PTAs with respect to country size. To account for potential self-selection we finally apply a matching technique as suggested in the literature.

The results for the gravity variables are in line with our expectations and also with the existing literature. Summarising the above results we find that considering all PTAs there is a positive and significant effect of the formation of a PTA on (contemporaneous) exports. This is the case regardless of whether we use a standard least squares methodology to estimate the gravity model or whether we use matching econometrics, suggesting that the self-selection problem may not be severe (despite the coefficient being somewhat lower in the matching analysis). Moreover, we find that the increase in exports is largely due to an increase in exports along the extensive margin (i.e. an increase in variety traded). Finally our tests for non-linear effects of PTAs indicate that PTAs seem to be more trade-creating for smaller exporters and smaller country-pairs, but that the extensive margin responds more strongly to PTAs in larger exporters and country-pairs. This latter result is consistent with the theory of Frankel et al (1995, 1996).

While the results from our analysis are consistent with other studies examining the response of the margins to trade liberalisation they should be treated with a degree of caution. The results in this paper consider the impact of PTAs on changes in contemporaneous exports volumes and the contemporaneous margins of trade. As emphasised by Baier and Bergstrand (2009) many PTAs have long phase-in periods and the effects of the formation of a PTA may have a further lagged effect due to changed terms of trade. It may be therefore that the short-run effects identified in this paper differ from the longer term effects of PTA membership. The approach of Baier and Bergstrand (2009) that both controls for self-selection using matching econometrics and allows for the identification of the long-run effect of PTA membership on trade volumes may be considered a useful extension of the current exercise on the margins of trade therefore. A further useful extension would be to attempt to account for the depth and breadth of PTAs by considering exports in products covered by the PTA only and/or accounting for changes in applied tariff rates over time.

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