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SENSITIVITY OF INTERNATIONAL BLOCS' TRADE EFFECT TO ALTERNATIVE SPECIFICATIONS OF THE GRAVITY EQUATION

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There are so many versions of the gravity model in the international trade literature that their results on trade effects inevitably vary even for the same international blocs. This paper evaluates these alternative specifications, and compares the resulting trade effects. The results show that there is considerable sensitivity to the specification of the gravity model used. Therefore, it is important to use the proper specification to accurately measure the trade effects. This paper suggests that removing restrictions on the parameters of the model with the introduction of year, exporter, importer, and bilateral effects is necessary to properly specify the model. In particular, factors included in the augmented model, especially monetary and spatial variables, are significant. An analysis of the resulting model also shows that international blocs effect on trade vary across blocs by the level of integration, the degree of their implementation, and their sectoral coverage.

JEL classification codes: F15, C52
Key words: gravity models, trade agreements, international organizations, blocs

I. Introduction

Numerous studies (Deardorff 1984; Eichengreen and Irwin 1998; Feenstra 1998; Evenett and Keller 2002) have shown that the most fruitful way to predict international trade flows is through gravity-type models. Accordingly, trade volume increases with the size of trading partners' economies, and decreases with the geographical distance between them (Tinbergen 1962; and Poyhonen 1963). These simple but successful empirical models are primarily used to test for the role of blocs on trade.[1]

Since then, a number of additions and adjustments have been proposed to the standard gravity model. The merits of using GDP at current prices versus purchasing power parity adjusted GDP, or choosing imports versus total trade as the dependent

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[1] Refer to Head (2003) for an overview of gravity models.

variable have been discussed. The standard model has also been augmented by factors such as common border and common language. Monetary variables were also added to capture the role of exchange rate variability. A location index was introduced to take the remoteness of a country into consideration. Most of these are now fairly common additions in gravity models. More recently, econometric issues such as the use of cross-sectional, time series, or panel data are being discussed. In particular, discussions on adjustments include Dhar and Panagariya (1999) on the choice of dependent variable, Winters and Soloaga (1999), Wall (2003), and Egger and Pfaffermayr (2003) on including fixed effects.

The contribution of this paper is tri-fold: evaluation of the above-mentioned specifications, extension of the econometric model of Egger and Pfaffermayr (2003) to allow simultaneous tests of multiple blocs, and assessment of the role of international blocs, ranging from various degrees of economic integration agreements to those organizations based on religion, ethnicity, colonial history, and security.

The results suggest that the additions of various factors to the standard model improve its overall fit. In particular, common border, common language, per capita incomes, monetary variables such as the real exchange rate and common currency, spatial effect factors such as the location index all significantly contribute to the explanation of the bilateral trade and should be standard in all gravity models. Secondly, the results indicate that the restrictions on the parameters of the model, specifically on the intercept, should be removed with the introduction of year, exporter, importer, and bilateral fixed effects. Furthermore, instead of bloc dummy variables directly in the models, these fixed effects should be analyzed for the blocs' role on bilateral trade. The analysis of the resulting properly specified model shows that trade effect varies not only across different types of blocs, but also with the degree of implementation and the coverage of the bloc agreements. Some blocs foresee a deeper level of integration than others. They may also differ in the duration of liberalization period towards zero tariffs, as well as how many and which sectors are included in liberalization. These characteristics play a significant role in explaining the differences in the size of trade effects across blocs.

The rest of the paper is organized as follows. Section II lays out the empirical strategy with a discussion of the particular blocs included in the analysis as well as the different specifications of the gravity model in the literature. In Section III, the data is applied to these specifications, and blocs' trade effects are compared across different gravity models, across blocs of different types, and with the results in the literature.

II. Empirical Strategy and Data

Ninety-nine countries are included in the analysis. These are all countries that reported their trade volumes to the World Trade Organization during 1992-99. These are listed in the Appendix according to their region: Middle East, Europe, Africa, Americas, and Asia-Pacific.

Countries are further grouped into blocs based on their membership in international organizations, and participation in important economic integration agreements. Organizations and agreements analyzed are listed in Table 1. The list of international organizations is obtained from CIA World Factbook. The resulting 14 organizations are separated into two categories based on their descriptions: Non-economic organizations (NEO), and organizations for economic cooperation without integration (OEC). These categories reflect the different expectations on the trade effects of NEOs and OECs: NEOs are chosen to capture the role of cultural, religious and ethnic similarity, and colonial or security relations.[2] OECs involve cooperation among countries that do not necessarily share common values, such as OPEC. OECs are not as extensive as an economic integration agreement, but they are expected to have some trade promoting effect.

International economic integration agreements are analyzed in separate categories, since they are expected to have a much more significant role on trade patterns and volumes than both the NEOs and the OECs. Twenty-two bilateral and eighteen multilateral agreements are considered. These are all of the economic integration agreements that were in force during the period of analysis according to WTO. These agreements are divided into six different types: preferential trade agreements (PTA), free trade agreements (FTA), customs unions (CU), economic areas (EA), monetary unions (MU), and full-fledged integrations (FI). The expectation is that the effects on trade get stronger with the removal of more trade barriers of any kind. Hence, the FTAs are expected to be more trade promoting than the PTAs, similarly EAs over FTAs, and MUs over EAs. However, trade effects of CUs are not necessarily expected to be higher than those of FTAs. Furthermore, the additional effect of FIs over other types depends on what full-fledge integration entails. For example, more regulations in factor and product markets in an FI would imply a negative effect over other types. Lastly, the degree

[2] Some organizations that are not exclusive in membership such as Organization of American States, Council of Europe, Organization for African Unity, and United Nations are excluded if membership in these organizations does not produce a meaningful testable hypothesis.

Table 1. International organizations and agreements

Type	Bloc code	Bloc name
NEO	AL	Arab League
NEO	AMU	Arab Maghreb Union
NEO	C	Commonwealth
NEO	CIS	Commonwealth of Independent States
NEO	GCC	Gulf Cooperation Council
NEO	NATO	North Atlantic Treaty Organization
NEO	OIC	Organization of the Islamic Conference
OEC	APEC	Asia-Pacific Economic Cooperation
OEC	ASEAN	Association of Southeast Asian Nations
OEC	BSEC	Black Sea Cooperation Zone
OEC	ECOWAS	Economic Community of West African States
OEC	OECD	Organization for Economic Cooperation and Development
OEC	SAARC	South Asian Association for Regional Cooperation
OEC	OPEC	Organization of Petroleum Exporting Countries
PTA	ACPEU	African Caribbean and Pacific Group of States-EU
PTA	BA	Bangkok Agreement
PTA	CAN	Andean Community of Nations
PTA	SAPTA	South Asian Preferential Trade Area
PTA	COMESA	Common Market for Eastern and Southern Africa
PTA	GATT	General Agreement on Trade and Tariffs
PTA	WTO	World Trade Organization
FTA	ANZCERTA	Australia-New Zealand
FTA	EA	Europe Agreements: 10 Central and East European Countries-EU
FTA	MEDI	Mediterranean Agreements: Algeria, Egypt, and Tunisia-EU
FTA	EUFTA	All free trade agreements of the EU
FTA	CEFTA	Central European Free Trade Area
FTA	NAFTA	North American Free Trade Area
FTA	EFTA	European Free Trade Area)
FTA	BFTA	All other bilateral free trade agreements
CU	CZSK	Czech and Slovak Republics
CU	EUCU	Cyprus, Malta, and Turkey-EU
CU	CARICOM	Caribbean Community and Common Market
CU	MERCOSUR	Southern Cone Common Market
CU	CACM	Central American Common Market
CU	CISCU	Commonwealth of Independent States Customs Union
EA	CAEU	Council of Arab Economic Unity
EA	EEA	European Economic Area
MU	WAEMU	West African Economic and Monetary Union
FI	EU	European Union

of implementation and the extent of coverage are also important factors that need to be considered in the comparisons.

Membership in these blocs is not static. New members join in, or the integration among all or a group of members often intensifies in sub-blocs over time, resulting in a nested structure. This structure can be best explained by taking Europe as an example, since it presents the most elaborate structure of blocs. There are two groups of FTAs in Europe: EFTA and EUFTA. The latter compromises the FTAs signed by the EU. Since some of these agreements are of particular interest, they are considered separately, such as the sub-bloc MEDI signed with Mediterranean countries, and the EA signed with East European countries. Some of the East European countries formed another sub-bloc, the CEFTA. Within the CEFTA, the Czech and Slovak Republics increased the intensity of integration to a customs union, the CZSK. Some of the countries participating in EUFTA formed a customs union EUCU. Some in the EUCU increased the intensity first to an economic union EEA, and some further into a full integration, the EU. Part of the EEA countries is also integrated to each other within the EFTA. Furthermore, the membership in these blocs has been increasing. For example, there were only twelve countries in the EU at the beginning of the period of analysis. Membership increased to fifteen by the end of the period. The EA was signed with only four countries in 1992. In 1999, there were ten countries in this bloc. Composition of these regional and interregional blocs is pictured in Appendices B and C.

The effects of these blocs are typically captured in gravity models with the help of dummy variables. In such analysis, signs and significance of these dummy variables quantifies the additional effect of a sub-bloc over the effect of the bloc itself. For example, the EU variable will capture the additional effect of being an EU member over the effect of being just an EEA member. The expected sign of a sub-bloc variable is positive if more trade barriers are removed as a result. Lastly, the signs of these bloc variables will show the differing effects if the intensity is the same. For example, the MEDI dummy variable will capture how different the Mediterranean agreements are relative to all FTAs signed by the EU (EUFTA). In this case, the signs will capture the role of factors such as the number of years, the degree of implementation, the coverage of the agreement, and how successful the agreement is in promoting trade among members.

Different gravity models have been used in the literature to measure the role of these blocs on trade. Table 2 lists a selection of the models used, including the blocs analyzed, the findings, as well as the specifications used in the analysis. The simplest version of the model has bilateral total trade between countries as a

function of the product of their GDPs and the geographical distance between them. This relationship is expressed in linear form using the logarithm of these variables. Dummy variables are added to this model to capture the role of blocs and to test for their significance. In this section, the specifications used in the literature are compared, and the superiority of these is evaluated using adjusted R^2, F statistic, root mean square error (RMSE), the Akaike Information Criterion (AIC), and the Schwarz Criterion (SC).[3]

Table 2. Previous literature

Data	Blocs/Results	Authors
Cross-sectional (yearly averages): Model (1)	EA(+)	Wang and Winters (1991)
	ACPEU+*	Nilsson (2002)
Cross-sectional (each year separate): Models (2) and (3)	EU+*, EFTA+*	Aitken (1973)
	EU+, EFTA+*	Bergstrand (1985)
	EU+, EFTA+*, CACM+*,CAN+	Brada and Mendez (1985)
	CACM+*, CARICOM+*	Thoumi (1989)
	APEC+*, EU+*, EFTA+*, EEA+	Frankel and Wei (1993)
	NAFTA+, CAN+*, MERCOSUR+*	Frankel et al. (1995)
	EA+*, CEFTA(-)	Gros and Gonciarz (1996)
	CAN-, CACM+*	Garman et al. (1998)
	APEC+*, ASEAN+	Endoh (1999)
	EU-, EFTA-*	Sapir (2001)
	SAARC-*	Hassan (2001)
	CIS+*	Djankov and Freund (2002)
	CIS+*, EA+*, CEFTA+*, CZSK+*	Fidrmuc and Fidrmuc (2003)
	EU+*, CACM+*, NAFTA+, AMU+	Martinez-Zarzoso (2003)
Time series	MU+	Thursby and Thursby (1987)
Panel: Model (4)	EEA+*, EA(+)	Baldwin (1994)
	NAFTA+*	Gould (1998)
	NAFTA+	Krueger (1999)

[3] AIC, which is a measure that balances the complexity of the model with its goodness of fit, is based on the concept of entropy. SC is similar but more general, and it imposes a penalty for including too many terms in a model relative to sample size.

Table 2. (Continued) Previous literature

Data	Blocs/Results	Authors
	AMU-*, GCC-*	Al-Atrash and Yousef (2000)
	ASEAN+*	Thorton and Goglio (2002)
Panel (year fixed effects)	EU+*, EFTA+*	Bayoumi and Eichengreen (1995)
	EU-*, EFTA-*, ASEAN-*, GCC+, NAFTA+*, CACM+*, CAN+*, MERCOSUR+*	Winters and Soloaga (1999)
Panel (country fixed effects)	NAFTA+*	Wall (2003)
	MU(+)	Kurihara (2003)
Panel (year, importer and exporter fixed effects): Model (5)	APEC+	Matyas (1997)
	CEFTA-*, EA(+)	Jakab et al. (2001)
Panel (year, importer, exporter, and bilateral fixed effects): Model (6)	APEC+*	Egger and Pfaffermayr (2003)

Notes: Effects are denoted as follows: +*: significantly positive; +: insignificantly positive; -: insignificantly negative;
-* significantly negative; (+) potentially positive; (-) potentially negative.

Most of the early models used cross-sectional data. The regressions were carried out using yearly averages of the variables, or separately for each year. Wang and Winters (1991) argue for averaging over years because this reduces the effects of temporary disequilibria and shocks. Accordingly, the standard gravity model is the following:

$$T_{ij} = \beta_0 + \beta_1 d_{ij} + \beta_2 Y_i + \beta_3 Y_j + \sum_k \sigma_k D_k + \varepsilon_{ij} \ , \qquad \text{Model (1)}$$

where T_{ij} is the total trade between countries i and j.[4] d_{ij} is the geographical distance

[4] One issue not addressed in this paper is the treatment of zero observations. While Santos Silva and Tenreyro (2006) argue that standard OLS regression can lead to severe biases in the coefficients, Feenstra (2002) argues for the consistency of OLS estimates as long as fixed effects for importer and exporter are taken into account. For the sake of comparability, zero observations are treated in the same manner across different models considered. The most widely used method of natural logarithm of dependent variable plus one, is also employed here. Poisson-pseudo maximum likelihood estimation suggested by Santos Silva and Tenreyro (2006) is applied only to the properly-specified model (6) to check the sensitivity of results. The

between *i* and *j*. Data on geographical distance is obtained from the US Census. Y_i and Y_j are the logarithms of the GDPs at current prices of countries *i* and *j*, respectively. The World Bank's WDI 2003 is the source for the GDP data. D_k is the dummy variable for bloc *k*. In this model, all variables are averages over the entire period of analysis.[5]

Averaging has an econometric problem: it forces the parameters of the model to be the same for every year. For this reason, as can be seen from Table 2, most of the cross-sectional analysis done in the literature involves separate regressions for each year:

$$T_{ijt} = \beta_{0t} + \beta_{1t} d_{ij} + \beta_{2t} Y_{it} + \beta_{3t} Y_{jt} + \sum_k \sigma_{kt} D_{kt} + \varepsilon_{ijt} \quad . \qquad \text{Model (2)}$$

The results of models (1) and (2) are given in Table 3. Note that all variables have the expected signs and are significant in both models. Although model (2) is more econometrically sound, model (1) provides a better fit, as can be seen from more significant coefficients, higher adjusted R^2, and lower RMSE, AIC, and SC. This is primarily because of reduced variability due to averaging.

Since these early models, there have been a number of additions to the gravity model, which are now frequently included. Most notably, per capita incomes (or population) of the partners are added to capture the effect of income levels. Common border has also proven to be an important determinant of trade flows (Thoumi 1989; Linnemann 1969; Bergstrand 1985). Furthermore, Frankel et al. (1995) show that countries with colonial links, thus common language, trade more with each other.

Monetary variables are also typically added to the model to obtain what is commonly referred to as the augmented model. While Bergstrand (1985) included the exchange rate and the GDP deflator separately to get the effect of changes in the real exchange rate, others such as Thoumi (1989) added the real exchange rate more directly.[6] It is also common to include variables to capture the effect of

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results are fairly robust due to very few zero observations in highly aggregated country-level trade data.

[5] If over the course of time one of the partners becomes a member of another bloc too, the period of analysis is divided into sub-periods, during which memberships of the two partners are the same, and averages are taken over these sub-periods.

[6] Bayoumi and Eichengreen (1995) also suggested including the real exchange rate to control for third country effects, which are otherwise omitted. Bergstrand (1985) included unit value prices as well. However, Wang and Winters (1991) argue that the inclusion of price terms is inconsistent with the long term nature of the model.

exchange rate uncertainty since Thursby and Thursby (1987) found its negative impact. For this purpose, foreign currency reserves of the importer as a measure of exchange rate stability are used in Matyas (1997). Common currency is also typically factored in as another variable, since countries that share a common currency engage in substantially higher international trade (Summers 1991; Rose 2000).[7]

Most recent additions to the model capture the spatial effects. In particular, Frankel and Wei (1998), and Anderson and van Wincoop (2003) introduced an indicator of countries' relative remoteness to the model. Omission of this indicator, also known as the location index, is said to influence the estimated effects of blocs in a systematic manner. The location index is computed by weighting bilateral distances with partner countries' share in world exports. Within this context, Porojan (2001) also argues that the traditional formulation of gravity models seriously overestimates trade flows from island countries, and that large explanatory power of dummy variables for blocs vanishes when spatial effects are introduced.

Another econometric problem is the choice of the dependent variable. Among others, Dhar and Panagariya (1999) argue that total trade should not be the dependent variable, because it imposes equality of coefficients for imports and exports. This criticism is widely accepted. In fact, most authors estimate the gravity equation using import data on the assumption that countries tend to monitor their imports more carefully than their exports (Baldwin 1994, p.85):

$$M_{ijt} = \beta_{0t} + \beta_{1t} d_{ij} + \beta_{2t} Y_{it} + \beta_{3t} Y_{jt} + \beta_{4t} y_{it} + \beta_{5t} y_{jt} + \beta_{6t} B_{ij} + \beta_{7t} L_{ij} \quad \text{Model (3)}$$
$$+\beta_{8t} e_{ijt} + \beta_{9t} R_{it} + \beta_{10t} l_i + \beta_{11t} I_i + \beta_{12t} I_j + \sum_k \sigma_{kt} D_{kt} + \varepsilon_{ijt} \ ,$$

where y_{it} and y_{jt} are per capita income levels in country *i* and *j* in year *t*, respectively. B_{ij} is set equal to 1 if countries *i* and *j* share a common border, and L_{ij} is equal to 1 if *i* and *j* speak the same language. e_{ijt} is the real exchange rate, and R_{it} is the importer's foreign currency reserves. Real exchange rate is defined as the price of country *j* products in terms of country *i* products. Data on monetary variables is obtained from the IMF International Financial Statistics. To incorporate the spatial effects, the location index (l_i) and island dummy variables (I_i and I_j) are also in the model.

[7] In this analysis, this is unnecessary since such effects are already captured in blocs that fall under the category of monetary union.

Table 3. Regression results for main factors

Variable	Symbol	(1)	(2)	(3)	(4)	(5)	(6)
Constant		-33.7**	-35.3**	-28.8**	-29.5**	-	-
		(-73.8)	(-49.7)	(-41.3)	(-114)	-	-
Distance	d_{ij}	-1.18**	-1.07**	-1.24**	-1.23**	-1.21**	-1.34**
		(-44.4)	(-25.7)	(-36.7)	(-96.9)	(-100)	(-126)
Importer GDP	Y_i	1.01**	1.05**	0.78**	0.74**	-	0.74**
		(95.2)	(63.6)	(31.6)	(85.1)	-	(85.2)
Exporter GDP	Y_j	1.03**	1.05**	1.17**	1.21**	-	1.23**
		(92.8)	(60.0)	(86.4)	-235	-	-250
Importer per capita	y_i	-	-	0.13**	0.12**	0.76**	0.10**
GDP		-	-	(7.00)	(16.8)	(15.6)	(15.1)
Exporter per capita	y_j	-	-	0.18**	0.15**	0.30**	0.12**
GDP		-	-	(9.50)	(21.4)	(6.07)	(18.6)
Common border	B_{ij}	-	-	0.35**	0.43**	0.27**	0.50**
dummy		-	-	(2.59)	(8.18)	(6.16)	(10.0)
Common language	L_{ij}	-	-	0.51**	0.46**	0.60**	0.59**
dummy		-	-	(8.03)	(19.4)	(26.9)	(28.2)
Real exchange	e_{ij}	-	-	-0.004**	*-0.000	-0.000	-0.000
rate			-	(-6.35)	(-1.27)	(-1.73)	(-1.42)
Importer FX reserves	R_i	-	-	0.053*	0.10**	0.18**	0.12**
		-	-	(2.06)	(11.7)	(12.9)	(13.7)
Importer location	l_i	-	-	-0.82**	-0.78**	-	-0.96**
index		-	-	(-10.9)	(-27.5)	-	(-35.3)
Importer island	I_i	-	-	0.14*	0.13**	-	0.26**
dummy		-	-	(2.43)	(6.20)	-	(12.6)
Exporter island	I_j	-	-	0.47**	0.57**	-	0.75**
dummy		-	-	(8.52)	(27.7)	-	(37.9)
n		8449	28343	53488	53488	53488	53488
Adj. R^2		0.752	0.724	0.744	0.740	0.980	0.995
F		595.7	1959	3386	2991	10598	163705
AIC		3.802	3.911	3.878	3.892	3.475	2.131
SC		3.839	3.923	3.886	3.900	3.515	2.142
RMSE		1.615	1.709	1.682	1.693	1.372	0.702

Notes: the numbers in parentheses are t-statistics. Variables significant at 95% and 99% confidence are denoted by * and **, respectively. In model (5), Y_i and Y_j are excluded due to multicollinearity with country fixed effects.

As can be seen from Table 3, using imports as the dependent variable in model (3) approximately doubles the sample size relative to model (2). This increases the overall fit of the model, as measured by the F statistic. However, at the same time, there is more variability, as reflected in lower adjusted R^2, and higher AIC and SC. Results of model (3) show that per capita GDPs, common border and common language variables have the expected signs, and all are significant. Furthermore, the change in the real exchange rate has the expected negative sign on imports, and as expected, exchange rate stability implied by higher levels of foreign currency reserves promotes trade. Both coefficients are significant. Results of model (3) also suggest that omission of the location index from the model would result in underestimated imports volume for remote countries. It is also found that imports from, and imports of island countries are significantly higher.

The yearly cross sectional models (1) through (3) considered so far have one econometric advantage over panel models. The former allows different parameters for each year. In contrast, the reasoning behind panel models is twofold. First, sample size increases in panel models. This allows more definite judgment on the role of blocs due to smaller confidence intervals (Breuss and Egger 1999). Second and more importantly, the additional effect of changes in the nature of a bloc from one year to another are now observable. The additional effects of such changes were not captured in yearly cross sectional analyses. For example, this was the case in SAARC and SAPTA, and for GATT and WTO. Since there is no year where both blocs exist at the same time, the observed effects in yearly cross sectional models are the combined effects of both of these blocs. The additional effect of SAPTA over SAARC, similarly that of WTO over GATT were not observed. For comparison, a panel regression is also carried out following the model below:

$$M_{ijt} = \beta_0 + \beta_1 d_{ij} + \beta_2 Y_{it} + \beta_3 Y_{jt} + \beta_4 y_{it} + \beta_5 y_{jt} + \beta_6 B_{ij} + \beta_7 L_{ij} + \beta_8 e_{ijt} + \beta_9 R_{it} + \beta_{10} l_i + \beta_{11} I_i + \beta_{12} I_j + \sum_k \sigma_k D_{kt} + \varepsilon_{ijt} \quad . \qquad \text{Model (4)}$$

Note that year subscripts from the coefficients of all variables are dropped, since the regression is carried out over pooled data over the years, rather than separately for each year.

Panel analyses, where year fixed effects or country fixed effects are incorporated, are only recently carried out. The idea is to allow the constant of the model to be different for each year and country, thus eliminate this econometric disadvantage of panel models over yearly cross sectional models. Winters and

Soloaga (1999) include time dummy variables to capture year fixed effects. Similarly, following Wall (2003), country fixed effects are incorporated into the model below separately for importers and exporters.

$$M_{ijt} = \alpha_t + \gamma_i + \lambda_j + \beta_1 d_{ij} + \beta_2 Y_{it} + \beta_3 Y_{jt} + \beta_4 y_{it} + \beta_5 y_{jt} + \beta_6 B_{ij} + \beta_7 L_{ij} + \beta_8 e_{ijt} + \beta_9 R_{it} + \sum_k \sigma_k D_{kt} + \varepsilon_{ijt} \quad , \qquad \text{Model (5)}$$

where α_t, γ_i, and λ_j are year, importer and exporter country fixed effects, respectively. In this model, also known as the triple-indexed model, exporter and importer fixed effects control for all time-invariant country characteristics. Year fixed effects capture cyclical influences commonly shared by all countries. Cross-sectional models and time series models set year fixed effects and country fixed effects to zero, respectively. Thus, these models are setting unnecessary constraints. Glick and Rose (2001), and Egger (2000, 2002) also argue that gravity models that restrict intercepts to equality suffer from heterogeneity, and result in inconsistent estimates.

Some time-invariant variables of country characteristics, such as island dummy variables and the location index, are omitted from the above model since these are captured by country fixed effects. The results of the above panel model can be found in Table 3. All coefficients have the expected sign, and all are significant, except for the real exchange rate. Sensitivity analysis suggests that the addition of year fixed effects to model (4) did not have much effect on the overall fit.[8] In contrast, the AIC and SC measures, and adjusted R^2 imply a significant improvement in fit with the addition of importer and exporter effects in model (5).

In all of the previous models, the role of blocs is captured by using dummy variables. Polak (1996) criticizes such use of bloc dummy variables directly in the model as they may lead to incorrect inferences. Following this argument, Matyas (1997) shows that all gravity type models used for this purpose are mis-specified from the econometric point of view. Instead of including bloc dummy variables directly in the model, Matyas (1997) argues that the country fixed effects should be analyzed for the role of blocs. In particular, Polak (1996), Matyas (1997), and Egger (2000, 2002) compare the exporter and importer effects of members of a bloc to those of non-members. They argue that both should be higher for members.

There are some limitations to their approach. First, they exclude time-invariant variables of country characteristics, arguing that exporter and importer effects will

[8] The adjusted R^2 of a model with a constant should not be compared to that of a model without a constant.

capture their effect, just like in model (5). However, in that case, the differences in these effects between members and non-members will be due not only to international blocs, but also these omitted variables. Alternatively, if all of the usual factors are controlled for, including these time-invariant variables, international blocs can be more accountable for the differences in these effects.

Furthermore, their approach does not accommodate changes in membership. This is because they are examining country fixed effects, which do not vary over time by definition. For the same reason, their approach does not allow multiple blocs where some countries establish a sub-bloc during the period analyzed. When membership in a bloc changes, or when more than one bloc is analyzed, simple comparisons of fixed effects of members with those of non-members will not be conclusive. During the period of analysis, if a country becomes a member of a bloc, whether you keep its importer or exporter effect within the bloc or outside, the difference between members and non-members will be blurred and most likely be insignificant. When multiple blocs are considered, the difference between members and non-members cannot be only attributable to the bloc being analyzed. This is because some of the members could also be a member of another bloc, possibly of higher density, which could be the primary reason for the difference. In another case, the difference due to a bloc may appear to be insignificant, since non-members of that bloc might be members of another bloc, which might be increasing their exporter and importer effects.[9] In both cases, multiplicity of blocs, and layers of intensity in sub-blocs within a bloc complicate the picture, and render simple comparisons of country fixed effects inconclusive.

Lastly, Egger and Pfaffermayr (2003) add bilateral interaction effects to the panel model with exporter, importer and year fixed effects. Bilateral effects capture any time-invariant influences for a country pair, including agreements between the two countries. They find that the hypothesis of zero bilateral interaction effect is strongly rejected and conclude that the triple indexed model ignores relevant information, suffers from omitted variable bias, and consequently results in inconsistent estimates. Formulated this way, the bilateral effects will primarily capture the role of blocs, and exporter and importer effects will capture any remaining fixed effects of a country after controlling for the usual factors.

These problems can be overcome if the bilateral interaction effects are analyzed instead of the importer and exporter effects, and if these bilateral effects are allowed

[9] In fact, Matyas (1997), who challenges the significant role of APEC found in previous studies, finds an insignificant role for APEC in his model.

to assume a different value each year. The analysis should also be done in two steps instead of one. First, a panel regression can be carried out against all of the usual factors. The bilateral effects obtained in this manner will be different for each year, and reflect only the abnormal levels of trade after controlling for all of the significant factors. Thus, the role of blocs can be better captured. In the second step, bilateral effects are regressed against all of the bloc dummy variables to correctly measure the blocs' effects given the membership dynamics and their nested structure. Note that this approach does not fall under the criticism of Polak (1996), since dummy variables are not directly used in the model with other variables, and it follows Egger and Pfaffermayr (2003) in the sense that the role of blocs is extracted from bilateral effects.

In sum, the whole process is as follows:

$$\begin{aligned}\text{Step 1: } M_{ijt} &= \alpha_t + \gamma_{it} + \lambda_{jt} + \delta_{ijt} + \beta_1 d_{ij} + \beta_2 Y_{it} + \beta_3 Y_{jt} + \beta_4 y_{it} + \beta_5 y_{jt} + \beta_6 B_{ij} + \beta_7 L_{ij} \\ &\quad + \beta_8 e_{ijt} + \beta_9 R_{it} + \beta_{10} l_i + \beta_{11} I_i + \beta_{12} I_j + \varepsilon_{ijt} \ . \\ \text{Step 2: } \delta_{ijt} &= \beta^{\delta} + \sum_k \sigma_k^{\delta} D_{kt} + \varepsilon_{ijt}^{\delta} \ . \end{aligned} \qquad \text{Model (6)}$$

Note that in step 1, separate bilateral interaction, importer and exporter constants are allowed for each year. The results of the first step of this model are shown in Table 3. Measures of specification are based on both steps. The introduction of bilateral fixed effects in model (6) made a significant improvement in fit, as reflected in substantial decreases in AIC, SC, and RMSE.

III. Results

In this section, the results about the role of blocs in trade are compared across blocs of different intensities, different gravity models, and with the findings in the literature. Before these comparisons, there are some important considerations that may be partly responsible for the observations.

One important factor to consider when comparing blocs of different intensities is that even if two blocs fall under the same category of intensity, this does not mean that their role in trade is going to be the same; their effect also depends on the degree of implementation. For example, while SAPTA is a fairly recent bloc, COMESA, and CAN have been in force for a long period of time. Therefore, their full effect is more reflected in trade volumes, which might not be the case for

SAPTA. Another source of difference is the way the dummy variables are formulated in the corresponding models in the literature. As discussed in Section II, blocs in this analysis are defined so that they reflect the additional effect over sub-blocs of different or the same intensity formed primarily by the same member countries. However, in most analysis in the literature, this distinction between EUFTA, EUCU, EEA, and EU has not been pointed out. Therefore, the only bloc used in such analysis, say EU, reflects the effects of all sub-blocs under it, while in this analysis it just reflects the additional effect of the bloc over its sub-blocs of highest intensity (EEA).

Table 4 gives the role of blocs obtained from the six gravity models discussed in Section II. A few observations are noteworthy. Most importantly, there is considerable variation in the magnitude, the sign and the significance of the bloc dummy variables across specifications. Out of forty blocs considered, only fifteen of them have consistently positive coefficients, and only five have consistent negative coefficients across different models. Among those that have consistent signs, only CIS, EUFTA, WAEMU, CACM, CARICOM, APEC, SAARC, C and GATT have been consistently significant. Even for these blocs, the changes in the magnitudes across models are quite striking. All of these observations lead to the importance of having the proper specification, where no unnecessary restrictions are imposed and where bloc dynamics are taken into account such as model (6).

The introduction of country fixed effects had the primary effect of making the role of almost all blocs more significant. Substantially more bloc effects turned out to be significant in models (5) and (6) in contrast to models (1)-(4). Despite the increased significance, the magnitude of bloc coefficients have decreased in model (5), and especially after the introduction of bilateral effects, and more careful consideration of bloc dynamics in model (6). This observation implies that gravity model specifications, where country fixed effects and especially bilateral effects are omitted, will overstate the role of blocs in trade volume.

In the rest of this section, the results of model (6) are examined in comparisons across blocs, and are contrasted to those of the literature. The signs of CIS, CZSK, WAEMU, MERCOSUR, CACM, CARICOM, APEC, and SAARC in model (6) are consistent with those of the literature listed in Table 2. For some blocs such as AMU, GCC, CEFTA, EFTA, EU, CAN and ASEAN, there is no well established consensus in the literature. Some predict positive effects while some others find negative impact of these blocs. Incidentally for GCC and EFTA, model (6) finds insignificant effects. For CEFTA, the widespread finding is a negative effect, but Fidrmuc and Fidrmuc's (2003) cross-sectional study finds a positive impact, just

Table 4. Magnitude of regional and global international organizations

Organization	Region	Type	(1)	(2)	(3)	(4)	(5)	(6)
AL	ME	NEO	1.10**	1.21*	-0.24*	-0.22	0.36**	0.40**
AMU	ME	NEO	0.01	-0.20	0.30	0.30	1.24**	0.82**
GCC	ME	NEO	2.94	2.29	0.17	0.47	0.66*	0.38
CAEU	ME	MU	0.74	-0.55	-0.07	-0.05	0.00	-0.21
MEDI	EU	FTA	-0.65*	-0.93*	-0.85*	-0.79**	0.23*	0.24**
BSEC	EU	OEC	-0.40	-0.33	0.26	0.24*	0.85**	0.68**
CIS	EU	NEO	1.14*	1.14*	2.34**	2.50**	2.47**	2.32**
CISCU	EU	CU	0.19	-0.45	-0.72	-0.45	-0.36	-0.34
EA	EU	FTA	-0.72**	-0.89*	-0.31	-0.10	-0.40**	-0.21**
CEFTA	EU	FTA	0.16	0.29	1.00*	1.08**	0.76**	0.65**
CZSK	EU	CU	2.63*	2.45	2.53	2.49**	2.45**	2.32**
EFTA	EU	FTA	0.59**	0.53*	0.22	0.18**	-0.14**	-0.00
EUFTA	EU	FTA	0.84**	1.10**	0.52*	0.47**	0.20**	0.09
EUCU	EU	CU	0.62*	0.55	0.00	-0.02	-0.00	0.15*
EEA	EU	EA	0.10	0.35	-0.27	-0.20**	-0.23**	-0.12*
EU	EU	FI	-0.84**	-1.18	0.02	-0.02	-0.46**	-0.52**
ECOWAS	AF	OEC	-0.61	-0.65	0.21	0.20	1.34**	0.52**
WAEMU	AF	MU	2.72**	3.22**	1.79*	1.93**	1.69**	1.62**
ACPEU	AF	PTA	0.70**	0.65**	0.21	0.22**	-0.00	0.12**
COMESA	AF	PTA	-0.46	-0.18	0.76*	0.84**	1.54**	1.09**
CAN	AM	PTA	0.72	0.79	0.90*	0.80**	1.00**	0.93**
MERCOSUR	AM	CU	1.42*	1.37*	0.27	0.29	1.59**	0.91*
NAFTA	AM	FTA	-0.79	-0.95	-1.08	-0.89**	-0.03	-0.40*
CACM	AM	CU	2.18**	2.38**	2.35**	2.43**	2.89**	2.02**
CARICOM	AM	CU	3.93**	4.28**	2.70**	2.64**	2.96**	2.49**
APEC	AP	OEC	1.58**	1.74**	1.13**	1.11**	0.73**	0.48**
ASEAN	AP	OEC	0.27	0.12	0.30	0.32*	-0.84**	-1.01**
SAARC	AP	OEC	-1.88**	-2.16**	-0.85	-0.74**	-1.21**	-1.20**
SAPTA	AP	PTA	0.26	-1.62**	-0.79*	-0.02	0.47	0.26
BA	AP	PTA	-0.52	-0.66	0.41	0.43**	-0.44**	-0.43**
ANZCERTA	AP	FTA	0.22	0.15	-0.52	-0.53	1.40**	1.05**
OIC	GL	NEO	-0.79**	-0.67**	0.36*	0.36**	0.79**	0.45**
NATO	GL	NEO	-0.58**	-0.66**	-0.23	-0.25**	-0.45**	-0.40**
C	GL	NEO	0.76**	0.63**	0.40**	0.41**	0.22**	0.12**
OPEC	GL	OEC	-0.53	-0.51	-1.11*	-1.20**	-0.21	-0.26*
OECD	GL	OEC	0.98**	0.98**	-0.17	-0.12**	0.21**	0.22**
GATT	GL	PTA	0.56*	0.41*	0.06*	0.16*	0.44*	0.08*
WTO	GL	PTA	0.02	1.05**	0.48*	0.02	0.26**	0.00
BFTA	GL	FTA	1.21*	1.85	1.48*	1.40**	1.15**	0.95**

Notes: *, ** denote significance at 95% and 99% confidence levels, respectively.

like model (6). For the EU, the majority of the analyses find a positive impact, with the only exception of the panel study of Winters and Soloaga (1999). Model (6)'s finding of negative impact could be due to differences across studies in definitions of the EU bloc, as discussed earlier. The same could be the reason for the negative significant effect found for EA in contrast to the findings in the literature since in this paper, the EA captures the additional effect over the EUFTA.

A major case of inconsistency of model (6)'s results with the literature arise in the case of NAFTA. While model (6) finds a negative significant effect of NAFTA, the finding in the literature is quite the opposite. This might be due to insufficient coverage and/or implementation in this bloc. One other possible explanation could be omission of bilateral effects from Wall (2003), and the omission of this and other country effects from other analyses in the literature, where unnecessary constraints are placed in the absence of these effects.

Generally speaking, a negative coefficient for a bloc could be a result of not only model misspecification but also some other factors. The added effect of the bloc over the sub-bloc has been trade restrictive due to over regulation in the name of further integration such as in the EU. Another explanation could be trade diversion[10] from non-members that have another bloc with some of the members of the former bloc.[11]

An important result from model (6) is that trade volumes incrementally increase with intensity of blocs. The additional effects of preferential trade agreements have been positive, as can be seen from SAPTA over SAARC. Free trade agreements and custom unions also had a positive additional impact over the role of blocs of lower intensity (BFTA over GATT; ANZCERTA over C; MERCOSUR over CAN; CZSK over CEFTA; and EUCU over EUFTA). The only exception is the additional effect CISCU over CIS, where CISCU suffers from late and insignificant implementation. More regionalization of an agreement had a positive impact as well, as can be seen from MEDI over EUFTA, CEFTA over the EA, COMESA over ACPEU, even if these agreements have the same intensity. One exception is the effect of the EA over the EUFTA. It must be remembered, however, that the EAs have been criticised because of sensitive sectors that were left out of liberalization.

[10] For more on trade creation and diversion, refer to Bayoumi and Eichengreen (1997), Endoh (1999), or Kruger (1999).

[11] In fact, the sensitivity analysis, where blocs are incrementally included in the analysis, suggests this as a possible explanation. Excluding the EU and its sub-blocs from analysis results in a positive coefficient for NATO.

These sectors happen to be those that the Eastern European countries have comparative advantage (Messerlin 1993).

At higher levels of intensity, the additional effects have been unexpectedly negative. The additional effects of the only two economic areas, CAEU and EEA have been negative over the sub-blocs of lower intensity in their region, AL, and EUCU, respectively. The same is true for the only full integration, EU over EEA. The causes of these could simply be that these particular blocs do not provide any additional trade promoting effects over the sub-blocs, and that instead, these blocs might imply restrictive regulations that hamper trade. Another high level of intensity bloc, monetary union, had a positive and significant additional impact, as can be seen from WAEMU. But, this is only over ECOWAS, which has the small intensity of OECs.

Finally, the expected positive effect of culture stemming from history, religion and ethnicity is observed. Common history through colonial links in C and CIS leads to a significant positive effects on the trade of member countries of these blocs. Common religion increases trade in members of the OIC. A similar positive result is observed in blocs of similar ethnicity such as AL and AMU. However, NATO, the only security alliance bloc analyzed, fails to have a positive impact on trade of its members.

IV. Conclusions

This paper applied trade data to different gravity models to compare and evaluate the specifications proposed in the literature. It examined the role of blocs in trade across different models, and groups of blocs with different intensity of integration. It also suggested some improvements of its own.

The results indicate that using the proper specification is crucial to accurately measure trade effects of blocs. All unnecessary restrictions on the parameters of the model should be removed, even if such changes might reduce the overall fit of the model. In particular, average values should not be used since that forces the parameters to be the same for every year. Moreover, imports should be used as the dependent variable rather than total trade; otherwise, equality of parameters is imposed for exports and imports. More importantly, different parameters should be allowed for different years, exporters, importers, and partner pairs, with the introduction of year, importer, exporter, and bilateral interaction effects to the model. Lastly, direct inclusion of dummy variables for blocs in regressions of trade should be avoided, and bilateral effects should be alternatively analyzed for the role of blocs.

This paper also extended the models with fixed effects to render the role of blocs more observable. Time invariant variables of country characteristics are kept in the model to control for all the usual factors affecting trade so that bilateral effects reflect only the other uncontrolled factors such as the international blocs. Fixed effects are measured separately for each year to capture changing memberships over the period of analysis. Furthermore, given the number of blocs considered, and their differing intensity of integration, to account for each bloc's additional effect, another step is added where bilateral effects are analyzed.

The analysis on the role of blocs shows that, although for some blocs the sign and significance is pretty much consistent throughout different models, any model other than a properly specified model might yield incorrect conclusions. The properly specified model suggests that cultural ties through religion, ethnicity and colonial relations are important trade promoting factors. Most importantly, trade increases with intensity of integration in blocs. Monetary unions have significant additional positive impact on trade over customs unions, which are in turn more trade promoting than free trade areas, preferential trade areas and organizations of economic cooperation. Only economic areas and blocs with full integration are found to have a negative additional impact over the sub-blocs of lesser intensity. The degree of implementation and the coverage of integration agreements are partly responsible for the difference in role of blocs of similar intensity.

Appendix

A. Country coverage

Middle East (ME): Israel, Jordan, Kuwait, Oman, Saudi Arabia.

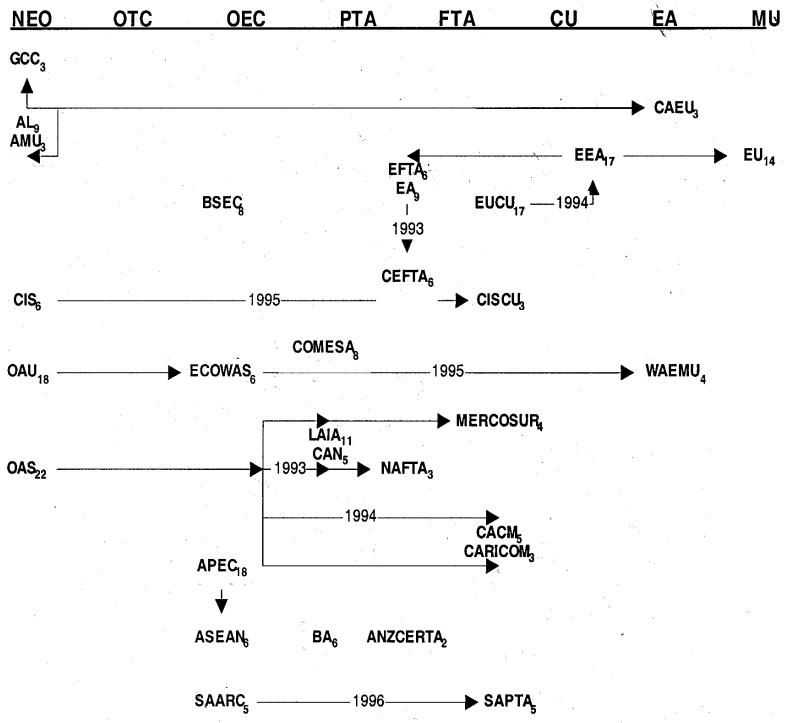
Europe (EU): Albania, Armenia, Austria, Azerbaijan, Belarus, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, and UK.

Africa (AF): Algeria, Benin, Egypt, Ghana, Kenya, Madagascar, Mauritius, Morocco, Niger, Nigeria, S. Africa, Senegal, Seychelles, Sudan, Tanzania, Togo, Tunisia, Uganda, and Zimbabwe.

Americas (AM): Argentina, Barbados, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, USA, Uruguay, and Venezuela.

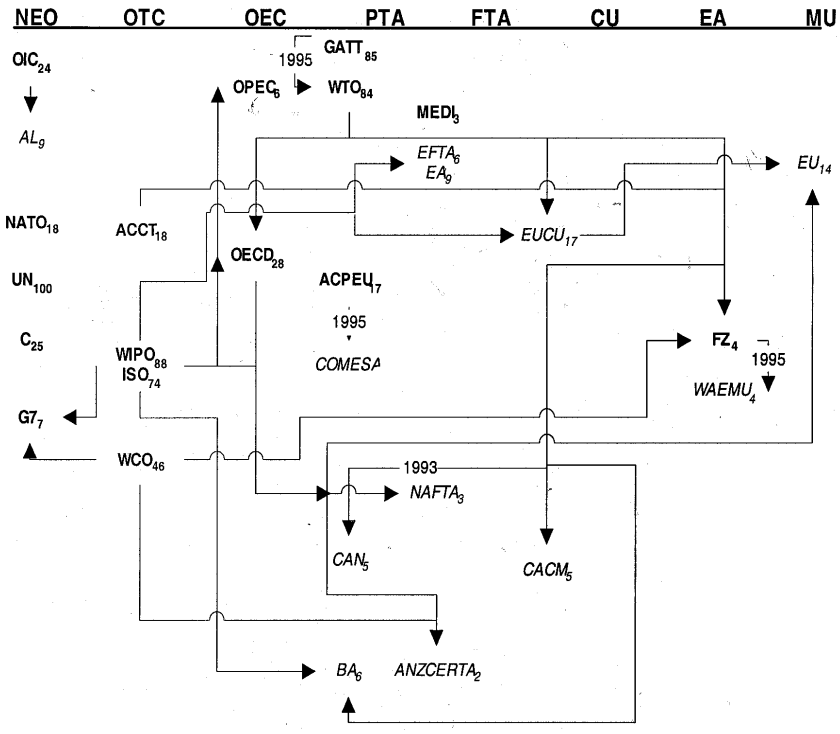
Asia-Pacific (AP): Australia, Bangladesh, China, Hong Kong, India, Indonesia, Japan, Kyrgyzstan, South Korea, Malaysia, Nepal, New Zealand, Philippines, Pakistan, Singapore, Sri Lanka, and Thailand.

B. Composition of regional blocs



Notes: the subscripts are the number of member countries covered in the analysis. Arrows connect an organization to another formed by some members at dates shown on the line, if the latter is formed after 1992. Sources: CIA World Factbook, and the official web sites of individual organizations.

C. Composition of interregional blocs



Notes: UN is connected to all organizations except GATT/WTO and APEC. Its connections are not shown to avoid complication. Regional organizations are denoted in italics. Sources: CIA World Factbook, and the official web sites of individual organizations.

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