Trade Creation and Diversion Revisited: Accounting for Model Uncertainty and Natural Trading Partner Effects*

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Abstract

The effect of Preferential Trade Agreements (PTAs) on trade flows is subject to model uncertainty stemming from the diverse and even contradictory effects suggested by the theoretical PTA literature. Existing empirical literature has produced remarkably disparate results and the wide variety of empirical approaches reflects the uncertainty about the "correct" set of explanatory variables that ought to be included in the analysis. To account for the model uncertainty that surrounds the validity of the competing PTA theories, we introduce Bayesian Model Averaging (BMA) to the PTA literature. Statistical theory shows that BMA successfully incorporates model uncertainty in linear regression analysis by minimizing the mean squared error, and by generating predictive distributions with optimal predictive performance. Once model uncertainty is addressed as part of the empirical strategy, we find strong evidence of trade creation, trade diversion, and open bloc effects. Our results are robust to a range of alternative empirical specifications proposed by the recent PTA literature.

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1 Introduction

Bhagwati and Panagariya (1996) call Preferential Trading Arrangements (PTAs) "two faced" because PTAs introduce trade liberalization at the cost of discrimination. The controversy regarding the costs and benefits of PTAs has raged since the 1950s, due to the potential for trade creation and trade diversion (Viner, 1950). Time has not provided a consensus; to the contrary, with the proliferation of PTAs in the 1990s, the number of theories that predict either increasing or decreasing trade flows among (non)members increased in tandem. And as the number of theories expanded, the set of candidate regressors suggested by empirical PTA approached the point where comprehensive robustness has become virtually unfeasible. Consequently, it has become common practice in this literature to juxtapose results that represent alternative PTA approaches. It is therefore not surprising that PTA coefficient estimates have been found to be highly sensitive to the specific set of regressors used in any given study (see Baxter and Kouparitsas, 2006).

Ghosh and Yamarik (2004) provide the most extensive PTA robustness analysis to date. Not only do they include a large set of PTAs, but also they employ Extreme Bound Analysis (Leamer, 1983) to examine a diverse set of PTA theories. Ghosh and Yamarik (2004) find little evidence for either trade creating or trade diverting PTAs. They conclude that "... the pervasive trade creation effect found in the literature reflects not the information content of the data but rather the unacknowledged beliefs of the researchers."

In this paper we introduce Bayesian Model Averaging (BMA) to the PTA literature to reexamine PTA model uncertainty. BMA is specifically designed to incorporate model uncertainty into the estimation process, and it is firmly rooted in statistical theory. It is a methodology that explores the model space without restrictions, weighs each model according to quality, and provides a probability distribution for each coefficient estimate. Raftery and Zheng (2002) prove that BMA maximizes predictive performance while minimizing the total error rate when compared to any individual model.[1]

The issue of model uncertainty surrounding PTA effects is well known in the PTA literature. Seldom do papers present less than a dozen different PTA regression specifications. This is why Ghosh and Yamarik's (2004) findings are so troublesome. We show that BMA overturns the fundamental Ghosh and Yamarik result by identifying a number of PTAs that exert decisive effects

[1] Alternative applications of BMA to international economics are Wright (2003) and Chen and Rogoff (2006).

on trade flows. Since Ghosh and Yamarik (2004), the PTA literature has evolved to introduce a number of innovations that address omitted variable bias. We show that our main finding of measurable PTA effects on trade flows is robust to an update of the Ghosh and Yamarik (2004) dataset to include additional years, additional PTAs, and alternative fixed effect specifications. Our methodological extensions include a full account of multilateral resistance (see e.g., Anderson and van Wincoop, 2003; Subramanian and Wei, 2007), bilateral unobserved heterogeneity (see, e.g., Glick and Rose, 2002; Egger and Pfaffenmayr, 2003), and accession dynamics (Freund and McLaren, 1999). Our approach follows a voluminous literature spanned by Frankel, Stein and Wei (1995), Frankel, Stein and Wei (1997), Rose and van Wincoop (2001), Frankel and Rose (2002), and Rose (2004).[2]

More specifically, our findings are as follows: Our BMA benchmark specification, using Ghosh and Yamarik's (2004) own dataset, shows strong trade creation, trade diversion, and open bloc effects for 12 PTAs.[3] Our results are at odds with Ghosh and Yamarik (2004), even if we use their identical dataset, and the differences arise for two reasons.[4] First, BMA inference is based on an unrestricted search of the model space spanned by all candidate regressors, while Extreme Bound Analysis covers only a fraction of the model space due to the researcher's categorization of variables into "free" (variables that should always be included in the regression specification) and "doubtful" (variables that *may* be effective in the regression specification). Secondly, BMA theory requires that each model is weighed according to its posterior model probability (which is associated with the model's quality or performance), while Extreme Bound Analysis weighs all models equally and thus attributes the same power of inference to exceptionally weak and strong models.

Even after we extend the Ghosh and Yamarik data from 1970-1995 to 1960-2000 and include more recent bilateral trade agreements, our results are robust. Indeed a number of PTAs are estimated with increased precision, which allows us to identify additional trade creating PTAs. The updated dataset also erases the suspicious trade diversion effects (for NAFTA) and the unexpectedly large open bloc effects (for MERCOSUR). Third, once we control for multilateral resistance, the

[2] An appealing alternative is to examine the intensive and extensive margins of trade as proposed by Helpman, Melitz and Rubinsein (2008), and Felbermayr and Kohler (2006). We leave this to future research

[3] It is common in Extreme Bound Analysis to attach all the weight of the posterior to the prior distribution. While Extreme Bound Analysis provides no guidelines, Ghosh and Yamarik (2004) also examine the case where 95 percent of the weight of the posterior distribution is on the prior and 5 percent on the sampling distribution – in this case Ghosh and Yamarik (2004) find trade creation in four PTAs (CACM, CARICOM, MERCOSUR and APEC).

[4] Previous comparisons between Extreme Bound Analysis and BMA results have also found Extreme Bound Analysis to be excessively stringent (see Sala-i-Martin, 1997; and Fernandez, Ley and Steel, 2001a).

key result continues to hold and the vast majority of PTAs is shown to exert influence on trade flows, most in trade creating direction.

Our approach to addressing multilateral resistance follows directly from Anderson and van Wincoop (2003) and Novy (2006, 2007), as implemented by Subramanian and Wei (2007) but in a different context that did not address PTA effects. As a corollary, we also show that estimates based on multilateral resistance are generally larger than estimates that account for unobserved country-pair heterogeneity (an approach advocated by Glick and Rose, 2002; Rose, 2004; and Rose, 2005). This may be due to the methodological difference, where country-pair fixed effects render estimates that measure only those PTA effects that are directly related to accession. This raises the question of accession dynamics. Our fourth result highlights that PTA trade effects generally appear *after* accession; although we also highlight PTAs with observable effects at or even pre-accession.

The remainder of the paper is organized as follows. Section 2 discusses the basic framework of the BMA methodology used in our estimation. In section 3 we take a look at the datasets employed, and in Section 4 we report and discuss our results. Section 5 concludes.

2 The Empirical Framework

Econometric studies that seek to identify the impact of PTAs on trade flows are generally based on the gravity model.[5] The approach fits the application particularly well, due to the gravity model's proven efficiency in predicting trade flows (see Frankel and Romer, 1999). This allows PTA coefficients to pick up on deviations between predicted and actual trade. The basic gravity framework is given by

$$\log T_{ijt} = \alpha_t + \beta_1 \log Y_{it} Y_{jt} + \beta_2 \log D_{ij} + \beta_3 X_{ijt} + \varepsilon_{ijt}, \tag{1}$$

where bilateral trade, T_{ijt}, between countries i and j at time t depends positively on national incomes, Y_{it} and Y_{jt}, and negatively on bilateral distance, D_{ij}. Typically a matrix of covariates, X_{ijt}, is included to represent alternative trade theories and to proxy for unobservable trade costs. Therefore our regression models should be seen as reduced forms that capture aspects of the theories described subsequently in Section 2.1. The inclusion of time fixed effects, α_t, is standard in the literature to eliminate bias resulting from aggregate shocks to world trade. Time fixed effects also

[5] The theoretical foundations of the gravity model are presented in Frankel (1997) and Deardorff (1998).

mitigate any spurious correlation introduced, for example, by the use of a U.S. price index to deflate all trade flows.

Ghosh and Yamarik (2004) include dummies that capture PTA effects on bilateral trade. The matrix X_{ijt} is then split into PTA related dummies and other covariates, Z_{ijt},[6] obtaining

$$\log T_{ijt} = \alpha_t + \beta_1 \log Y_{it} Y_{jt} + \beta_2 \log D_{ij} + \beta_3 Z_{ijt} + \beta_4 PTA_{ijt} + \beta_5 PTA_{it} + \varepsilon_{ijt}. \tag{2}$$

Two sets of zero-one dummy variables are included to indicate whether both trading partners are members of the same PTA in year t, PTA_{ijt}, or whether only one trading partner has joined, PTA_{it}. These dummies enable us to isolate the three distinct effects that PTAs may exert on trade flows. A positive coefficient on PTA_{ijt} captures trade creation among PTA members, while trade diversion registers a negative PTA_{it} coefficient. Finally, open bloc trade creation is simply the opposite of trade diversion, characterized by a positive PTA_{it} coefficient.

Equation (2) can be extended to control for multilateral resistance and country-pair fixed effects. In place of average trade, multilateral resistance requires the use of either bilateral imports (Subramanian and Wei, 2007) or bilateral exports (Novy 2006, 2007) as the dependent variable.[7] Here we largely follow Subramanian and Wei (2007) to generate results that are comparable to their benchmark.

$$\log\left(Imports_{ijt}\right) = \alpha_t + \alpha_{it} + \alpha_{jt} + \beta_2 \log D_{ij} + \beta_3 \tilde{Z}_{ijt} + \beta_4 PTA_{ijt} + \varepsilon_{ijt}. \tag{3}$$

The added advantage of using bilateral imports, $Imports_{ijt}$, as the dependent variable is that it avoids bias induced from averaging trade flows (see Baldwin and Taglioni, 2006).[8] Since any nation faces only one import/export price index at any point in time, multilateral resistance can be accounted for with time-varying country fixed effects (represented by α_{it} and α_{jt}).[9] Multilateral resistance controls in (3) prohibit the identification of separate trade creation and diversion effects.[10] Instead the PTA_{ijt} dummies represent net trade creation.

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[6] The set of specific correlates used are discussed in Section 2.1.

[7] Some argue that this is advantageous, since trade theories yield predictions on unidirectional trade (see Freund, 2000; Anderson and van Wincoop, 2003; Baldwin and Taglioni, 2006).

[8] Alternative estimation approaches can also address measurement error bias see Felbermayr and Kohler (2006), and Silva and Tenreyro (2006).

[9] Time-varying country dummies are lucidly motivated by Baldwin and Taglioni (2006).

[10] Multicollinearity does not allow for separate trade creation and diversion effects in the presence of multilateral resistance controls. For a given year, a typical PTA member country's import observations are partitioned into a) imports originating from fellow PTA members and b) imports from non-members. The linear combination of two separate dummy variables for each type of imports would be perfectly collinear with time-varying importer dummy that controls for multilateral resistance.

Alternatively, unobserved country pair heterogeneity can be addressed by controlling for all time-invariant bilateral heterogeneity with country-pair fixed effects, α_{jt}, as follows:

$$\log\left(Imports_{ijt}\right) = \alpha_t + \alpha_{ij} + \beta_1 \log Y_{it}Y_{jt} + \beta_3 \bar{Z}_{ijt} + \beta_4 PTA_{ijt} + \varepsilon_{ijt}. \tag{4}$$

Note that all time-invariant regressors are now absorbed into the pair-specific fixed effects.[11] These fixed effects capture any similarities among trading partners that are constant over time. The country-pair fixed effects, together with Rose's remoteness variable to capture (albeit imperfectly) multilateral resistance, represents a general formulation of the gravity equation to address unobserved heterogeneity (e.g., Egger, 2000; Baldwin, 2005). If country-pair fixed effects are omitted, the PTA coefficients are biased upward picking up trade creation that is simply due to unobserved bilateral heterogeneity. Notice that the introduction of additional fixed effects that control for either multilateral resistance or unobserved country-pair heterogeneity actually absorb control variables that were introduced previously. This reduces the matrix of controls from Z_{ijt} to $\bar{Z}_{ijt}$ and $\tilde{Z}_{ijt}$, respectively.

2.1 Model Uncertainty in PTA Theory

There exists a voluminous theoretical literature that discusses the appropriate controls to be used in Z_{ij}. They include covariates that reference geography, history, economic policy, and development and factor endowments. Each control is motivated by a particular theory, and at times the same control is claimed for different theories (with opposite sign), which reflects the inherent model uncertainty. Below we provide a brief description of the theoretical underpinnings of the various controls suggested by the previous literature to highlight the diversity of the approaches used. It is crucial for us to outline this diversity of approaches to justify the use of the model averaging methodology. Table 1 summarizes the degree of model uncertainty by tabulating the relationships of our covariates with bilateral trade as estimated by earlier studies. The table highlights the many attempts to identify determinants of trade flows, and the plethora of differing and/or opposite results. It provides a visual motivation for addressing model uncertainty inherent in gravity/PTA regressions directly as part of the empirical strategy.[12]

[11] We estimate equations (2)-(4) using the Andrews, Schank and Upward's (2006) "FEiLSDVj" estimator, which relies on partitioned regression techniques to reduce computational burden; it delivers identical results as LSDV regressions.

[12] Leamer (1978) was the first to emphasize that this uncertainty regarding the validity of theories must be accounted for in the empirical strategy.

Feenstra, Markusen and Rose (2001) argue that empirical gravity models can be used to discriminate between alternative trade theories. BMA allows to take advantage of this favorable feature of gravity models, while thoroughly accounting for model uncertainty. This is crucial because if the uncertainty about the true specification is not accounted for in the econometric method, the precision of estimates is inflated, since they neglect the uncertainty surrounding the true theory.

It is important to outline the theoretical backbone of each regressor included in the analysis because without theoretical support the results are difficult to interpret. We start with important control variables that capture historical ties, such as *Common Language*, *Common Colonizer*, or *Colony.* These covariates are commonly added in attempts to capture transaction costs caused by the inability to communicate and/or overcome cultural differences.[13] Common historical ties lead to similar institutions and similar levels of development, implying reliable contractual and legal standards, as well as trust in shared values. Controlling for model uncertainty addresses not only which one of these regressors (or regressor combinations) is appropriate, but also whether their inclusion is indeed approximating the true model.

Geographic factors have been introduced as proxies for either transport costs (e.g., Aitken, 1973), trade-and-geography theories (e.g., Helpman and Krugman, 1985), or for New Trade Theories (e.g., Rivera-Batiz and Romer, 1991). *Remoteness* is widely used to capture the notion that relatively remote country pairs are expected to trade more, because they have fewer options in choosing trade partners.[14] It has also been motivated as a proxy for multilateral resistance, or the average trade costs facing a country (Brun, Guillamont and de Melo, 2005; Carrere, 2006). Land *Area* is intended to capture self-sufficiency and scale effects that are prominent in both the new trade and growth theories (e.g., Rose, 2000; Rose and Van Wincoop, 2001; Soloaga and Winters, 2001). Scale effects are also proxies for technology or knowledge spillovers (e.g., Grossman and Helpman, 1991).

Alternative proxies in the geography category, such as *Border*, *Landlocked*, and *Island* have previously been utilized by a variety of authors although it is not immediately clear why adjacency should matter after having controlled for distance.[15] Perhaps variables that measure distance center-to-center introduce errors that are mitigated by the additional controls because neighboring

[13]See Wei (1996), Frankel (1997), Rose (2000), Soloaga and Winters (2001), Rose and van Wincoop (2001), and Frankel and Rose (2002).

[14]See Wei (1996), Rose (2000), Soloaga and Winters (2001), and Baier and Bergstrand (2007).

[15]See Frankel and Romer (1999), Rose (2000), Feenstra, Markusen and Rose (2001), Rose and van Wincoop (2001), Soloaga and Winters (2001), and Frankel and Rose (2002).

countries often engage in large volumes of border trade. BMA addresses the uncertainty among geography variables and resolves whether additional variables for proximity ought to be included and which covariates are relevant to explaining how PTAs influence trade patterns.

Development and factor endowments covariates juxtapose the Heckscher-Ohlin factor endowments driven trade theory with Linder's (1961) hypothesis that similar countries trade more due to comparable tastes. Davis (1995) presents an augmented Heckscher-Ohlin-Ricardo model that provides support for either theory, depending on the technological distance between the countries and Spilimbergo and Stein (1996) examine the issue empirically. Common proxies for factor endowments differences are based on *Per Capita GDP, Schooling,* and *Population Density.*[16] The best theoretical rationale for *Per Capita GDP* is based on the strategic trade literature (e.g., Helpman and Krugman, 1985) that predicts intra-industry trade decreases as a result of differences in the countries' levels of development. Furthermore, countries with higher per capita GDP are likely to have better access to less distortionary revenue sources, hence they may experience more bilateral trade since they can afford lower tariffs.

Economic policy variables in the matrix Z_{ijt} include measures related to trade/financial openness and exchange rate management. These are important controls to account for trade restrictions that may explain trade pattern deviations from those implied by the pure gravity equation. The *Sachs-Warner Trade Openness* variable is inserted into the gravity equation to account for trade policy effects. In addition, proxies that measure capital account openness, and financial transaction costs such as *Currency Union, Floating FX Rate,* and *FX Volatility* are usually included although it is not clear what coefficient estimates are to be expected. Clark et al. (2004) survey the literature and highlight that just this subset of regressors alone is so deeply affected by model uncertainty that the impact of exchange rate fluctuations depends on the specific assumptions of each model.[17]

Finally we address model uncertainty in the PTA theory itself.[18] Not only do we have opposing implications suggested by different theories, but at times opposing theories have been suggested by the same author (see e.g., Krugman, 1991a,b). The theory of PTAs is based on Viner's (1950) theory of trade creation and diversion. By the 1990s, however, a full scale discussion erupted regarding the drivers of trade creation and diversion. Krugman (1991a,b) examined the relative merits of PTAs

[16] They have been introduced by Frankel (1992), Frankel and Wei (1993), Frankel, Stein and Wei (1995), Frankel (1997), Freund (2000), Rose and van Wincoop (2001), and Frankel and Rose (2002).

[17] Authors who introduced such regressors into the gravity equation include Rose (2000), Frankel and Rose (2002), Rose and van Wincoop (2001), Glick and Rose (2002), and Tenreyro and Barro (2007).

[18] For a more detailed literature review see, Panagariya (1999, 2000).

in a static, monopolistically-competitive framework that emphasized economic geography. His first model implied PTAs should not be welfare creating in the absence of intercontinental transport costs. At the other extreme, Krugman's second model suggested regional PTAs increase trade flows and subsequently welfare in the presence of prohibitive inter-continental transport costs. Krugman's theories led Frankel, Stein, and Wei (1995), Frankel (1997), and Wei and Frankel (1998) to develop theories based on a continuum of transport costs. Their work characterizes trade partners as "natural" on the basis of relatively low intra-continental transport costs and their approach implies that trade creation among "natural" trading partners should dominate small trade diversion among remote country pairs from a welfare perspective. As trade costs fall, however, trade diversion may become larger since "natural" trading partners overly skew their trade toward PTA partners. Frankel, Stein and Wei (1995) suggest two hypotheses. First, the more remote trading partners are from the rest of the world, the more likely they are to form PTAs due to less potential trade diversion. This effect could be picked up by the *Remoteness* proxy, too. Second, the more "natural" trading partners are, the more likely PTAs are to lead to trade creation.

Krugman's and Frankel, Stein and Wei's theories are based on one factor – one industry models. Deardorff and Stern (1994) and Haveman (1996), note that these models preclude trade due to comparative advantage. Deardorff and Stern point out that this "stacks the cards" against bilateralism and argue that, given differences in factor endowments, trade with a few countries suffices in order to maximize gains from trade, so that trade diversion would be minimal. In response, Baier and Bergstrand (2004) construct a model that builds upon Frankel, Stein and Wei (1995) to allow for comparative advantage and scale effects. Freund (2000) argues strongly for PTA open bloc trade creation effects (even if trade creation among members is absent) since PTAs help outside exporters overcome fixed trade costs. Trade diverting effects, instead, are highlighted by Bond and Syropoulos (1996) and Syropoulos (1999), who indicate that the increased market power of PTAs, relative to the market power of each member taken individually, may lead to higher external tariffs.

2.2 Bayesian Model Averaging

Next we briefly comment on the BMA methodology used in our estimation. We will limit ourselves to discussing the properties relevant to our application. The interested reader is referred to the comprehensive tutorial by Raftery, Madigan and Hoeting (1997) for further discussion. BMA is a natural candidate to address model uncertainty surrounding the correct controls in equations (2)-

(4), since it provides a probability distribution over the model space as well as over the parameter space. In our PTA estimation, the model space consists of all the possible subsets of candidate regressors that have been suggested by the distinct theories summarized above.

For linear regression models, the basic BMA setup can be concisely summarized as follows. Given a dependent variable, Y, a number of observations, n, and a set of candidate regressors, $X_1, X_2, ..., X_k$, the variable selection problem is to assess the quality of model

$$Y = \alpha + \sum_{j=1}^{p} \beta_j X_j + \varepsilon, \tag{5}$$

where $X_1, X_2, ..., X_p$ is a subset of $X_1, X_2, ..., X_k$, and β is a vector of regression coefficients to be estimated. Note that (5) is specified for linear models. At this point no BMA search algorithms exist that search not only the linear model space, but also all of the possible nonlinear dimensions. Given the data, d, BMA first estimates a posterior distribution $P(\beta_r|d,\, M_k)$ for every candidate regressor, r, in every model M_k that includes β_r. It then combines all posterior distributions into a weighted averaged posterior distribution, $P(\beta_r|d)$, using each model's posterior probability, $P(M_k|d)$, as model weight

$$P(\beta_r|d) = \sum_{r \in M_k} P(\beta_r|d,\, M_k)\, P(M_k|d). \tag{6}$$

The posterior model probability of M_k is simply the ratio of M_k's marginal likelihood to the sum of the marginal likelihoods over all other models[19]

$$P(M_k|d) = \frac{l(d|M_k)}{\sum_{h=1}^{2^k} l(d|M_h)}. \tag{7}$$

Intuitively, this implies that a model's weight is proportional to its relative efficiency in describing the data. Posterior model probabilities are also the weights used to establish the posterior means and variances

$$\mu \equiv E\left[\beta_k|d\right] = \sum_{k \in M}^{K} \hat{\beta}_k pr\left(M_k|d\right), \tag{8}$$

[19] Equation (6) assumes a uniform prior over the model space, which is the standard in the literature; see Raftery, Madigan and Hoeting (1997), and Fernandez, Ley and Steel (2001a,b). The marginal likelihood includes parameter priors, and their choice can be contentious, see Fernandez Ley and Steel (2001b), Sala-i-Martin Doppelhofer and Miller (2004) and Eicher, Papageorgiou and Raftery (2007). Given the large dataset, however, our results are insensitive to the choice of parameter priors.

$$\sigma \equiv Var\left[\beta_k|d\right] = \sum_{k\in M}^{K}\left(Var\left[\beta_k|d, M_k\right] + \hat{\beta}_k^2\right) pr\left(M_k|d\right) - E\left[\beta_k|d\right]^2. \tag{9}$$

Barbieri and Berger (2004) show that the median model (closely related to the vector of posterior means) provides excellent, if not optimal predictive performance. Providing economically meaningful coefficient estimates requires conditioning them on whether a regressor is included in the model (otherwise the distribution would contain a spike at zero, representing models that do not include the regressor). By summing the posterior model probabilities over all models that include a candidate regressor, we obtain the posterior inclusion probability

$$P\left(\beta_k \neq 0|d\right) = \sum_{r\in M} P\left(M_k|d\right). \tag{10}$$

The posterior inclusion probability provides a probability statement regarding the importance of a regressor that directly addresses the researchers' prime concern: what is the probability that the regressor has a non-zero effect on the dependent variable? The larger the probability of zero effect, the larger the evidence against a regression being part of the true theory. The posterior inclusion probability thus carries an important interpretation that goes beyond the information contained in standard P-values.

The general rule developed by Jefferies (1961) and refined by Kass and Raftery (1995) stipulates effect-thresholds for posterior probability. Posterior probabilities $< 50\%$ are seen as *evidence against* an effect, and the evidence for an effect is either *weak*, *positive, strong*, or *decisive* for posterior probabilities ranging from 50-75%, 75-95%, 95-99%, and $> 99\%$, respectively. In our analysis, we refer to a regressor as "effective," if its posterior inclusion probability exceeds 50%.

BMA has a number of key advantages over estimating a single model, and over Extreme Bound Analysis. Hjort and Claeskens (2003) point out that for good reasons BMA "dominates the literature on accounting for model uncertainty in statistical inference." Raftery and Zheng (2003) summarize the main theoretical results proving that BMA a) minimizes the total error rate (sum of Type I and Type II error probabilities), b) point estimates and predictions minimize mean squared error (MSE), and c) predictive distributions have optimal predictive performance relative to other approaches.[20]

[20] The rapidly growing literature on economics applications using BMA include policy evaluations (e.g. Brock, Durlauf and West, 2003) monetary policy (e.g. Levin and Williams, 2003), macroeconomic forecasting (e.g. Garratt, Lee, Pesaran and Shin, 2003), and economic growth (e.g., Fernandez, Ley and Steel, 2001a).

As compared to Extreme Bound Analysis, BMA examines the entire model space and forces no restrictions on the size of the model that can be considered. For example, Ghosh and Yamarik (2004) only consider models that contain a specific number of fixed variables to which a specific number of regressors is rotated in and out across models. This limits the search for the exact model to an exceedingly small part of the model space. The absence of information regarding the quality of models in Extreme Bound Analysis renders the approach excessively stringent (see Sala-i-Martin, 1997; Sala-i-Martin, Doppelhofer and Miller, 2004).

3 Data

To start with, we use the Ghosh and Yamarik (2004) dataset to allow for a direct reexamination of their evidence using BMA as our alternative statistical methodology. The Ghosh and Yamarik dataset is based on Frankel and Rose (2002) that consists of 12 major PTAs, [21] 3,420 bilateral trade pairs at five year intervals from 1970 to 1995, and a total of 14,522 observations.[22] This dataset features average bilateral trade as the dependent variable, recorded in U.S. dollars and deflated by the U.S. GDP chained price index. In addition to the basic gravity and trade agreement variables, 16 controls variables have been suggested by various gravity approaches discussed in Section 2.1.

To address refinements in the theoretical and empirical trade flow specifications suggested by the recent literature, we expand the baseline dataset in several dimensions. We extend the time horizon from 1960 to 2000 and allow for 60 additional (bilateral) trade agreements that are included in Subramanian and Wei (2007). The total number of observations increase substantially 37,983 observations. We follow Subramanian and Wei (2007) and choose bilateral imports as the dependent variable; nominal imports are obtained from the IMF's *Direction of Trade Statistics*.[23] Overall our updated dataset extends the unbalanced panel of Subramanian and Wei (2007) in the following three dimensions: (a) disaggregates the Subramanian-Wei catch-all PTA variable, (b) al-

[21] The PTAs are the European Union (EU), European Free Trade Arrangement (EFTA), European Economic Area (EEA), Central American Common Market (CACM), Caribbean Community (CARICOM), North America Free Trade Arrangement (NAFTA), Latin America Integration Agreement (LAIA), Andean Pact (AP), Southern Cone Common Market (MERCOSUR), Association of South-East Asian Nations Free Trade Area (AFTA), Australia-New Zealand Trade Agreement (ANZCERTA), and Asian Pacific Economic Cooperation (APEC).

[22] See Ghosh and Yamarik (2004, Appendix C) for further details. To deal with the large number of fixed effects in BMA, we use a partitioned regression technique equivalent to Andrews, Schank, and Upward.'s (2006) "FEiLSDVj" method.

[23] Note that Subramanian and Wei (2007) deflate bilateral imports by the U.S. CPI. Here we use nominal import values as they yield the same results once time fixed effects are included (see Baldwin and Taglioni, 2006).

lows for additional PTAs not considered in the Subramanian and Wei (2007),[24] (c) incorporates a comprehensive list of additional controls suggested by the previous literature. Detailed descriptions of PTAs and the controls in the extended dataset can be found in Tables 2a-c.

4 Results

4.1 PTA Trade Creation: Differences due to Methodologies

Ghosh and Yamarik (2004) embarked on the most comprehensive robustness test of PTAs to date. They considered not just a subset, but all major PTAs and employed Extreme Bound Analysis to explore the model space far beyond what ordinary robustness exercises can hope to represent. Our first objective is to replicate Ghosh and Yamarik's (2004) results using BMA methodology. Table 3 reports results for two specifications. Specification 1 employs BMA on the exact same data and regression equation in Ghosh and Yamarik (2004, equation 1). Specification 2 differs from Specification 1 only in that it uses our new updated dataset based on Subramanian and Wei (2007).

Table 3 highlights that our key result is independent of the choice of datasets. Once model uncertainty is addressed in a principled fashion using BMA, Ghosh and Yamarik's (2004) own econometric specification produces a host of PTA effects that range from trade creating to open bloc and even trade diverting. We obtain effective coefficients (indicated with asterisks) whose signs and magnitudes are similar to those commonly reported in the previous literature. BMA thus provides evidence that the model space spanned by "free and doubtful variables" through Extreme Bound Analysis was too restrictive. The models flagged out by Extreme Bound Analysis did not contain those that feature the highest posterior probabilities and the heuristic model weighting assigned by Extreme Bound Analysis's generated excessively conservative results that indicated no PTAs effects. The expanded model space together with a principled weighting of effective models, are the reasons why BMA provides superior predictive performance.

Of the 13 major trade agreements, 8 are found to be either trade creating and/or exhibiting open bloc effects in Specification 1. All western hemisphere PTAs are identified as trade diverting in the original Ghosh and Yamarik dataset (Specification 1). The additional years and controls for bilateral agreements in our updated dataset (Specification 2) increase the precision of the estimates,

[24]This extension adds the European Free Trade Agreement (EFTA), the European Economic Area (EEA), the Andean Pact (AP), the Latin America Integration Agreement and the Asia Pacific Economic Community (APEC) to the analysis.

but render our key insights unchanged. Specification 2 produces four additional trade creation effects (for key PTAs such as the EFTA, AFTA and the EU), and erases the odd implication of NAFTA trade diversion that was reported by Specification 1. These changes are most certainly due to the extension of the time horizon from the mid 1990s to 2000. In summary, the BMA results robustly link PTAs to changes in trade flows, although the effect varies across PTAs.

A substantial literature addresses the possibility of PTA coefficient bias due to omitted variables or inaccurate model specification. We extend our analysis to incorporate the insights of this recent literature to examine the robustness of our results. The scale of some PTA coefficients in Table 3 is certainly suspicious if not implausible. Coefficients that exceed unity imply that a PTA increased trade more than twofold (since the regression is in logs); such aberrant magnitudes have previously been noted and questioned in the literature (e.g., Frankel, 1992; Frankel, Stein and Wei, 1995; Frankel and Wei, 1993; Frankel, 1997). We take up the issue of omitted variable bias in the following section.

4.2 Accounting for Multilateral Resistance

Ghosh and Yamarik (2004) and our Specifications 1 and 2 (Table 3) include time fixed effect, but the recent PTA literature suggests the inclusion of additional fixed effects that account for multilateral trade costs. Wei (1996), Deardorff (1998), Anderson and van Wincoop (2003), and Subramanian and Wei (2007) emphasized that the standard gravity model is subject to misspecification bias if multilateral trade costs are ignored. The crucial insight is that even bilateral trade is influenced by the average multilateral trade cost faced by a country in any given period. Anderson and van Wincoop (2003) suggest that, empirically, the inclusion of country fixed effects captures such "multilateral resistance." Since bilateral trade between any two countries depends on the multilateral resistance of *both* importers and exporters, the Anderson and van Wincoop (2003) model requires fixed effects for both countries involved in any bilateral trading relationship.[25] In a panel, these importer and exporter fixed effects must be time varying, which allows the PTA dummies in equation (2) to identify net trade creation. This fixed effect approach has been popularized by Subramanian and Wei (2007) in their analysis of WTO trade effects (although these authors do not break out the effects of individual PTAs).

[25] Helpman, Melitz and Rubinstein (2008) suggest an alternative rationale for importer and exporter fixed effects based on firm heterogeneity.

Table 4 reports results that control for multilateral resistance. First, we confirm in Specification 3 that our new set of results is not driven by changing in the PTA dummy specification, to represent net trade creation. In short, Specification 3 replicates Specification 2, without separate trade diversion/open bloc effects. As expected, the results are just about identical to the sum of trade creation and diversion in Specification 2.[26] More importantly, however, Table 4 shows that even after controlling for multilateral resistance, the fundamental result of our analysis remains unchanged: PTAs have a strong impact on bilateral trade. Of the 13 major PTAs covered, 8 PTAs exhibit an effect on bilateral trade, only one of which is trade diverting. This implies that controlling for multilateral resistance identifies four additional PTAs with significant impacts on bilateral trade flows.

The one surprise in Specification 4 is negative net trade creation for the EU. The attractiveness of the EU market with its large size and strong harmonization likely exerts a significant pull on non-EU exporters, resulting in large open bloc effects (of about 0.6) in Specifications 1 and 2. The drag of open bloc effects on net trade creation by itself thus explains roughly half of the negative coefficient estimate. It is, moreover, well known that the gravity equation, overpredicts EU trade, when estimated on a global sample. Given their close proximity and other bilateral characteristics, EU countries undertrade relative to the global-based prediction, resulting in a (negative) EU coefficient. This may be related to the gravity equation's inability to proxy firms' fixed costs in establishing trade relations (e.g. Freund, 2000). Empirically, Aitken (1973), Soloaga and Winters (2001) and Rose (2004), among many others, find similarly negative results regarding the EU. Inclusion of country pair fixed effects is commonly suggested to control for such time-invariant bilateral heterogeneity. It thus represents the main alternative to time-varying country fixed effects for our robustness analysis.

4.3 Accounting for Unobserved Heterogeneity

To capture unobserved time-invariant heterogeneity among trade partners, we reestimate Specification 4, accounting for country-pair fixed effects. This specification does not address multilateral trade costs as comprehensively as suggested by Anderson and van Wincoop (2003), especially if they exhibit large fluctuations over time. However, Rose (2004) makes the point that country-pair

[26] For example, the Central American Common Market (CACM) featured a coefficient for trade creation of 2.3 in Specification 2, and a trade diversion effect with the rest of the world of 0.17. The combined net trade creation for PTA members is then an implied 2.47, which is closely matched by the estimate of 2.45 in Specification 3.

fixed effects constitute a valid proxy for average multilateral resistance exhibited in country pairs. Hummels and Levinsohn (1995) first introduced country-pair fixed effects to better distinguish between factor endowments and market structure as trade flow drivers. Egger and Pfaffermayr (2003) advocate country-pair fixed effects to account for heterogeneity induced by time-invariant factors (e.g., geography, history, policy, and culture) that are only partially accounted for by the explanatory variables or completely unobserved. Glick and Rose (2002) use the same specification as Egger and Pfaffermayr (2003), but motivate country-pair fixed effects as proxies for trade resistance. Here we employ it as a robustness test of the estimated parameter magnitudes for specific PTAs, such as the EU.

Note that the introduction of country-pair fixed effects removes the cross-sectional information so that Specification 5 relies *only* on the time-series information content of the data. Specification 5, therefore, expresses only PTA effects directly caused by PTA accession or exit. Nevertheless, our central result remains robust: PTAs exert a significant effect on trade flows. The rewarding aspect of the country-pair analysis is that BMA confirms the hypothesis that the gravity model overpredicts trade flows only when pair specific heterogeneity is ignored. Once these effects are accounted for, EU trade creation is indeed positive. On the other hand, other previously quite (maybe unreasonably) large effects are muted. In fact, ANZCERTA, AP, EEA and MERCOSUR lose their influence on net trade flows pointing at considerable unobserved bilateral heterogeneity among PTA members. With the exception of the Latin American Integration Agreement (LAIA), magnitudes of significant PTA impacts are uniformly smaller when we explore only the specific effect of entering and exiting a trade agreement. These results raise the general question of integration dynamics. Are average estimates over the life of PTA membership appropriate or can we observe accession dynamics where static effects (before or at accession) differ fundamentally from subsequent dynamic changes in trade flows?

4.4 Accession Dynamics

Further investigation of accession dynamics may also yield benefits beyond the reconciliation of remaining differences between Specifications 4 and 5. Namely, accession dynamics provide insights whether gains from trade tend to be static, as advocated by neoclassical trade theory, or dynamic (e.g., Young 1991). Indeed the gain might even commence *before* the PTA accession. Hence we recode the PTA dummy into three separate effects. If accession occurs at time t, the *pre-accession* *(t-1)* effect is captured by the change in trade flows in the period prior to accession, the *accession* (t) effect takes place during the first period after joining the PTA, and finally there remains the average *post accession* (t+1, n) effect that captures trade effects in all subsequent periods (where n indicates either the year 2000, or the year a country exited the PTA).

The results that characterize the accession dynamics are presented in Table 5, where we present again specifications that control for multilateral resistance (Specification 4a) and unobserved bilateral heterogeneity (Specification 5a). For expositional purposes, Table 5 excludes the host of additional controls that were included in the analysis, because the posterior estimates and their inclusion probabilities were identical to the original Specifications 4 and 5, respectively. Table 5 also includes the average PTA effects (t, n) established in Specifications 4 and 5 to allow for a quick comparison between average effects and accession dynamics for each PTA.

The accession dynamics differ across PTAs, but in general the trend clearly indicates that for all PTAs with a trade effect in their original specifications, it only materializes in the post accession phase. Only in the case of bilateral PTAs do accession dynamics reveal an additional effect (Specification 4a). For the case of multilateral resistance, bilateral trade agreements show a strong post accession effect that is washed out when accession and post accession are averaged. Interestingly, the effects are mostly show up in the post accession period, so that the static effects either before or during accession usually show no effect. The two exceptions in the case of multilateral resistance are the EU and APEC, which have similar effects pre to post accession. This result is negated with pair fixed effects, which only show the EU as trade creating in the post accession period and the EEA posting a significant pre-accession effect.

4.5 Additional Effects on Trade Flows

So far we have solely considered the impact of PTAs on trade flows. However, the BMA exercise holds important additional information regarding other determinants of trade flows. The geography and history controls are highly significant in Specifications 1 and 2 (in agreement with the previous literature). Despite the fact that some of their effects are absorbed into the fixed effects once we control for multilateral resistance and bilateral heterogeneity, those remaining generally stay significant.

BMA identifies trade openness as a key variable in all specifications, which is not surprising since we are attempting to explain trade flows. More interesting is that a host of variables related to exchange rate policy are not significant unless we control for bilateral unobservables. The currency union variable on the other hand shows a strong effect independent of dataset or empirical specification. Additional variables that might influence trade flows are factor endowments. Here BMA allows us to examine the competing hypotheses that trade flows are either driven by differences in endowments (Heckscher-Ohlin) or by similarities (Lindner). In Specifications 1 and 2, the Heckscher-Ohlin factor endowment theory finds strong support as differences in per capita GDPs and population densities are strongly associated with greater trade flows. The endowment effect vanishes however, when we consider multilateral resistance while the density effect disappears when we consider bilateral heterogeneity. Finally, the BMA methodology shows that differences in schooling increase bilateral trade flows once we control for unobserved heterogeneity or multilateral resistance.

5 Conclusion

The literature on preferential trade agreements (PTAs) features an unusual diversity of theoretical and empirical approaches. In this paper we incorporate model uncertainty into our empirical strategy by applying Bayesian Model Averaging (BMA). To date the most extensive robustness analysis by Ghosh and Yamarik (2004) used Extreme Bound Analysis and found evidence *against any* effects of PTAs at the extreme bounds. In contrast, by using BMA on the Ghosh and Yamark's dataset we find that PTA trade creation is strong and produces coefficient estimates that resolve a number of empirical puzzles.

We confirm strong PTA effects with Ghosh and Yamarik's original dataset, and with an updated dataset that includes additional years and PTAs. Our results are robust to the inclusion of multilateral resistance, accession dynamics, and unobserved bilateral heterogeneity. Overall the PTA effects reflect the diversity of PTAs and the degree of tariff reductions they encompass. BMA allows to also account for model uncertainty in the set of additional control variables usually featured in PTA regressions. Our approach highlights the importance of including all controls for policy, development, factor endowments, geography, and history that have been suggested by the previous literature. Among these regressors, the only ones that receive mixed evidence are related to exchange rate fluctuations.

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Table 1: Relationship between Gravity Model Controls and Bilateral Trade in Past Studies

		Relationship in past studies		
		Positive	*None*	*Negative*
Trade Creation 0-1 dummies	$AFTA_{ij}$	3	2	
	$ANZCERTA_{ij}$	1		
	$APEC_{ij}$	3		
	AP_{ij}	3	2	
	$CACM_{ij}$	4	2	
	$CARICOM_{ij}$			
	EEA_{ij}			
	$EFTA_{ij}$	3	5	
	EU_{ij}	9	9	
	$LAIA_{ij}$	4	2	
	$MERCOSUR_{ij}$	2	3	
	$NAFTA_{ij}$	1	3	
Trade Diversion / Open Bloc 0-1 dummies	$AFTA_i$	2	1	1
	$ANZCERTA_i$			
	$APEC_i$			
	AP_i		1	2
	$CACM_i$		2	2
	$CARICOM_i$			
	EEA_i			
	$EFTA_i$	1	1	
	EU_i	2	1	
	$LAIA_i$		2	2
	$MERCOSUR_i$		2	2
	$NAFTA_i$	1	2	1
Core Gravity	log($DISTANCE_{ij}$)		1	23
	log($GDP_i\ GDP_j$)	23	2	1
	log($gdp_i\ gdp_j$)	9	1	2
Economic Policy Variables	$SACHS_i$+$SACHS_j$	1		
	CU_{ij}	3	1	
	$FLOAT_{ij}$	1		1
	$VOLATILITY_{ij}$	1	1	4
Dev't/Factor Endowment	abs(gdp_DIFF)	3	1	1
	abs($DENS\_DIFF$)	1	1	
	abs($SCHOOL\_DIFF$)		1	
Geography	$BORDER_{ij}$	19	5	
	$REMOTE_{ij}$	4	3	
	$LANDLOCK_{ij}$	3	2	2
	log($AREA_i\ AREA_j$)	4		
	$ISLAND_{ij}$	3	1	1
Historical Ties	$COMLANG_{ij}$	12	1	1
	$COMCOL_{ij}$	3		
	$COLONY_{ij}$	5		2

Notes: Following Ghosh and Yamarik (2004), from whom parts of this table are adapted, an estimated relationship is reported positive or negative when a paper reports the coefficient significant at the 1% level. One paper may have multiple entries for the same regressor, if different regressions in the paper yield different relationships. See Tables 2a-c for additional variable description.

Sources: Aitken (1973); Aitken and Lowry (1973); Baier and Bergstrand (2007); Baldwin and Taglioni (2006); Baxter and Kouparitsas (2006); Bergstrand (1985); Brada and Mendez (1988); Carrere (2006); Cheng (2005); Coe and Hoffmaister (1999); Eichengreen and Irwin (1996); Egger (2000); Egger and Pfaffermayr (2003); Feenstra, Markusen, and Rose (2001); Frankel (1992); Frankel and Rose (1998); Frankel, Stein, and Wei (1995); Frankel and Wei (1993), and (1996); Freund (2000); Montenegro and Soto (1996); Rose (2000); Soloaga and Winters (2001); Thursby and Thursby (1987); Wei (1996); Wei and Frankel (1998); and Wei and Zhang (2006).

Table 2a: Preferential Trading Arrangements

Abbreviation	Name of PTA	Start	Member countries
ANZCERTA	Australia – New Zealand Closer Economic Relations Trade Agreement	1983	Australia, New Zealand
APEC	Asia Pacific Economic Community	1989	Australia, Brunei, Canada, China (1991), Chile (1994), Taiwan (1991), Hong Kong (1991), Indonesia, Japan, South Korea, Malaysia, Mexico (1993), New Zealand, Papua New Guinea (1993), Peru (1998), Philippines, Singapore, Thailand, United States, Vietnam (1998).
AP	Andean Community / Andean Pact	1969	Bolivia, Colombia, Ecuador, Peru, Venezuela (1973), Former: Chile (1969-76)
AFTA	Association of South East Asian Nations (ASEAN) Free Trade Area	1967	Brunei (1984), Cambodia (1998), Indonesia, Laos (1997), Malaysia, Myanmar (1997), the Philippines, Singapore, Thailand, Vietnam (1995).
CACM	Central American Common Market	1960	Costa Rica (1963), El Salvador, Guatemala, Honduras, Nicaragua.
CARICOM	Caribbean Community/ Carifta	1968	Antigua and Barbuda, Bahamas (1983), Barbados, Belize (1995), Dominica (1974), Guyana (1995), Grenada (1974), Jamaica, Montserrat (1974), St. Kitts and Nevis, St. Lucia (1974), St. Vincent and the Grenadines, Suriname (1995), Trinidad and Tobago.
EEA	European Economic Area	1994	Austria, Belgium, Denmark, Finland, France, Germany, Greece, Luxembourg, Iceland, Italy, Ireland, Liechtenstein, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom.
EFTA	European Free Trade Association	1960	Iceland, Liechtenstein (1991), Norway (1986), Switzerland Former: Denmark (1960-72), United Kingdom (1960-72), Portugal (1960-85), Austria (1960-94), Sweden (1960-94), Finland (1986-94).
EU	European Union	1958	Austria (1995), Belgium, Denmark (1973), Finland (1995), France, Germany, Greece (1981), Luxembourg, Ireland (1973), Italy, Netherlands, Portugal (1986), Spain (1986), Sweden (1995), United Kingdom (1973).
LAIA/LAFTA	Latin America Integration Agreement	1960	Argentina, Bolivia (1967), Brazil, Chile, Colombia (1961) Ecuador (1961), Mexico, Paraguay, Peru, Uruguay, Venezuela (1966).
MERCOSUR	Southern Cone Common Market	1991	Argentina, Brazil, Paraguay, Uruguay
NAFTA	Canada-US Free Trade Arrangement / North America Free Trade Agreement	1988	Canada, United States, Mexico (1994).
BilateralPTA	Bilateral Preferential Trade Agreements		All bilateral agreements considered are listed in Table 2b.

Notes: This table is based on Ghosh and Yamarik (2004) and includes corrections to some of the original PTA coding as follows. ASEAN, which is no free trade area was changed to AFTA with AFTA membership starting in 1992 instead of 1980. For the Andean Pact, Chile had to be excluded post-1976, when it left the AP. Finally, CARICOM membership for Guyana is corrected to start in 1973 (instead of 1995). The corrections do not alter the qualitative results.

Table 2b: Bilateral Preferential Trade Agreements considered in *BilateralPTA*

US - Israel	Slovak Republic - Turkey
Turkey - Slovenia	Papua New Guinea - Australia Trade & Commercial Relations Agreement (PATCRA)
EC - Slovenia	EC - Tunisia
EC - Lithuania	Estonia – Turkey
EC - Estonia	Slovenia – Israel
EC - Latvia	Poland – Israel
Chile - Mexico	Estonia - Faroe Islands
Mexico - Israel	Czech Republic - Estonia
Georgia - Armenia	Slovak Republic - Estonia
Georgia - Azerbaijan	Lithuania – Turkey
Georgia - Kazakhstan	Israel – Turkey
Georgia - Turkmenistan	Romania – Turkey
Georgia - Ukraine	Hungary – Turkey
Latvia - Turkey	Czech Republic – Israel
Turkey - former Yugoslav Rep. of Macedonia	Slovak Republic - Israel
EC - South Africa	Slovenia – Croatia
EC - Morocco	Hungary – Israel
EC - Israel	CEFTA accession of Romania
EC - Mexico	CEFTA accession of Slovenia
Estonia - Ukraine	Poland – Lithuania
Poland - Turkey	Slovak Republic - Latvia
EFTA - Morocco	Slovak Republic - Lithuania
Bulgaria - former Yugoslav Rep. of Macedonia	Canada – Chile
Hungary - Latvia	Czech Republic - Latvia
Hungary - Lithuania	Czech Republic - Lithuania
Poland - Latvia	Slovenia – Estonia
Poland - Faeroe Islands	Slovenia – Lithuania
Kyrgyz Republic - Moldova	EC - Faeroe Islands
Kyrgyz Republic - Ukraine	Canada – Israel
Kyrgyz Republic - Uzbekistan	EFTA – Estonia
Bulgaria - Turkey	EFTA – Latvia
Czech Republic - Turkey	EFTA – Lithuania
EAEC	EC – Turkey
CEFTA accession of Bulgaria	

Source: Subramanian and Wei (2007).

Table 2c: Description of non-PTA related variables

Variable	Description	Source
log(*$IMPORTS_{ijt}$*)	Natural log of bilateral imports (current US Dollars)	IMF Direction of Trade Statistics
log(*$DISTANCE_{ij}$*)	Natural log of the bilateral distance	Subramanian and Wei (2007)
log(*GDP_{it} GDP_{jt}*)	Natural log of the product of nominal GDP	Penn World Tables
log(*gdp_{it} gdp_{jt}*)	Natural log of the product of real GDP per capita	Penn World Tables
$SACHS_{it}$+$SACHS_{jt}$	The sum of the Sachs-Warner index of an open trade policy	Sachs and Warner (1995), Wacziarg and Welch (2003)
CU_{ijt}	Dummy (1 if the two share a common currency)	Subramanian and Wei (2007)
$FLOAT_{ijt}$	Number of countries with a floating exchange rate (0,1,2)	IMF Annual Report on Exchange Rate Arrangements and Restrictions
$VOLATILITY_{ijt}$	The standard deviation of the first difference in the bilateral exchange rate during the previous three years	IMF International Financial Statistics
abs(*gdp_DIFF*)	The absolute log difference of real GDP per capita	Penn World Tables
abs(*DENS_DIFF)*	The absolute log difference in population density	CIA World Fact Book
abs(*SCHOOL_DIFF*)	The absolute log difference in the average years of secondary schooling in the 25+ population	Barro and Lee (2001)
$BORDER_{ij}$	Dummy (1 if the two share a common land border and 0 otherwise)	Subramanian and Wei (2007)
$REMOTE_{ijt}$	The natural log of the product of the average distance (weighted by relative GDP) of each country from all trading partners*	CIA World Fact Book and Penn World Tables
$LANDLOCK_{ij}$	Number of landlocked countries (0,1,2)	Subramanian and Wei (2007)
log(*$AREA_i$ $AREA_j$*)	Natural log of the product of the surface area of the two countries	CIA World Fact Book
$ISLAND_{ij}$	Number of island countries (0,1,2)	Subramanian and Wei (2007)
$COMLANG_{ij}$	Dummy (1 if the two share a common language and 0 otherwise)	Subramanian and Wei (2007)
$COMCOL_{ij}$	Dummy (1 if the two share a common colonizer and 0 otherwise)	Subramanian and Wei (2007)
$COLONY_{ij}$	Dummy (1 if one was a former colony of the other and 0 otherwise)	Subramanian and Wei (2007)

* The construction of the remoteness variable in the Ghosh and Yamarik (2004) dataset varies slightly from ours, but does not alter the qualitative results.

Table 3: PTA Trade Creation and Trade Diversion

		Specification 1			Specification 2		
		Time Fixed Effects Original Ghosh & Yamarik (2004) Specification & Data			Time Fixed Effects Ghosh & Yamarik (2004) Specification, Updated Subramanian/Wei Data		
		p≠0	μ	σ	p≠0	μ	σ
Trade Creation	$AFTA_{ijt}$	0	-0.22	0.54	1	0.36	0.35
	$ANZCERTA_{ijt}$	1	0.89	0.96	1	0.88	0.62
	$APEC_{ijt}$	100	1.48***	0.15	100	1.71***	0.09
	AP_{ijt}	1	-0.05	0.27	99	0.67***	0.15
	$CACM_{ijt}$	100	2.25***	0.23	100	2.30***	0.15
	$CARICOM_{ijt}$	100	2.08***	0.41	100	2.83***	0.30
	EEA_{ijt}	1	0.26	0.19	2	0.22	0.15
	$EFTA_{ijt}$	0	0.02	0.26	100	0.67***	0.13
	EU_{ijt}	0	0.03	0.14	100	0.51***	0.09
	$LAIA_{ijt}$	91	0.46***	0.13	1	-0.05	0.08
	$MERCOSUR_{ijt}$	12	1.66	0.7	14	0.96	0.36
	$NAFTA_{ijt}$	1	-0.89	0.84	0	0.20	0.47
	$BILATERAL_{ijt}$	na	na	na	1	0.13	0.13
Trade Diversion, Open Bloc	$AFTA_{it}$	3	0.17	0.11	100	0.41***	0.06
	$ANZCERTA_{it}$	100	-0.47***	0.1	100	-0.81***	0.06
	$APEC_{it}$	100	0.55***	0.06	100	0.48***	0.04
	AP_{it}	52	-0.19*	0.06	2	0.07	0.04
	$CACM_{it}$	85	-0.18**	0.05	100	-0.17***	0.03
	$CARICOM_{it}$	100	-0.74***	0.07	100	-0.58***	0.05
	EEA_{it}	0	0.01	0.08	92	-0.17**	0.04
	$EFTA_{it}$	100	0.35***	0.05	100	0.37***	0.03
	EU_{it}	100	0.56***	0.04	100	0.65***	0.03
	$LAIA_{it}$	100	-0.40***	0.07	100	-0.52***	0.03
	$MERCOSUR_{it}$	79	0.42**	0.12	0	-0.04	0.06
	$NAFTA_{it}$	100	-0.63***	0.1	4	0.13	0.06
	$BILATERAL_{it}$	na	na	na	100	-0.27***	0.04
Core Gravity	$\log(GDP_{it}\ GDP_{jt})$	100	0.88***	0.01	100	0.94***	0.01
	$\log(DISTANCE_{ij})$	100	-1.19***	0.02	100	-1.08***	0.02
	$\log(gdp_{it}\ gdp_{jt})$	100	0.55***	0.02	100	0.28***	0.01
Economic Policy	$SACHS_{it}+SACHS_{jt}$	100	0.35***	0.03	100	0.22***	0.02
	$VOLATILITY_{ijt}$	25	0.006	0.002	0	-0.0003	0.00
	$FLOAT_{ijt}$	0	-0.01	0.02	100	0.09***	0.02
	CU_{ijt}	100	1.40***	0.29	100	1.22***	0.10
Development, Factor Endowments	abs($SCHOOL\_DIFF$)	1	0.02	0.02	14	0.04	0.02
	abs($DENS\_DIFF$)	100	0.23***	0.01	100	0.13***	0.01
	abs(gdp_DIFF)	100	0.18***	0.02	100	0.08***	0.01
Geography	$BORDER_{ij}$	100	0.53***	0.1	100	0.40***	0.06
	$ISLAND_{ij}$	2	-0.05	0.03	100	-0.22***	0.03
	$LANDLOCK_{ij}$	100	-0.42***	0.04	100	-0.26***	0.02
	$\log(AREA_i\ AREA_j)$	92	-0.03**	0.01	100	-0.08***	0.01
	$REMOTE_{ijt}$	100	342***	39.79	100	1.31***	0.04
History	$COLONY_{ij}$	100	1.44***	0.12	100	1.12***	0.06
	$COMCOL_{ij}$	100	0.77***	0.07	100	0.55***	0.04
	$COMLANG_{ij}$	100	0.47***	0.05	100	0.28***	0.02

Notes: Fixed effect coefficients are omitted. *, **, *** represent *weak*, *positive,* and *decisive* evidence for an effect of the regressor, corresponding to posterior inclusion probabilities of 50-75%, 75-99, and > 99%, respectively (see Jefferies, 1961 and Kass and Raftery, 1995). p≠0 is the inclusion probability, μ is the posterior mean, and σ is the posterior standard deviation.

Table 4: PTA Net Trade Creation
Controlling for Multilateral Resistance and Bilateral Heterogeneity

	Specification 3			Specification 4			Specification 5		
Updated Subramanian / Wei Data		yes			Yes			yes	
Time Fixed Effects		yes			yes			yes	
Importer Exporter Fixed Effects		no			Yes			no	
Country Pair Fixed Effects		no			No			yes	
Accession Dynamics?		no			No			no	
	p≠0	μ	σ	p≠0	μ	σ	p≠0	μ	σ
$AFTA_{ijt}$	1	0.46	0.35	1	-0.44	0.33	1	0.27	0.24
$ANZCERTA_{ijt}$	19	1.73	0.63	89	2.19**	0.58	0	-0.02	0.51
$APEC_{ijt}$	100	1.39***	0.08	100	0.64***	0.09	100	0.52***	0.06
AP_{ijt}	88	0.63**	0.16	93	0.62**	0.16	6	0.44	0.19
$CACM_{ijt}$	100	2.45***	0.15	100	2.45***	0.15	100	2.19***	0.26
$CARICOM_{ijt}$	100	2.89***	0.31	100	4.06***	0.29	63	1.45*	0.43
EEA_{ijt}	10	0.35	0.13	98	0.51**	0.12	25	-0.24	0.08
$EFTA_{ijt}$	1	0.15	0.12	1	-0.14	0.12	5	0.26	0.12
EU_{ijt}	19	-0.29	0.13	100	-1.15***	0.10	100	0.41***	0.10
$LAIA_{ijt}$	100	0.40***	0.09	100	0.89***	0.09	100	1.68***	0.19
$MERCOSUR_{ijt}$	6	0.79	0.37	57	1.16*	0.35	1	0.38	0.26
$NAFTA_{ijt}$	1	-0.25	0.48	0	0.08	0.45	1	0.48	0.34
$BILATERAL_{ijt}$	12	0.34	0.13	47	0.43	0.14	14	0.24	0.09
$\log(GDP_{it}\ GDP_{jt})$	100	1.02***	0.01				15	0.01	0.00
$\log(DISTANCE_{ij})$	100	-1.09***	0.02	100	-1.17***	0.02			
$\log(gdp_{it}\ gdp_{jt})$	100	0.18***	0.01				100	1.06***	0.02
$SACHS_{ijt}$	100	0.34***	0.02				100	0.20***	0.02
$VOLATILITY_{ijt}$	1	0.00	0.00	1	0.01	0.01	100	-0.01***	0.00
$FLOAT_{ijt}$	3	0.03	0.02				100	-0.06***	0.01
CU_{ijt}	100	1.26***	0.10	100	1.17***	0.10	100	0.66***	0.13
$\|SCHOOL\_DIFF\|$	100	0.08***	0.01	77	0.05**	0.02	100	0.23***	0.02
$\|DENS\_DIFF\|$	100	0.12***	0.01	100	0.12***	0.01	28	0.11	0.04
$\|gdp\_DIFF\|$	100	0.09***	0.01	6	-0.04	0.02	100	-0.19***	0.03
$BORDER_{ij}$	100	0.42***	0.06	98	0.24**	0.06			
$ISLAND_{ij}$	100	-0.26***	0.02						
$LANDLOCK_{ij}$	100	-0.20***	0.02						
$\log(AREA_i\ AREA_j)$	100	-0.13***	0.00						
$REMOTE_{ijt}$	100	0.81***	0.04				0	-0.01	0.02
$COLONY_{ij}$	100	1.19***	0.06	100	1.13***	0.06			
$COMCOL_{ij}$	100	0.27***	0.02	100	0.34***	0.05			
$COMLANG_{ij}$	100	0.59***	0.04	100	0.30***	0.03			

Notes: Fixed effect coefficients are omitted. *, **, *** represent *weak*, *positive,* and *decisive* evidence for an effect of the regressor, corresponding to posterior inclusion probabilities of 50-75%, 75-99, and > 99%, respectively (see Jefferies, 1961 and Kass and Raftery, 1995). p≠0 is the inclusion probability, μ is the posterior mean, and σ is the posterior standard deviation.

Table 5: PTA Accession Dynamics

		Specification 4a			Specification 5a		
Updated Subramanian / Wei Data		**Yes**			**yes**		
Time Fixed Effects		**Yes**			**yes**		
Importer Exporter Fixed Effects		**Yes**			**no**		
Country Pair Fixed Effects		**No**			**yes**		
Accession Dynamics?		**Yes**			**yes**		
		p≠0	μ	σ	**p≠0**	μ	σ
$AFTA_{ijt}$	***average (t, n)***	**1**	**-0.44**	**0.33**	**1**	**0.27**	**0.24**
	Pre-accession (t-1)	0	-0.16	0.36	1	0.00	0.07
	Accession (t)	1	-0.57	0.44	0	0.00	0.02
	Post accession (t+1, n)	0	-0.18	0.48	1	0.01	0.07
$ANZCERTA_{ijt}$	***average (t, n)***	**89**	**2.19****	**0.58**	**0**	**-0.02**	**0.51**
	Pre-accession (t-1)	3	2.24	1.14	1	0.00	0.03
	Accession (t)	1	1.76	1.14	0	0.00	0.05
	Post accession (t+1, n)	53	2.16*	0.66	0	0.00	0.04
$APEC_{ijt}$	***average (t, n)***	**100**	**0.64*****	**0.09**	**100**	**0.52*****	**0.06**
	Pre-accession (t-1)	100	0.73***	0.12	100	0.54***	0.08
	Accession (t)	100	0.77***	0.12	100	0.64***	0.08
	Post accession (t+1, n)	100	0.60***	0.12	100	0.66***	0.08
AP_{ijt}	***average (t, n)***	**93**	**0.62****	**0.16**	**6**	**0.44**	**0.19**
	Pre-accession (t-1)	3	-0.64	0.34	0	0.00	0.02
	Accession (t)	0	-0.02	0.34	2	-0.01	0.07
	Post accession (t+1, n)	96	0.70**	0.17	4	0.01	0.08
$CACM_{ijt}$	***average (t, n)***	**100**	**2.45*****	**0.15**	**100**	**2.19*****	**0.26**
	Pre-accession (t-1)	3	0.79	0.42	2	-0.02	0.21
	Accession (t)	2	-0.78	0.44	100	1.85***	0.35
	Post accession (t+1, n)	100	2.64***	0.16	100	2.24***	0.27
$CARICOM_{ijt}$	***average (t, n)***	**100**	**4.06*****	**0.29**	**63**	**1.45***	**0.43**
	Pre-accession (t-1)	0	-0.08	1.16	2	-0.02	0.21
	Accession (t)	100	3.93***	0.44	2	0.02	0.17
	Post accession (t+1, n)	100	4.14***	0.37	2	0.02	0.14
EEA_{ijt}	***average (t, n)***	**98**	**0.51****	**0.12**	**25**	**-0.24**	**0.08**
	Pre-accession (t-1)	2	0.24	0.15	92	0.34**	0.13
	Accession (t)	3	0.29	0.15	11	0.03	0.08
	Post accession (t+1, n)	100	0.76***	0.15	30	-0.10	0.16
$EFTA_{ijt}$	***average (t, n)***	**1**	**-0.14**	**0.12**	**5**	**0.26**	**0.12**
	Pre-accession (t-1)	3	-0.62	0.32	1	0.00	0.03
	Accession (t)	0	-0.11	0.25	1	0.00	0.01
	Post accession (t+1, n)	1	-0.16	0.13	30	-0.10	0.16
EU_{ijt}	***average (t, n)***	**100**	**-1.15*****	**0.10**	**100**	**0.41*****	**0.10**
	Pre-accession (t-1)	100	-0.95***	0.15	3	0.01	0.05
	Accession (t)	100	-0.78***	0.14	38	0.12	0.17
	Post accession (t+1, n)	100	-1.30***	0.10	95	0.37**	0.15
$LAIA_{ijt}$	***average (t, n)***	**100**	**0.89*****	**0.09**	**100**	**1.68*****	**0.19**
	Pre-accession (t-1)	42	-1.01	0.32	2	0.00	0.09
	Accession (t)	1	-0.15	0.26	42	0.31	0.40
	Post accession (t+1, n)	100	0.98***	0.08	100	1.62***	0.28
$MERCOSUR_{ijt}$	***average (t, n)***	**57**	**1.16***	**0.35**	**1**	**0.38**	**0.26**
	Pre-accession (t-1)	1	0.73	0.48	0	0.00	0.02
	Accession (t)	2	0.88	0.49	1	0.00	0.03
	Post accession (t+1, n)	13	1.26	0.48	1	0.00	0.06
$NAFTA_{ijt}$	***average (t, n)***	**0**	**0.08**	**0.45**	**1**	**0.48**	**0.34**
	Pre-accession (t-1)	0	-0.15	0.67	0	0.00	0.03
	Accession (t)	0	-0.14	0.67	1	0.00	0.04
	Post accession (t+1, n)	0	0.21	0.58	1	0.00	0.05
$BILATERAL_{ijt}$	***average (t, n)***	**47**	**0.43**	**0.14**	**14**	**0.24**	**0.09**
	Pre-accession (t-1)	1	-0.10	0.15	3	0.01	0.04
	Accession (t)	5	0.30	0.14	8	0.02	0.07
	Post accession (t+1, n)	98	1.96**	0.47	0	0.00	0.03

Notes: Fixed effect coefficients and additional controls omitted. *, **, *** represent *weak, positive,* and *decisive* evidence for an effect of the regressor, corresponding to posterior inclusion probabilities of 50-75%, 75-99, and > 99%, respectively (see Jefferies, 1961 and Kass and Raftery, 1995). p≠0 is the inclusion probability, μ is the posterior mean, and σ is the posterior standard deviation.