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Export diversification and growth

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Abstract

In preliminary empirical analysis, we have uncovered a link between export diversification and growth, in which both the level of diversification and the type of diversification matter. We have come at this from various angles to determine causality, and so far we have found a causal link from diversification to growth. We have completed a related purely empirical paper that shows that membership in the WTO increases export diversification even though its overall impact on exports is small. The current paper, which is in progress, focuses on this link between diversification and growth. We are building a theoretical model that is based on the exploitation-exploration trade-off. Exploiting one's current comparative advantage may involve very specialized exports. However, with changing technology and market conditions, a country can be left behind when the comparative advantage it enjoys in its current exports erodes but it does not know where its next comparative advantage lies. With diversified exports, a country is constantly exploring other sectors and can better adapt to change. We model this with restless bandits (multi-armed bandits in which the parameters follow ergodic processes, i.e., there is constant change over time so learning can never be complete), with the additional complications that the exploration-exploitation trade-off is based on decentralized decisions within a country and there is competition between countries,

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This summary prepared by a coauthor is roughly an extended abstract; appended is a completely empirical paper from a closely related project.

Trade Diversification and Economic Development[1]

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Introduction

In 1978, South Korea was a net importer of non-electrical machinery with imports in this sector exceeding 15% of total manufacturing imports while exports being less than 2% of total exports. In the same year, the US was a net exporter of machines in this category. By 1999, South Korea had become a leading exporter of machinery while the US became a net importer in this category. Over the same period of time, the industrial structure as well as the trade structure of South Korea changed rapidly. There was a massive relocation of capital and labor across sectors and, more importantly, a parallel process of diversification of output and exports. South Korea did not just specialize in a few industries but diversified its production and exports across many different categories of goods. Over the past 30 years, this process of diversification was accompanied by a five-fold increase in South Korea's income per capita.

Both from a theoretical point of view and from a policy perspective, there are several questions that emerge from the process of development in countries like South Korea: How do countries diversify their export base? How do they gain and sustain comparative advantage in different industries over time? Why is development associated with diversification rather than specialization?

What is diversification?

Export diversification means broadening of the range of products that a country exports. One standard measure of diversification is the Herfindahl index. The value of this index for county *i* at time *t* is the squared sum of export shares, where the summation is across all goods in the set J_{it} of categories in which the country exports:

$$HFI_{it} = \sum_{j \in J^{it}} s_{i,jt}^2 = \sum_{j \in J^{it}} \left(\frac{p_{jt}^i q_{jt}^i}{\sum_{k \in J^{it}} p_{kt}^i q_{kt}^i} \right)^2$$

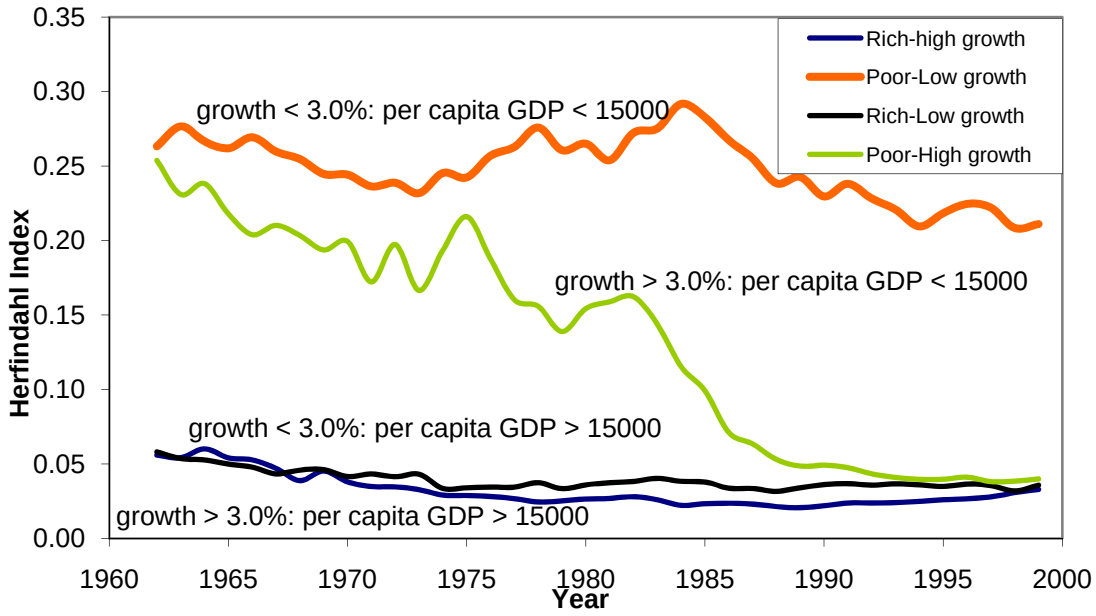
The numerator is the value of exports in country *i* of good *j* at time *t*, while the denominator is the value of total exports fro country *i*. It is an inverse measure of diversification that ranges from maximum value of 1 (no diversification: all exports are in a single category) down to a minimum value of 1/n where n is the number of export categories. Full diversification is achieved when the country exports equal values in all export categories.

[1] This article is based on a research project with Pushan Dutt and Timothy van Zandt called “Trade Diversification and Economic Development.”

In order to construct these Herfindahl indices for all countries, we use trade data from the World Trade Flows Database (Feenstra et al., 2005), which contains information on bilateral exports for more than 150 countries over the period 1962—1999. We aggregate bilateral flows across countries to obtain total exports in each country and industry. The data on the value of exports are at the 4-digit Standard International Trade Classification, revision 2. There are 790 categories, which implies that the Herfindahl index will vary from about 0.0013 for a fully diversified country to 1 for countries that export only one product.

Figure 1 presents a striking picture of the relationship between export diversification and economic development. It plots the Herfindahl index of exports at the 4-digit (SITC) level over time for four sets of countries: Rich countries with low growth rates, rich countries with high growth rates, poor countries with high growth rates, and poor countries with low growth rates. We classify a country as rich, rather than poor, if its per-capita GDP exceeds $15,000 in the year 2000 (in constant PPP dollars, according to Penn World Tables 6.2). We classify a country as high-growth, rather than low-growth, if its average growth rate between 1960 and 1999 exceeds 3%. Low-growth poor countries did not experience a significant change in their export diversification: they started off less diversified and remained so for the entire time period. However, high growth rates experienced a substantial rise in their diversification of exports (decline in the Herfindahl index from about 0.25 to less than 0.05). Also, we can notice here that rich countries are substantially more diversified than poor countries.

Figure 1: Export Herfindahl for Different Groups

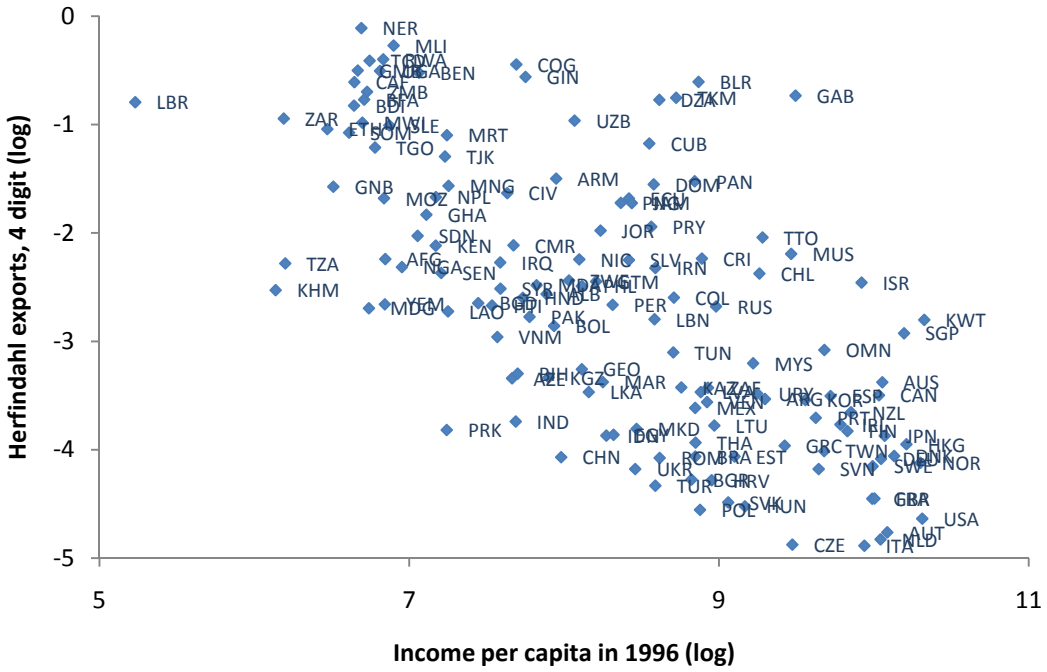


More evidence on the link between export diversification and income per capita is provided in Figure 2. On the vertical axis we plot logarithm of real income per capita in international dollars and on the horizontal axis is the logarithm of the Herfindahl index. The graph represents a snapshot for 1996.

The correlation is striking: All rich countries have a diversification index below 0.08, while all poor countries are specialized in exporting only a few categories.

The key question is whether this link implies a causal effect from diversification to economic development. In other words, is diversification a necessary condition for growth? Alternatively, can a country become rich by specializing in just a few industries? As usual, there are two potential problems with establishing the causality. The first is the possibility for reverse causality, i.e. growth leads to more diversification. The second problem is that there might be a third variable that drives both growth and diversification at the same time. If this variable is excluded from the regression, then we might incorrectly attribute its explanatory power to diversification. Below, we discuss how we control for omitted variables in more detail. To address the issue of reverse causality, we need to use instruments for diversification. We first turn to theory to get some guidance as to what will determine the number of varieties being exported by a country.

Figure 2: Diversification and Income per capita (logs)



A brief review of the theory

The neoclassical Ricardian and the Heckscher-Ohlin models provide no clear role for export diversification. Underlying both models is the idea that countries specialize internally according to comparative advantage, and exports match such specialization. The Ricardian approach emphasizes technological or productivity differences between countries and shows that countries can gain by specializing in and exporting goods in which they have a relative cost advantage. The Heckscher-Ohlin model focuses on the relative proportion between productive factors (i.e., physical capital, labor, land, skills or human capital). Hence, poor countries specialize in goods intensive in unskilled labor and land, whereas richer countries specialize in goods intensive in human and physical capital.

In both these models, the export Herfindahl would depend entirely on whether the underlying technological or resource comparative advantage provides a comparative advantage across a small or large number of product categories.

The ``new'' trade models, which we turn to next, emphasize the extensive margin of trade and are better suited for understanding the determinants of export diversification. Krugman (1979) presents the workhorse model of trade with a monopolistic competitive market structure. The model was originally designed to address the high incidence of trade between countries that have similar technologies and factor endowments---an empirical fact that was in stark contrast with the traditional Ricardian and Heckscher-Ohlin predictions that the bulk of trade would be between dissimilar countries. In the Krugman (1979) model, the emphasis is on the extensive margin of trade (i.e. the number of categories being traded), with countries in equilibrium producing an endogenous number of varieties. The number of varieties produced in a country is proportional to the size of the economy, with each country (conditional on exporting a particular variety) exporting that variety to all other countries.

Recently, a richer specification of the Krugman (1979) model has been proposed by Melitz (2003), in which firms are heterogeneous in terms of productivity. When firms vary by productivity, only the more productive firms find it profitable to export. Melitz shows that this cut-off productivity level depends on trade barriers faced by the exporters and other features of the world market; profitability is higher and the corresponding cut-off productivity level for exporting is lower when exporting to countries with higher demand levels, and when firms in the focal country face lower costs of exporting.

Transport costs that depend on geographic distance, as well as are artificial barriers such as tariffs and quotas, are trade costs that vary across country pairs and affect the composition of trade. The role of such costs is incorporated by Eaton and Kortum (2002) into a Ricardian model of trade (one based on differences in technology). Transport costs and market access play a key role in determining the extensive margin of trade.

We can use the insights from these models in order to build a better understanding of what drives product diversification of exports: market size, transport costs, market access, etc. are good candidates to explain the number of varieties exported by the country.

What explains diversification? Empirical analysis

Our first variable is the logarithm of population of the country, a proxy for the size of an economy. To capture geographic barriers to trade, we use a remoteness index from Rose (2005). This is not a measure of distance for a country pair, but rather it is a multilateral analogue that measures the overall distance of one country from the remaining potential trading partners. We use this measure because our analysis is also at the level of the country rather than the country pair. It is defined as the average of log distances from each country to all other countries, weighted by GDP. According to this measure, Luxembourg has the lowest value of the index and therefore the easiest market access, while New Zealand is the most remote. To capture market access and the ability to circumvent artificial trade barriers, we use three measures of preferential access: (1) membership in

the GATT/WTO; (2) membership in preferential trade arrangements (PTA); (3) Generalized System of Preferences (GSP).

The results from regressing the export Herfindahl index on these determinants of trade are reported in Table 1. Since most of the literature treats these regressors as reasonably exogenous, we estimate these regressions by OLS. Column (1) reports pooled OLS results with time fixed effects, while columns (2) and (3) also include country fixed effects. For both the pooled and within estimates, the signs are as expected -- entering GATT leads to a statistically significant increase in export diversification.

Table 1: Effect of Trade Costs and Market Access on Export Diversification

Dependent Variable: Export Herfindahl Index using 4 –digit SITC classification

	(1)	(2)	(3)
GATT dummy	-0.031***	-0.044***	-0.033***
	(0.006)	(0.007)	(0.010)
PTA access	-0.0002***	-0.0002***	-0.0001**
	(0.000)	(0.000)	(0.000)
GSP access	0.004***	-0.004***	-0.003*
	(0.000)	(0.001)	(0.002)
Remoteness index	3,966.744***	2,649.364***	2,498.592*
	(297.456)	(462.253)	(1,466.423)
Population (logged)	-0.026***	0.052***	-0.031
	(0.001)	(0.015)	(0.037)
Production Herfindahl of neighbors			-0.228***
			(0.058)
Constraints on the executive			0.010***
			(0.002)
Openness: (X+M)/GDP			0.000
			(0.000)
Observations	4428	4428	2217
Number of countries	143	143	122
R-squared	0.18	0.07	0.04
Time fixed effects	Yes	Yes	Yes
Country fixed effects	No	Yes	Yes
Joint significance test	44.58***	38.7***	28.73***

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

To understand the magnitude of the effect consider the estimated coefficient on the GATT/WTO dummy in column (2). If a country exports evenly in several industries and has a value of the Herfindahl index equal to the overall mean of 0.18, then a coefficient of -0.044 implies that this country will start exports in slightly fewer than two new industries following accession to GATT/WTO. The first row of the table indicates that while the magnitude is sensitive to the specification of the regression, but it is always highly significant. At the low estimate in column (3), a country with an equal distribution across export industries will add just one new industry to its nomenclature of exports. However, these calculations underestimate the impact of GATT because

they assume that exports are evenly distributed. If this is not the case and if new exports do not jump in value right away to the values in the old exporting sectors, then an entry to GATT may result in a bigger expansion on the extensive margin.

Countries with greater market access as measured by the sum of market size of countries with whom they have preferential trade agreements also tend to be more diversified, and the result holds for both the pooled estimates in column (1) and the within estimates in columns (2) and (3). With GSP access, the estimate for the pooled OLS specification in column (1) has the opposite sign from the specification with country fixed-effects in column (2). While across countries, GSP access is associated with higher levels of export concentration, within countries over time GSP access leads to export diversification. This is not surprising given that preferential agreements are generally granted to the least developed countries for specific products or groups of product (mainly agriculture). The least-developed countries tend to have a much less diversified export base and tend to specialize in primary and unskilled-intensive products. However, granting preferential access to a country leads it to diversify exports over time as the negative coefficient in columns (2) and (3) signify.

Next, the remoteness index also has significant explanatory power for export diversification: The further away a country is, the lower is the degree of diversification. This suggests that productive firms are clustered in certain industries and if the threshold for exporting is higher for countries due to higher transportation costs, then these countries tend to be less diversified in their exports. The decline in the significance of the coefficient on *Remote* in column (2) is not surprising, given the lack of time variation in this variable. Finally, estimates in column (1) suggest that larger countries in terms of population are more diversified in their exports.

In addition to the standard variables used to explain trade patterns, we include additional controls in column (3) to examine the robustness of our results. These are the Herfindahl index capturing production concentration in neighboring countries, the volume of trade defined as (Exports+Imports/GDP), and a measure of institutions, constraints on the executive from the Polity IV database. Addition of these variables results in a decline in the magnitude of our estimates. However, all variables, save population, remain significant. In terms of these additional controls, we find that the Herfindahl index of exports of the focal country is negatively related to the Herfindahl index of production of its neighbors. The coefficient on this variable implies that if neighboring countries have a well-diversified industrial structure (i.e. low level of the production Herfindahl index) then the exports of the home country are quite concentrated. The volume of trade does not seem to matter, while an improvement in institutions increases export diversification.

From a theoretical point of view, the results in Table 1 may be somewhat puzzling. In standard neoclassical trade models of Ricardo and Heckscher-Ohlin, a fall in trade costs/barriers should lead to concentration of exports in the sectors where the country has a comparative advantage. And yet, one of the most robust findings in cross-country or panel regressions is that entry into GATT, or participation in PTAs leads to a sizable increase in exports diversification. This finding is not easily reconciled within a monopolistic competitive model of trade either. In such a model, all varieties are exported and the f.o.b. prices are identical for all destinations, regardless of trade barriers.

However, this evidence is consistent with the Melitz (2003) model with heterogeneous marginal costs of firms and fixed costs of exporting. The fixed costs explain why not all varieties are sold in all markets while the heterogeneous marginal costs explain why some firms (the productive ones with

low marginal costs) in a country manage to export while others focus purely on the domestic market.

Overall, we find that export diversification is well explained by standard variables like trade costs, remoteness, market access, etc. The result is robust to changes in specifications, and changes in the data set. Dutt et al. (2011a) show that if diversification is measured by the extensive margin of trade, and the data set is changed to include more detailed varieties (6-digit level), then still standard gravity variables explain very well diversification. With this results at hand, we turn now to the link between diversification and development.

Diversification of Exports and Economic Development

When examining the links between trade and economic development, researchers have tended to focus on whether higher ratios of trade volumes to GDP (or lower levels of protectionist policies) are positively correlated with growth, even after controlling for a variety of other growth determinants. Such a positive link is suggested by Sachs and Warner (1995), Frankel and Romer (1999), and Wacziarg and Welch (2008) amongst others. However, in a critical survey of this literature, Rodriguez and Rodrik (2000) question the robustness of these findings, due to problems in measuring openness, the collinearity of protectionist policies with other bad policies, and other econometric difficulties. More recently, a consensus seems to be emerging that the deeper determinants of economic development are not policies (trade policies as well as macroeconomic policies) but the underlying institutions in a country. Institutional indicators such as the constraints on executive decision-making, the rule-of-law, and bureaucratic corruption have been shown to have a much more significant impact on economic growth and level of development (Mauro, 1995; Hall and Jones, 1999; Rodrik et al, 2004; Easterly, 2005). The prevailing consensus is that institutional quality trumps both the role of geography and economic integration with the rest of the world in accounting for cross-country differences in income levels. This verdict of the primacy of institutions over policies, while illuminating, may be of little comfort to policymakers who have much less flexibility when it comes to institutional reform.

Recently, research has gone beyond analyzing the role of trade volumes for growth and more attention has been directed towards the analysis of the composition of trade. Broda et al. (2006) show that, across a wide sample of countries, the growth in the extensive margin of imports can also account for an important component of that country's productivity growth. Hausmann et al. (2007) show that the type of goods countries export matters---exporting goods associated with higher productivity levels leads to rapid economic growth grow more rapidly, after controlling for standard growth regressors such as initial income per head, human capital levels, etc.

Imbs and Wacziarg (2003) were the first to document the relationship between production and employment diversification and per capita income. They showed, that as countries develop, they tend to diversify their production structure but after a threshold level of per capita income, we observe a reversal and a tendency towards re-concentration. Klinger and Lederman (2004, 2005) and Cadot, Carrere, and Strauss-Kahn (2007) show a similar result using export data. However, these papers simply present a pattern between development and diversification, leaving aside questions of causality.

We analyze the link between diversification of exports and economic development and examine if there is a causal relationship from export diversification to per capita GDP. We go back now to Figure 2 and we try to analyze the negative relationship between the income per capita and the Herfindahl index. We start with a simple pooled OLS regression where we regress per capita GDP on export Herfindahl at the 4-digit level, controlling for trade volumes (Exports+Imports/GDP), an institutional variable, measured as constraints on the executive, and distance to the equator. Our specification follows that of Rodrik et al. (2004) who use a similar specification to examine the relative importance of institutions over geography and integration.

Table 2: Effect of Export Diversification on Economic Development
Dependent variable: Per Capita GDP (PWT Panel)

	(1)	(2)	(3)	(4)	(5)
	Pooled OLS	Lagged Herfindahl	Initial Herfindahl	Fixed effects	IV-fixed effects
Herfindahl index of exports (4-digit)	-1.199***	-1.195***	-0.516***	-0.335***	-1.229***
	(0.064)	(0.066)	(0.077)	(0.040)	(0.172)
Constraints on the executive	0.150***	0.155***	0.161***	0.007**	0.009*
	(0.005)	(0.005)	(0.005)	(0.003)	(0.005)
Openness: (X+M)/GDP	0.003***	0.004***	0.003***	0.002***	0.012***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Distance to equator	0.025***	0.026***	0.028***		
	(0.001)	(0.001)	(0.001)		
Observations	3780	3419	3782	3780	3674
Number of countries	136	134	113	136	124
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Country fixed effects	No	No	No	Yes	Yes
R-squared	0.59	0.60	0.56	0.43	0.31
Joint significance test	172.87***	190.11***	153.30***	66.92***	46.83***
F-test of excluded instruments					
Export Herfindahl					91.14***
Openness: (X+M)/GDP					46.17***
OID test p-value					0.27

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Column (1) in Table 2 shows that export diversification is associated with significantly higher levels of per capita GDP. Meanwhile, the signs and significance on the other variables are in line with Rodrik et al. (2002) --- countries that are more open, with better institutions and that are distant from the equator are more developed. Since this in no way establishes causality, the second column of Table 2 uses the Herfindahl index of exports lagged by 5 years, while column 4 uses the initial Herfindahl index from the year 1962. Here with reverse causality less of a concern, we again find that a country with a diversified export base tends to be richer. The estimates in column (1) imply that a one standard deviation decline in the export Herfindahl (which is roughly equivalent to a country that produces equally in two industries to adding an extra industry) raises the log of per capita GDP by 0.21.

The magnitude of effect is largest for distance and institutions---a one standard deviation increase raises log of per capita GDP by 0.41 and 0.34 respectively.

Column (4) adds country fixed effects to column (1). Using fixed effects in this manner also dramatically reduces the scope for omitted variables and mis-measurement that may plague our estimates, as the intercepts take out all variation that is country-specific but time-invariant. Despite the fall in the absolute magnitude of the coefficient on export diversification, it remains significant. In fact, these estimates indicate that the magnitude of the effect is largest for export diversification, as compared to institutions and integration. Since these are within-estimates, it implies that there are significant returns for a country if it manages to diversify its export base over time.

There are two potential problems with the results reported in table 2: omitted variables and endogeneity of trade policies. While the country-fixed effects remove all time invariant omitted variables, it may be argued that a move towards diversification may be accompanied by other policy changes (e.g., industrial policies) which also affects per capita GDP. To address these concerns we use instrumental variables. In column (5) we instrument the Herfindahl index of exports with a Herfindahl index of agricultural exports (calculated as the Herfindahl index of exports for SITC 1-digit code 0), the GATT dummy, and the PTA access variable. We believe the Herfindahl index of agricultural exports to be a valid instrument, since logically it is related to contemporaneous overall export diversification and unlikely to be directly related to per capita GDP (other than through its effect on overall export diversification.) This seems plausible since natural endowments of land, fertility, and weather mainly affect this variable. Similarly, accession to the GATT is not conditional on changing any other policy stance prior to membership. And finally, PTAs tend to be geographically localized with neighboring countries entering into such preferential trading arrangements. However, it may be argued that both GATT membership and PTA access affects trade volumes and through it per capita GDP, we instrument openness using these instruments as well.

Upon instrumenting export diversification and openness in column (5), we observe a coefficient on export diversification which is similar to that in column (1) and significantly higher than that in column (4) which includes fixed effects.

Overall, our results indicate that there is a tight link between export diversification and development, that export diversification in all likelihood has a causal effect on per capita GDP (if we believe that the instrumenting strategy is valid), and that expansion of exports along the extensive margin delivers bigger benefits in terms of facilitating economic development. Whatever the driving force of economic development is, it cannot be the forces of static comparative advantage as conventionally understood. The trick seems to be to acquire mastery over a broader range of activities, instead of concentrating on what one does best.

Summing up

First, we find that all countries who became rich, diversified their base of exports over time. We show that trade costs---measured in terms of distance to trading centers and market access through a host of trading arrangement (multilateral, bilateral and unilateral) are key drivers of diversification. However, there are various subtle differences in how these market access variables work---some increase diversification over both time and across countries, while the effect of others is realized only when we do a cross-country comparison.

Second, we show that there is a tight link between economic development as measured by per capita GDP, and export diversification as measured by the Herfindahl index of exports. Third, Dutt et al. (2011b) show that the most effective diversification for economic development is by mimicking the production structure of the US. This is an especially powerful path of diversification if the country concentrates in those industries where the US is the most productive. In other words, not every diversification is associated with higher income per capita.

Once we recognize the link between export diversification and development, several policy implications emerge from our findings. First, our findings imply that development is fundamentally about structural change: it involves producing and exporting new goods with new technologies and transferring resources from traditional activities to these new ones. This insight is not new and was the central insight of the classical two-sector models of development (Lewis 1954). Second, our paper makes a case for trade liberalization on a multilateral basis, since this leads to a diversification of exports. While Rose (2004) shows that the volume or volatility of trade flows are unaffected by GATT/WTO accession, Dutt et al. (2011a) show that this negative result manifests itself differently at the extensive and the intensive margins of trade. Similar to Rose (2004) we find that the intensive margin of exports does not respond to GATT accession, but the extensive margin is affected by accession to WTO. Second, since preferential trade arrangements are also instrumental in diversifying the export base, welfare implications of PTAs cannot simply be evaluated in terms of trade creation and trade diversion. Instead, one must take into account, the impact on the extensive margin of trade. Third, given that diversification into particular productive sectors delivers the maximum gains, our paper makes a case of targeted industrial policies as was adopted by the growth miracle countries like South Korea, Taiwan and Japan prior to that. We do recognize that there are two practical bottlenecks to adopting a successful industrial policy. First the informational requirements for governments to identify with any degree of precision and certainty the relevant sectors, or markets to target. Second is the objection that activist industrial policies is an invitation to corruption and rent-seeking (see Dutt, 2009). Recently Rodrik (2007) has made a strong case for reinstituting activist industrial policies that have been discarded or fallen into disuse. By showing that some forms of diversification matters more than others, our paper provides empirical support for such a pursuit.

Our findings raise a number questions: Which trade theories can explain how countries identify and develop their comparative advantage, and diversify into these sectors? Note that even the new trade models are static in nature and are less equipped to explain how patterns of comparative advantage shift over time. Of course, diversification can be driven by portfolio diversification motifs as in Acemoglu and Zilliboti (1997). The topic of our future research (Dutt et al., 2011b) is to identify how countries search for their comparative advantage and to analyze the interplay between diversification and specialization in the process of development.

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ABSTRACT

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JEL Classification: F02, F13 and F15
Keywords: extensive margin of trade, gravity, intensive margin of trade and wto

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Abstract
We use 6-digit bilateral trade data to document the effect of WTO/GATT membership on the extensive and intensive product margins of trade. We construct gravity equations for the two product margins where the specifications of these gravity equations are motivated by the model of Eaton and Kortum (2002). The data show that the puzzle of no significant impact of WTO membership on trade documented by Rose (2004) manifests itself differently at the product margins of trade. We show that the impact of the WTO is almost exclusively on the extensive product margin of trade, i.e. trade in goods that were not previously traded. In our preferred specification, WTO membership increases the extensive margin of exports by 31%. At the same time, WTO membership has a negligible or even a negative impact on the intensive margin (the volume of already-traded goods). Incidentally, we also document that standard gravity variables provide good explanatory power for bilateral trade on both margins.

Keywords: WTO, PTA, GSP, extensive margin of trade, intensive margin of trade, gravity model.

1. Introduction

The purpose of this paper is to decompose growth of trade into increased trade in products already traded by a country pair (the intensive product margin) and new trade in products not previously traded by a country pair (the extensive product margin), and then—in particular—to understand the effect of WTO membership on these two margins. Whereas previous work has found that trade growth has come primarly as increased trade among countries that already trade with each other (the intensive partner margin), we find the opposite when taking a product perspective. WTO membership has a significant effect on the extensive product margin but little effect on the intensive product margin.

Since its inception in 1948, the General Agreement on Tariffs and Trade (GATT) has formulated and implemented the rules of world trade. The biggest overhaul of

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trading rules took place in the 1980s through the Uruguay Round of talks, and eventually led to the creation of the World Trade Organization in 1995. The agenda of GATT/WTO has been to promote trade, reduce trade barriers through rounds of trade talks, and provide a venue for settling trade disputes.

However, its raison d'être as the promoter of world trade was cast in doubt by a seminal paper by Rose (2004), who found a negligible impact of WTO membership on the volume of bilateral trade flows. That paper spawned multiple follow-up attempts to validate or overturn Rose's surprising result. For instance, Subramanian and Wei (2007) show that the impact of GATT/WTO depends on what the country does with its membership, with whom it negotiates, and which products the negotiation covers. Developing countries (e.g., India) enjoyed special exemptions in particular sectors (e.g., textiles) from the liberalization of trade; once these exceptions are accounted for, the WTO does promote trade. Tomz et al. (2007) argue that many countries are mistakenly classified as outside the GATT, even though they were de facto members with similar rights and obligations. They show that not counting such countries as GATT members systematically underestimates the effect of GATT on trade flows. Liu (2009) highlights the sample selection bias in the traditional gravity formulation: many country pairs exhibit zero trade, which the traditional formulation ignores by examining only strictly positive trade flows. Accounting for this, he finds a strong role for the WTO in initiating trade between non-trading countries—the so-called partner-level extensive margin of trade, as opposed to the partner-level intensive margin (increases in trade between partners that already trade with one another). Felbermayr and Kohler (2006) also emphasize the decomposition of the expansion of trade into partner-level extensive and intensive margins.[1]

In recent years, theoretical models of trade have emphasized firm-level productivity differences in trade patterns (the so-called new-new trade theory). These models arose out of empirical work showing striking firm-level differences in trading behavior. The data show that only a few firms export; among exporters, only a few firms export to more than a few countries; and most exporters only sell a small fraction of their output abroad. Moreover, exporting behavior is positively associated with productivity and size. (See Bernard and Jensen 1995, 1999, 2004; Clerides et al. 1998; Aw et al. 2000; Eaton et al. 2004.)

Incorporating such firm-level heterogeneity into trade models leads first of all to a decomposition of trade expansion into an increase in export volume by firms that are already exporters (the firm-level intensive margin) and the the entry of new firms into the export market (the firm-level extensive margin). When firms produce differentiated products, these firm-level margins translate into product-level margins. Multiple theoretical papers have then analyzed the consequences of trade liberalization on these margins (Eaton and Kortum 2002; Melitz 2003; Bernard et al. 2003; Chaney 2008). At the same time, empirical research (e.g. Hummels and Klenow 2005; Evenett

1. Throughout this paper, the terms "extensive margin" and "intensive margin", when used without a qualifier, refer to the product-level margins.

and Venables 2002) have shown that countries differ in the variety of goods that they trade.

In our paper, we decompose the total volume of trade into the extensive and intensive product margin and examine how membership in the GATT/WTO influences these two margins of trade. We link our empirical findings to the new-new trade theories to show support or lack of support for models with varying predictions about how the two margins are affected by trade liberalization. We also spend some time analyzing how bilateral trade preferences, through the formation of preferential trading arrangements (PTAs), and unilateral trade preferences, influence each of the extensive and intensive product margin. We do this decomposition, while accounting for the zeros in the bilateral trade matrices (zero trade between partners) and allowing the GATT/WTO, PTAs and GSP to influence the extensive partner margin of trade as emphasized by Felbermayr and Kohler (2006); Liu (2009).

We begin, in Section 2, by taking a first look at the data. We decompose the evolution of the volume of world trade (among 148 countries over the period 1970–1999 who account for 98% of all trade) into changes in the extensive product margin (the rise in trade in new products) and changes in the intensive product margin (rise in trade volume of goods that were traded at the beginning of the sample period). A couple of features stand out. First, as in Helpman et al. (2008), we show that the rapid growth of world trade from 1970 to 1999 was predominantly due to the growth of the volume of trade among countries that traded with each other in 1970 rather than due to the expansion of trade among new trade partners. Second, amongst countries that traded with one another in 1970, the extensive product margin accounts for a significant fraction of the rise in trade volumes (72% over the period 1970–1999). We also perform an event study around the time of WTO accession showing the changes in the extensive and intensive product margins change in response to WTO membership.

In Section 3, we perform two decompositions of the traditional gravity equation into an extensive and intensive product margin. The first one simply decomposes the volume of bilateral exports into the number of products multiplied by average export per product. The second follows the methodology of Hummels and Klenow (2005). The Hummels–Klenow extensive margin of exports for a country pair measures the fraction of goods sold by the exporter in the destination but it weights each product by its importance in world exports to this destination. The Hummels–Klenow intensive margin is the market share of the exporter in the importer's total spending on the products the exporter sells there. The volume of bilateral exports equals the product of the two margins multiplied by the total imports of the destination country. Section 4 details the data sources and describes the other independent variables commonly used in the gravity equation specification.

In Section 5, across gravity-based specifications for these margins, we show that the effect of WTO membership is mainly along the extensive product margin. In the most demanding specification (with time-varying importer and exporter fixed effects) we find that the WTO raises the extensive margin by 42% for the count measure and 29% for the Hummels–Klenow measure. In contrast, depending on the specification, WTO has either a negative impact or no impact on the intensive margin

of exports as measured by exports per product. For the Hummels–Klenow intensive margin measure, we find mixed results—it is positive and significant in a subset of specifications and for some years in the data, and insignificant in others. This allows us to reconcile the Rose (2004) result with respect to WTO membership—if the WTO has opposing effects on the two margins, raising the extensive and reducing the intensive, then their product may remain unaffected. Finally, we find that the gravity specification is a good fit for explaining variations in the two margins, accounting for at least 50% of the variation in our preferred specification.

We also obtain interesting results on the effect of PTAs. Across specifications, membership in PTAs reduces the extensive margin of exports and raises only the intensive margin of exports. Moreover, the reduction in the extensive margin in absolute terms often outweighs the rise in the intensive margin. This explains the fragility of estimated PTA effects on trade flows previously noted in the literature (Bergstrand 1985; Frankel et al. 1995; Ghosh and Yamarik 2004). Finally, unilateral access via GSP raises both margins, and is most effective in raising the volume of bilateral exports. Section 6 concludes with various implications of our findings.

Our paper makes three contributions. First, it shows that the effect of WTO membership is mainly on the extensive margin rather than the intensive margin. Broda et al. (2006) show that the extensive margin and the rise in imports of new varieties is responsible for important increases in productivity growth. The WTO, by facilitating such trade, has potentially large welfare effects. Second, our empirical results allows us to understand how well the theoretical predictions of the various new-new trade models are borne out in the data. Finally, our decomposition allows us to evaluate how well the traditional gravity specification holds up in the data for the extensive and intensive margins.

2. A First Look at the Data

We use bilateral trade data from two sources to examine the evolution of world exports. We use UNCTAD's COMTRADE database at the Harmonized System 6-digit (HS6) level of disaggregation where there are data on 5017 product categories or lines. UNCTAD provides the HS6 data over the period 1988–2006 for 183 importers and 248 exporters.[2] The data are collected by the national statistical agencies of the importing countries and covers all exporting countries. For each year in our sample, our data span more than 99% of all world trade, based on the calculation of total world trade using the IMF's Direction of Trade Statistics Database. The latter provides data on aggregate trade between country pairs where trade is summed over all products.

We supplement this with trade data from the World Trade Flows Database (Feenstra et al. 2005), which contain information on bilateral exports for more than

2. Adding all the other explanatory variables, results in a sample consisting of 189 exporters and 167 importers, for a total of 24,261 country pairs.

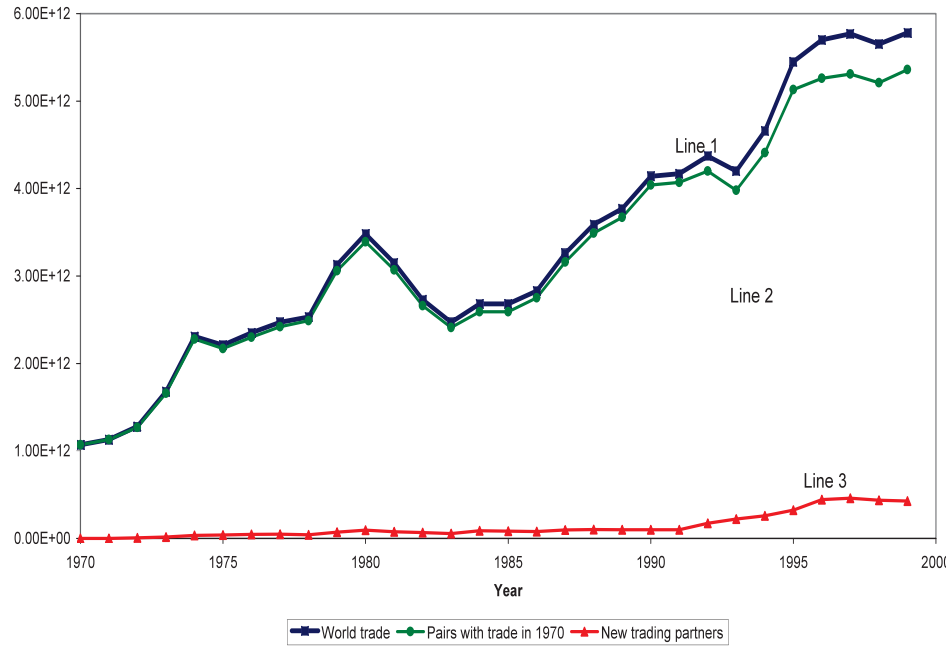

FIGURE 1. Intensive and extensive partner margins (by trading partners, aggregate real exports, 1970–1999).

150 countries over the period 1962–1999. The authors give primacy to the trade flows reported by the importing country, whenever they are available, assuming that these are more accurate than reports by the exporters. They use exporter reports only when the corresponding importer report is not available for a country pair. The data are based on the 4-digit Standard International Trade Classification, revision 2, with 790 4-digit categories and accounts for 98 percent of all world trade.[3] While these data are available only at a higher level of aggregation than that of the UNCTAD data, they are available over a longer time frame with a consistent definition of product categories over time and across space. We use these data mainly for graphical depictions of the evolution of the extensive and intensive margins, over time.

2.1. Evolution of Trade

Figures 1 and 2 provide a graphical depiction of the evolution of the extensive margin of trade. We perform a decomposition of world trade similar to that of Helpman et al. (2008), who derive and estimate a generalized gravity equation that accounts for the self-selection of firms into export markets and their impact on trade volumes. We use

3. Some trade gets classified at the 3-digit level but cannot be classified at the 4-digit level. We drop such trade. However, assigning it to fictitious sub-categories does not qualitatively affect our results.

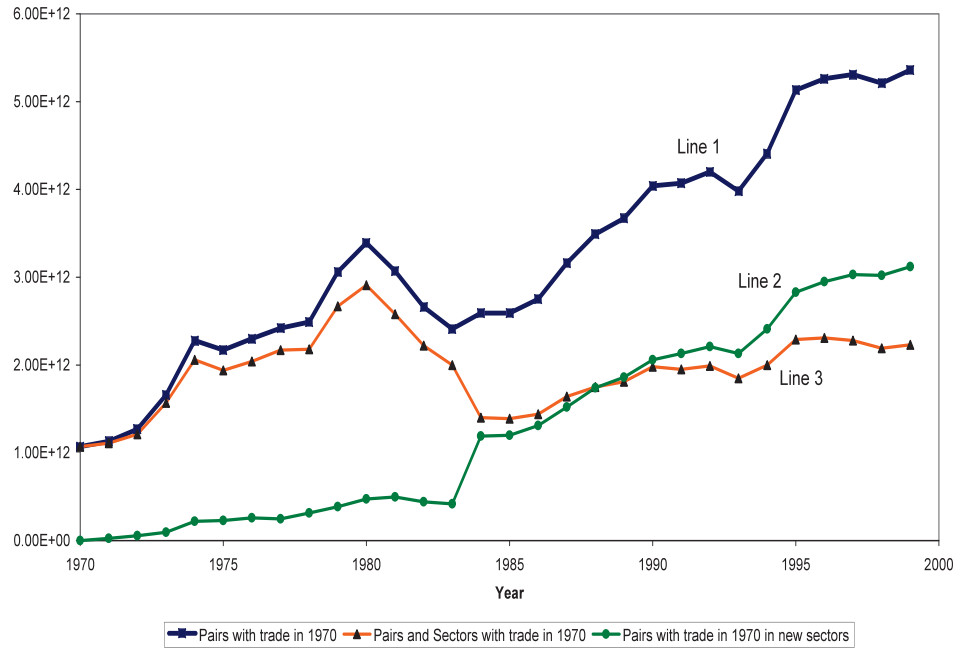

FIGURE 2. Intensive and extensive product margins. Lines show aggregate real exports, 1970–1999, among country pairs that already traded in 1970: total (blue), amounts in sectors in which the pair already traded in 1970 (orange), and amounts in new sectors for a pair (green).

the World Trade Flows Database and for the sake of comparison restrict the time-period from 1970-1999, the same one as in Helpman et al. (2008). Figure 1 shows the evolution of the aggregate real volume of exports of all 158 countries in our sample, and of the aggregate real volume of exports of the subset of country pairs that had positive exports in 1970. The difference between the two curves (plotted as line 3 in Figure 1) shows the volume of exports due to the emergence of trade between country pairs who did not export in 1970. As in Helpman et al. (2008), the graph suggests that the increase in the volume of trade over time can be mainly attributed to the expansion of trade between partners who were already trading in 1970.

Figure 2 examines the importance of trade along the extensive vs. intensive product margins. Line 1 reproduces the aggregate real volume of exports of the set of country pairs that had positive exports in 1970. Line 2 shows the evolution of trade volume between these country pairs in sectors where there was positive trade in 1970. We can think of this as the intensive margin of trade. The difference (plotted as line 3) shows the evolution of trade in sectors where there was zero trade at the beginning of the period within the set of countries that traded with each other in 1970. Line 3 captures the evolution of the extensive margin of trade. Figure 2 strongly suggests that from the 1980s onwards, trade in sectors that these countries already had positive trade in 1970 remains relatively flat. At the same time, the growth in the overall trade volume is closely mirrored by the expansion of trade in new products. In fact, more than half

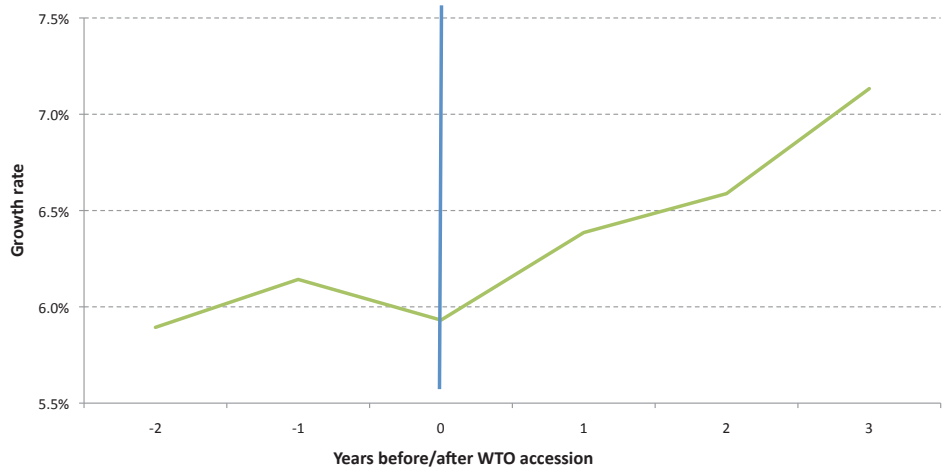

FIGURE 3. Growth of the extensive product margin around WTO accession of the exporter.

of trade increase is in goods that were not traded in 1970. This at least suggests, that the extensive margin of trade has been relatively a much more significant contributor to the expansion in trade volumes rather than the intensive margin.[4]

2.2. Event Study

To finish our description of the data, we present the evolution of the intensive and extensive margins of trade around WTO accession dates. Figure 3 shows the evolution of the extensive product margin around the time when the exporter enters WTO. The series are constructed from the bilateral trade data by first calculating how many products each exporter exports to their partners and then averaging the number of product categories across exporters. The figure shows the growth rate in the number of categories. In the two years before joining and in the year of accession categories are growing at a relatively constant rate of about 6% p.a. Once in WTO, the growth in categories accelerates for the next three years reaching over 7% growth in year $t + 3$. Thus preliminary evidence suggests that accession to WTO speeds up the process of diversification of country's exports. Section 5 offers a detailed statistical analysis to determine whether this pattern holds after controlling for a number of other determinants of trade flows and whether the acceleration is statistically significant.

4. The World Trade Flows Database has a significant discontinuity in 1984 where there was a change in the product classification system. This is responsible for the sharp increase around 1984 shown by the extensive margin (line 3) in Figure 2. The only way to correct for thisis to confine the sample period to 1984–1999. Between 1984 and 1999, trade expanded by trade $2.7 billion for countries that had strictly positive trade in 1984. Of this, 66% can be attributed to an increase in trade on the intensive margin (expansion in trade volume in the same products that traded in 1984) and 34% to the extensive margin (trade in new products).

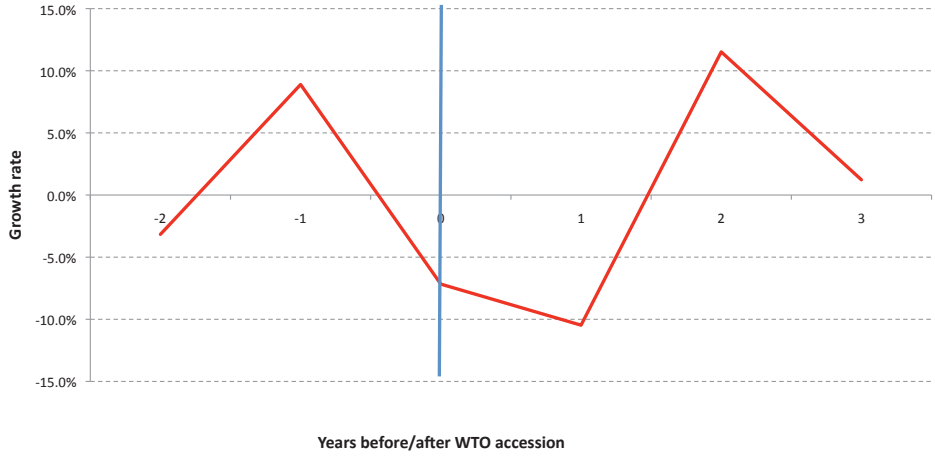

FIGURE 4. Growth of the intensive product margin around WTO accession of the exporter.

Figure 4 presents data for the intensive margin of trade. We start by calculating first the average volume of trade per category and then we average these volumes across all exporters. Interestingly, there is no clear pattern in the behavior of the intensive product margin. Average volumes per category increase one year before accession. Then there is a decline in the average value per category and then there is acceleration again. It seems that from this data we cannot establish any particular trend or pattern. But again, the dynamics of the intensive margin might be affected by other factors. To establish the role of WTO fro the product margins of trade we turn now to statistical analysis.

3. Extensive and Intensive Margins of Exports

We next create two measures of the intensive and extensive margins of exports. There are multiple ways to define the extensive margin of exports. These range from counting categories exported, to counting categories over a certain size, to weighting categories in various ways, etc. We construct measures that are close, albeit not identical, to the specification in Eaton and Kortum (2002). Indeed, their model, which we briefly outline in the Appendix, is used to construct the gravity equation for the extensive margin of trade. Trade volume reflects an extensive margin (number of sectors/goods traded) and an intensive one (volume of trade per product/sector). Therefore, our first measure of the bilateral extensive margin is simply a count of the number of products exported from country i to country j at time t. The bilateral intensive margin is defined as the exports per product. This permits a natural and easily interpretable decomposition of the overall volume of bilateral exports $X_{ni}(t)$ to destination n from exporter i at time t as

$$X_{ni}(t) = N_{ni}(t) * x_{ni}(t)$$

the product of the extensive ($N_{ni}(t)$) and the intensive margins ($x_{ni}(t)$). Since the gravity specification is always implemented in terms of the natural log of trade volumes, the sum of the logged margins will equal the log of the aggregate bilateral exports. Moreover, the sum of the estimated coefficients for the two margins of any independent variable will equal the coefficient on that variable in a standard gravity specification, with total bilateral exports as the dependent variable. In our dataset, the extensive margin in terms of number of products, is the highest between US and Canada, with the US exporting 4930 products to Canada in the year 1994. For this country-pair–year, we observe positive exports in 98% of all 5017 HS-6 product categories. We also observe that 70% of all bilateral exports is in less than 100 categories amongst all country pairs that exhibit strictly positive exports. However, once we take into account that 40% of all country pairs exhibit zero exports, we find that 90% of all bilateral exports is in less than 100 categories amongst all country pairs in the world. In terms of the intensive margin, we observe the highest intensive margins for oil exporters such as Angola, Iran, Iraq, Libya and Saudi Arabia.

Following Hummels and Klenow (2005), we construct an alternate measure of extensive and intensive margin of exports. Hummels and Klenow (2005) build on the methodology of Feenstra (1994) to investigate the extent to a country with a higher volume of exports does so because it exports a wider variety of goods (extensive margin) or because it exports larger quantities of each variety (intensive margin).[5]

We construct the extensive margin of exports from county i to county n (dropping the time subscript t) as

$$EM_{ni} = \frac{\sum_{j \in J^{ni}} X^j_{nW}}{\sum_{j \in J^{nW}} X^j_{nW}}, \tag{1}$$

where W denotes World, X^j_{nW} is the value of world exports of good j to country n, J^{ni} is the set of products where country i has strictly positive exports to country n and J^{nW} is the set of products exported by the World as a whole to n. Thus, this is a measure of the fraction of products in which country i exports to n, but it weights each product by its importance in world exports to n. Alternatively, it measures an individual exporter's market share in the importing country, had it sold the total amount imported of each good that it does sells there.

5. Feenstra (1994) and Feenstra and Kee (2004) provide microfoundations for the construction of these indices. These papers develop a methodology for measuring the impact of new varieties on productivity. It uses a constant elasticity of substitution (CES) specification that identifies the gains from variety by keeping track of only two factors: the elasticity of substitution among different varieties of a good and shifts in expenditure shares among new, remaining, and disappearing goods. The main intuition is that increasing the number of varieties does not increase productivity much if new varieties are close substitutes to existing varieties or if the share of new varieties is small relative to existing ones. Broda and Weinstein (2003) use this methodology as well and apply it to all U.S. imports. They find that increased import variety contributes to a 1.2% per year fall in the "true" import price index.

The intensive margin of exports for county i to n (once again dropping the time subscript t) is

$$IM_{ni} = \frac{\sum_{j \in J^{ni}} X_{ni}^{j}}{\sum_{j \in J^{ni}} X_{nW}^{j}}, \tag{2}$$

where X_{ni}^{j} is the value of exports from country i to country n of good j. The intensive margin equals i's nominal exports relative to W's nominal exports in those categories in which i exports to n (J^{ni}). Thus, it measures the overall market share country i has within the set of categories in which it exports to n.[6] Note that the product of the two Hummels–Klenow margins is

$$EM_{ni} * IM_{ni} = \frac{\sum_{j \in J^{ni}} X_{ni}^{j}}{\sum_{j \in J^{nW}} X_{nW}^{j}} = \frac{X_{ni}}{X_n},$$

where X_n is simply the total imports by country n. Therefore, the decomposition of bilateral trade between county pair i and n is given by

$$X_{ni}(t) = EM_{ni}(t) * IM_{ni}(t) * X_n(t).$$

This implies that adding the coefficients on the extensive and intensive margins will not yield the traditional gravity coefficients. This will be the case only when we include time-varying import country fixed effects which would then exactly capture the term $X_n(t)$. The Eaton and Kortum model assumes that each country n buys a good from exactly one source country i. This in turn implies that

$$X_{ni}^{j} = X_{nW}^{j} \quad \text{for } j \in J^{ni},$$

so that $IM_{ni} = 1$ in the model and the extensive margin is $EM_{ni} = X_{ni}/X_n$. There are two ways to reconcile this. Perhaps we simply lack data at extremely fine levels of disaggregation and if we have such data the assumption that each country buys a good from exactly one source country may well be true. An alternate explanation is that this assumption is not borne out in the data.

The correlation between the count measure and the Hummels–Klenow extensive margin measure equals 0.86 and correlation between exports per product measure and the Hummels–Klenow intensive margin measure equals 0.88. Both measures of extensive margins are highly skewed. For instance, in the year 2006 (the last year for which data are available), we have data on 27,900 country pairs that had strictly positive bilateral trade flows. In 31% of these country pairs, we observe exactly one product being exported, whereas in only 7% of the sample, the exporting

6. Hummels and Klenow (2005) calculate the two margins between country pairs relative to the rest of the world rather than to the world as a whole, as we do. We feel that the the two margins are more easily interpreted in terms of market shares if we use the world as a whole. Second, for a small subset of country pairs, the intensive margin may be negative. This would happen, for example, if a single country accounts for all exports to a destination country of the only product that is exported to it.

country exported more than 1000 products to at least one trading partner. Similarly $EM_{ni} < 0.05$, for 54% of the country pairs whereas only 10% of country pairs exhibit $EM_{ni} > 0.5$.

4. Independent variables

Market access. To capture market access and the ability to circumvent artificial trade barriers, we use three measures of preferential market access: multilateral, bilateral, and unilateral. Trade liberalization under GATT/WTO is on a Most Favored Nation basis, whereby trade concessions granted to one member should be available to all members. Therefore, multilateral market access, the main focus of our paper, is captured by a dummy variable which takes the value 1 if both trading partners are members of the GATT/WTO and 0 otherwise. Data on dates of accession to the GATT/WTO are from the WTO website. Our data covers the period 1988–2006 and we find that 91 countries were already GATT/WTO members by 1988. 52 additional countries joined the WTO during the time period of our study, whereas 45 countries remained outside the multilateral trading system up until 2006. This, in our view, provides sufficient variation in membership as well as changes in WTO membership over time.

Since the early days of GATT, there have been two major ways in which the non-discriminatory aspect has been violated. First, GATT permits exemptions to the MFN principle for regional or bilateral preferential trade arrangements that reduce local barriers to trade. Members in free trade areas and customs unions obtain privileged access to each others markets that do not have to be granted to non-members. Such bilateral preferential trade arrangements are captured by a dummy variable which takes the value 1 if both trading partners are members in a preferential trade arrangements (PTA). Data on PTAs are also from the WTO website. PTAs account for 3% of our sample and 1634 of the 24,261 country pairs were part of a PTA for at least one year of the sample. The second major exemption to the multilateral principle is the Generalized System of Preferences (GSP). This is a scheme of trade preferences granted on a non-reciprocal basis by developed countries to developing countries. It is a unilateral tariff preference which facilitate developing country access to markets of rich countries. We code a dummy variable as 1 if the importing county j grants a GSP to exporter j at time t.[7] GSP data are from Andrew Rose's website. 71 importing countries granted unilateral preferential access to at least one exporting country, whereas 124 exporters were beneficiaries under the GSP exception.

Gravity variables. We use traditional gravity variables—such as exporter and importer size, geographic distance, contiguity, colonial links, and linguistic

7. GSP resulted in a substantial increase in developing country exports. For empirical evidence, see Baldwin and Murray (1977), Romalis (2003), and Rose (2004).

TABLE 1. Summary statistics.

Variable	*No. of obsv.*	*Mean*	*Std. Dev.*
Extensive margin (log)	275841	3.21	2.34
Intensive margin (log)	275841	10.89	2.38
Hummels-Klenow extensive margin (log)	275841	-3.87	2.59
Hummels-Klenow intensive margin (log)	275841	-5.12	2.35
Both in GATT/WTO	558502	0.48	0.50
Preferential trading arrangement	558502	0.03	0.17
GSP	547799	0.06	0.24
GDP of exporter (log)	498189	23.48	2.34
GDP of importer (log)	510247	23.57	2.35
Distance	550948	8.72	0.80
Contiguity	550948	0.02	0.13
Common official language	550948	0.17	0.37
Common language spoken by at least 9% of population	550948	0.16	0.37
Colonial relationship	550948	0.01	0.12
Common colonizer	550948	0.11	0.32
Same country	550948	0.01	0.10
Common religion	558503	0.35	0.33

similarities—to capture factors that facilitate or impede trade. Exporter and importer size are measured as nominal GDP, data for which are from the World Development Indicators. As suggested by the gravity model, GDP is measured as the logarithm of GDP in current US dollars (Baldwin and Taglioni 2006). Geographic distance is measured as the logarithm of the distance (in kilometers) between the two most populous cities. Contiguity is a dummy variable that takes the value 1 if the country pair shares a common border. Linguistic similarity is captured using two variables: one is a dummy that equals one if the country pair shares a common official language; the other takes the value one if a common language is spoken by at least 9% of the population. Colonial links are measured using two variables, one that measures whether a country pair were ever in a colonial relationship (one country was the colonizer and the other colonized or vice versa) and one that captures the fact if a country pair had a common colonizer (for instance, Singapore and Malaysia). Our final measure of links between countries is a dummy that takes the value one if a country pair in the past had been part of the same country (example, Georgia and Russia). Data on these variables are obtained from the CEPII bilateral distance database (www.cepii.fr).

Table 1 presents the summary statistics for measures of extensive and intensive margins as well as for other variables used in this paper. When all independent

variables are included, our sample size has 228,465 country-pair–year observations covering 189 exporters and 167 importers over the period 1988–2006.

4.1. Empirical specification

We estimate gravity models for the extensive and intensive margins using OLS in all specifications save one. All our specifications include time dummies to capture global shifts in the patterns of world trade. We also add various combinations of country-fixed effects. In one specification we use separate set of dummies for exporters and importers while in another we employ pair-specific dummies. Using fixed effects in this manner also dramatically reduces the scope for omitted variables and mis-measurement that may plague our estimates: with country-specific dummies, the intercepts take out all variation that is time-invariant and country specific, while the country-pair dummies account for all variation that is time-invariant but specific to bilateral pairs.

In gravity model estimations, particular care has to be exercised in capturing the impact of the price indices, often addressed as multilateral trade resistance terms (Anderson and van Wincoop 2004; Baldwin and Taglioni 2006). The multilateral trade resistance terms reflect both the openness of the importing nation to all goods and the openness of the world to the exporter's goods (not simply the openness of a pair of exporter and importer). Trade between any pair of countries depends on their bilateral trade costs (including here transport and border costs) *relative* to average trade costs with all trade partners (measured by the multilateral trade resistance terms). As discussed at length in the literature (see Feenstra 2002; Baldwin 2006), the multilateral resistance term raise an important caveat for the role of bilateral trade costs on trade flows. If trade costs are reduced among a set of countries that already trade a lot with each other, multilateral trade resistance will drop a lot, and relative trade resistance will fall little. The drop in multilateral resistance of member countries reduces the impact of the reduction of bilateral trade costs on trade between any pair of countries. Hence, the omission of these multilateral trade resistance terms biases estimates of the trade costs toward zero.

Accounting for the multilateral trade resistance terms has proved challenging and various papers employ different fixes for the problem. A series of papers use country-specific fixed effects for exporting and importing country to control for the multilateral trade resistance terms (see Harrigan 1997; Rose and Wincoop 2001; Hummels 2007). Baldwin and Taglioni (2006) argue that time-invariant country-specific fixed effects may not suffice, since omitted terms reflect factors that vary every year, so the country dummies need to be time varying.[8] To account for this, we employ two additional

8. Feenstra (2002) argues that the fixed effects method provides consistent estimates of the average border effect across countries and recommends this as the preferred empirical method given the simplicity in its implementation. However, Frankel (2006) argues, that the trade diversionary role of the multilateral trade resistance indices may be overemphasized in the literature, and that adding a plethora of dummies

specifications. In one, we use time-varying, import country and export-country-specific fixed effects, and in the second, we estimate each of the margins year by year with exporter and importer specific country dummies. These are very demanding specifications with the country-dummies capturing the multilateral trade resistance terms. When we estimate the model year-by-year, rather than report each gravity estimate, we only show the coefficient and the standard error on the GATT/WTO and PTA variables (Table 5). This also allows us to compare the coefficients for the WTO and PTA dummy over time. This, in turn, allows us to infer whether the GATT/WTO and PTA effects are increasing, decreasing, or roughly constant over time.

Recent papers by Evenett and Venables (2002), Anderson and van Wincoop (2004), Haveman and Hummels (2004), and Helpman et al. (2008) all highlight the prevalence of zero bilateral trade flows. This is a potential concern for our estimates since the dataset from UNCTAD which we use to calculate the various margins reports only positive levels of trade. For the aggregate bilateral trade data over the period 1988–2006, 37% of all possible bilateral trade flows show a zero value. For these country pairs, the extensive margin is clearly equal to zero but taking log of the extensive margin automatically drops these observations. To examine whether this introduces a bias in our estimates, we employ two fixes. First, we estimate a censored Tobit model for the count measure, where the count measure is left-censored at 1. Second, we also follow Helpman et al. (2008) and estimate a Heckman selection model to account for the prevalence of zeros in the bilateral trade matrices.[9]

5. Results

The results from estimating gravity-specifications for the extensive and intensive margins of exports are reported in Tables 2 and 3, respectively. columns (1)–(3) in Table 2 use the product count as the measure of the extensive margin, while columns (4)–(6) use the Hummels–Klenow measure of the extensive margin. Similarly, columns (1)–(3) in Table 3 use the export per product as the measure of the intensive margin, whereas columns (4)–(6) use the Hummels–Klenow measure of the intensive margin. All specifications include time-dummies, which accounts for all common global trends. All standard errors are adjusted for clustering on country pairs.

In Table 2, for both the pooled and the estimates with country fixed effects, the signs are as expected—entering GATT/WTO leads to a statistically significant increase in the extensive margin. Moreover, the results are remarkably consistent regardless of the methodology used to construct the various margins of exports, count or Hummels–Klenow. To understand the magnitude of the effect consider the estimated coefficient on the GATT/WTO dummy in column (1). If both countries in

(for time- and country-specific fixed-effects) entails eliminating a lot of variation in the data, with a consequent, unwarranted loss in statistical significance.

9. We use the IMF's Direction of Trade Statistics Database to confirm that the total volume of exports between a pair of countries is indeed zero.

TABLE 2. Gravity specification for the extensive margin.

	(1) extensive margin (log)	(2) extensive margin (log)	(3) extensive margin (log)	(4) HK extensive margin (log)	(5) HK extensive margin (log)	(6) HK extensive margin (log)
Both in GATT/WTO	0.363***	0.269***	0.199***	0.323***	0.118***	0.098***
	(0.018)	(0.017)	(0.012)	(0.020)	(0.023)	(0.019)
Preferential trading arrangement	0.418***	-0.109***	-0.034**	0.007	-0.376***	-0.120***
	(0.029)	(0.027)	(0.017)	(0.032)	(0.034)	(0.020)
GSP	0.249***	0.331***	0.146***	0.368***	0.459***	0.014
	(0.027)	(0.025)	(0.038)	(0.028)	(0.033)	(0.060)
GDP of exporter	0.757***	0.159***	0.175***	0.737***	0.265***	0.289***
	(0.004)	(0.014)	(0.013)	(0.004)	(0.022)	(0.020)
GDP of importer	0.392***	0.307***	0.350***	0.313***	0.230***	0.270***
	(0.004)	(0.014)	(0.013)	(0.005)	(0.023)	(0.022)
Distance	-0.743***	-0.953***		-0.798***	-0.994***	
	(0.012)	(0.012)		(0.012)	(0.014)	
Contiguity	0.248***	0.307***		0.054	0.085	
	(0.071)	(0.077)		(0.077)	(0.085)	
Common official language	0.387***	0.428***		0.358***	0.403***	
	(0.042)	(0.035)		(0.048)	(0.044)	
Common language spoken by at least 9% of population	0.186***	0.108***		0.285***	0.094**	
	(0.040)	(0.035)		(0.046)	(0.045)	
Colonial relationship	0.825***	0.698***		0.622***	0.592***	
	(0.063)	(0.066)		(0.068)	(0.075)	
Common colonizer	0.423***	0.561***		0.557***	0.661***	
	(0.036)	(0.030)		(0.039)	(0.037)	
Same country	0.582***	0.483***		0.584***	0.502***	
	(0.106)	(0.106)		(0.111)	(0.114)	
Observations	228465	228465	228465	228465	228465	228465
R-squared	0.70	0.82	0.29	0.53	0.62	0.33
Joint significance test	2504.53***		716.92***	1455.47***		302.65***
Number of pairs	24261	24261	24261	24261	24261	24261
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	No	Yes	No	No	Yes	No
Pair effects	No	No	Yes	No	No	Yes

Standard errors, adjusted for clustering on country-pairs, are in parentheses.

*significant at 10%; **significant at 5%; ***significant at 1%.

Columns (1)–(3) use the number of products exported as measure of extensive margin; Columns (4)–(6) use the Hummels-Klenow measure of extensive margin. In all columns, we log the dependent variable. All columns include a constant (not shown).

a country pair are members of the WTO, then the coefficient of 0.363 implies that the WTO boosts the extensive margin of exports by 43%. Adding country-specific fixed effects in column (2), which accounts to some degree for the multilateral trade resistance terms, as well as time-invariant unmeasured country characteristics, reduces the magnitude of the effect to 31%. The corresponding magnitude of the effects, when we use the Hummels–Klenow measure of the extensive margin are 38% and 12.5% respectively in columns 4 and 5. In either case, the WTO exerts a significant influence on the extensive margin of trade. Columns 3 and 6 replaces the importer and exporter dummies with country-pair dummies (distinct dummies are used for exports from i to n and for exports from n to i) so that the coefficient estimates are within-estimates. The country-pair dummies also eliminate the time-invariant cross-section correlation

TABLE 3. Gravity specification for the intensive margin.

	(1)	(2)	(3)	(4)	(5)	(6)
	intensive margin (log)	intensive margin (log)	intensive margin (log)	HK intensive margin (log)	HK intensive margin (log)	HK intensive margin (log)
Both in GATT/WTO	-0.066***	-0.052**	-0.055***	-0.045**	0.067***	0.003
	(0.021)	(0.024)	(0.020)	(0.020)	(0.022)	(0.020)
Preferential trading arrangement	-0.096***	0.058**	0.202***	0.176***	0.316***	0.270***
	(0.030)	(0.029)	(0.024)	(0.030)	(0.028)	(0.024)
GSP	0.020	0.289***	0.086	-0.115***	0.159***	0.197**
	(0.036)	(0.038)	(0.088)	(0.035)	(0.036)	(0.094)
GDP of exporter	0.393***	0.250***	0.258***	0.426***	0.144***	0.144***
	(0.004)	(0.026)	(0.025)	(0.004)	(0.024)	(0.024)
GDP of importer	0.577***	0.476***	0.484***	-0.236***	-0.180***	-0.166***
	(0.005)	(0.026)	(0.025)	(0.005)	(0.026)	(0.025)
Distance	-0.407***	0.520***		-0.318***	-0.481***	
	(0.012)	(0.013)		(0.012)	(0.012)	
Contiguity	0.291***	0.058		0.692***	0.280***	
	(0.057)	(0.054)		(0.056)	(0.053)	
Common official language	-0.045	-0.013		0.122**	0.013	
	(0.048)	(0.046)		(0.049)	(0.045)	
Common language spoken by at least 9% of population	0.193***	0.076		0.041	0.089**	
	(0.047)	(0.047)		(0.048)	(0.045)	
Colonial relationship	0.292***	0.419***		0.440***	0.526***	
	(0.065)	(0.060)		(0.061)	(0.057)	
Common colonizer	0.612***	0.452***		0.391***	0.354***	
	(0.039)	(0.039)		(0.037)	(0.036)	
Same country	0.123	0.140*		0.248***	0.123	
	(0.081)	(0.077)		(0.080)	(0.077)	
Observations	228465	228465	228465	228465	228465	228465
R-squared	0.40	0.50	0.36	0.35	0.46	0.29
Joint significance test	1049.68***		65.98***	817.06***		227.60***
Number of pairs	24261	24261	24261	24261	24261	24261
Time effects	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	No	Yes	No	No	Yes	No
Pair effects	No	No	Yes	No	No	Yes

Standard errors, adjusted for clustering on country-pairs, are in parentheses.

*significant at 10%; **significant at 5%; ***significant at 1%.

Columns (1)–(3) use the export per product as the measure of intensive margin; Columns (4)–(6) use the Hummels-Klenow measure of intensive margin. In all columns, we log the dependent variable All columns include a constant (not shown).

between any omitted terms (including multilateral trade resistance terms) and the included variables. This reduces the estimated impact of the WTO (comparing column (3) to column (1) and column (6) to column (4)) suggesting that this cross-correlation is positive. We find that for both measures of the extensive margin, the coefficient on WTO membership is significant so that if both the exporting and importing country join the WTO, their extensive margin rises significantly. The magnitude of this effect is 22% for the count measure and 10.3% for the Hummels–Klenow measure. That is, starting from a scenario where neither or exactly one of a country pair are in the WTO, as both become members, the exporting country experiences a rise in its extensive margin of exports.

The estimated coefficients for bilateral PTAs in Table 2 suggest that country pairs who are members of a bilateral PTA also tend to be exhibit higher extensive margins. However, when we add country fixed effects, either importer and exporter specific as in column (2) or pair-specific as in column (3) then the sign on PTA becomes negative and significant. With the Hummels–Klenow measure of the extensive margin, we observe a similar effect - membership in PTAs reduces the extensive margin of trade significantly, once we add fixed effects, pairwise or country-specific. Similar to Rose (2004), who shows that the Generalized System of Preferences plays a strong role in trade flows, we find that across specifications GSP raises the extensive margin of trade. Therefore, market access granted by rich countries to poor countries is instrumental in raising their extensive margin of export, both over time and when compared to countries that lack such market access.[10]

Next, the traditional gravity variables have significant explanatory power for the extensive margin. Country size, whether that of the exporter or the importer, increases the extensive margin of exports in line with Melitz (2003). If we think of distance as capturing trading costs, then greater the distance between partners, greater is the threshold for exporting and lower are the extensive margin of exports. Countries that border each other exhibit higher extensive margin, as are countries with linguistic and colonial links. Finally, if a country pair were part of the same country, then these past ties tend to increase the extensive margin of exports. Overall, the traditional gravity variables affect the extensive margin of exports in much the same as it has been shown to affect bilateral trade flows.

Table 3 reports the gravity estimates for the intensive margin of exports. Here we find that membership in the WTO reduces the intensive margin of exports, when we measure the intensive margin as exports per product. This holds for all three dummy variable specifications - with only time dummies in column (1), with exporter and importer fixed effects in column (2) and with pair-fixed effects in column (3). With the Hummels–Klenow measure of the intensive margin, we fail to find consistent results. The coefficient on the WTO is negative and significant in column (4), which includes only time fixed effects, positive and significant in column (5) with country-fixed effects and insignificant with pair fixed-effects. These results seen in conjunction with the results for the extensive margin, do however imply, that the WTO is much more effective in raising the extensive margin of exports than the intensive margin. Unlike Rose (2004), we therefore obtain a strong role played by the WTO, but for the extensive margin only. In fact, the weak effect of the WTO that Rose shows for trade volumes may be explained by the fact that while the extensive margin of exports increases, the intensive margin declines, so that the impact of the WTO on their product is significantly weaker and the coefficient on WTO has an ambiguous sign in the Rose (2004) estimates. Our results on the importance of the WTO are especially relevant since the data shows that a significant expansion in world trade has

10. Collier and Venables (2007) show that various Sub-Saharan African countries have had large manufacturing export supply response to trade preferences following the African Growth and Opportunities Act which gives trade preferences to African countries in the US market.

come through the exports of new varieties rather than expansion in trade in existing varieties (see Figure 2).

In terms of PTAs we find that unlike the extensive margin, bilateral trading arrangements are very effective in raising the intensive margin of exports across specifications, once the specifications include either county fixed effects or country-pair fixed effects. This is true regardless of the measure of the intensive margins used (see columns (2), (3), (5), and (6) in Table 3). For GSP, we do find that in three out of the six specifications in Table 3, it increases the intensive margin of exports. In addition, the traditional gravity variables such as country-size, distance, linguistic and colonial links are all instrumental in influencing the intensive margin of exports.

Next, to assure us of the validity of our results, we compare our estimates of the traditional gravity variables with those in the literature. While these coefficients are not shown separately, they can be easily calculated by adding the corresponding coefficients for extensive and intensive margins, where we measure the margins in terms of the number of products exported and the export per product. For instance, if we add the coefficients on GDP of the exporter and importer from column (1) in Tables 2 and 3, then the coefficients equal 1.150 for exporter GDP and 0.969 for importer GDP. Both and importer are close to unity in line with the traditional gravity estimates of the total volume of trade, which does not use any country or country-pair fixed effects. The coefficient on distance, -1.15, is also close to unity in line with earlier estimates. Next, sum of the extensive and intensive margin coefficients on contiguity (common border) and common language in column (2) are indistinguishable from those in Eaton and Kortum (2002). We use column (2) since the Eaton and Kortum (2002) specification uses importer and exporter country fixed-effects. The coefficients on colonial ties are similar to the ones in Helpman et al. (2008). Finally, the decline in the coefficient in GDP once country dummies or country-pair dummies are added reflect a similar pattern reported by Rose (2004), Baier and Bergstrand (2007), and Dutt and Traça (2010).

5.1. Multilateral Trade Resistance

Table 4 presents results with the most demanding specification for the extensive and intensive margins. Here each specification includes a full set of time-varying exporter and importer specific fixed effects which should capture the multilateral trade-resistance terms. As before, columns 1 and 2 show that GATT/WTO membership increases the extensive margin, as measured by the number of products exported, while it has no effect on the intensive margin. In fact, once we add time-varying country fixed effects, the coefficient on GATT/WTO is very close to the one in the most basic specification—the pooled gravity estimates of column (1) which includes only time dummies. The coefficient implies that the extensive margin of exports for country pairs that are GATT/WTO members is 42% larger than that of country pairs where either one or both is a non-member. Columns 3 and 4 show that the results for the Hummels–Klenow measure of the extensive and intensive margins. As before, we find that the extensive margin is higher for country pairs who are WTO members,

TABLE 4. Results with time-varying country fixed effects.

	(1) extensive margin (log)	(2) intensive margin (log)	(3) HK extensive margin (log)	(4) HK intensive margin (log)
Both in GATT/WTO	0.350***	0.061	0.251***	0.160***
	(0.032)	(0.042)	(0.041)	(0.039)
Preferential trading arrangement	-0.043	0.078**	-0.345***	0.380***
	(0.030)	(0.031)	(0.037)	(0.031)
GSP	0.409***	0.297***	0.493***	0.213***
	(0.023)	(0.037)	(0.031)	(0.036)
Distance	-0.903***	-0.507***	-0.945***	-0.465***
	(0.011)	(0.012)	(0.013)	(0.011)
Contiguity	0.389***	0.080	0.167**	0.302***
	(0.072)	(0.053)	(0.081)	(0.053)
Common official language	0.395***	0.086**	0.407***	0.074*
	(0.034)	(0.043)	(0.041)	(0.042)
Common language spoken by at least 9% of population	0.151***	-0.004	0.121***	0.026
	(0.034)	(0.043)	(0.041)	(0.041)
Colonial relationship	0.673***	0.418***	0.577***	0.515***
	(0.061)	(0.060)	(0.071)	(0.058)
Common colonizer	0.512***	0.416***	0.596***	0.332***
	(0.028)	(0.037)	(0.035)	(0.034)
Same country	0.461***	0.111	0.476***	0.097
	(0.099)	(0.075)	(0.107)	(0.075)
Observations	264624	264624	264624	264624
Number of pairs	24261	24261	24261	24261
Joint significance test	1199.68***	512.22***	853.16***	405.42***
Time variant country fixed effects	Yes	Yes	Yes	Yes
R-squared	0.83	0.53	0.63	0.50

Standard errors, adjusted for clustering on country-pairs, are in parentheses.
*significant at 10%; **significant at 5%; ***significant at 1%.
In all columns, we log the dependent variable. All columns include a constant (not shown).

and their bilateral extensive margin of exports is 29% larger. In column (4), where we find that the WTO membership is also instrumental in increasing the Hummels–Klenow intensive margin of exports. This supports Melitz (2003) in whose model, a decline in variable trade costs, raises both the extensive margin (more firms export products) and the intensive margin (the market share of exporters). In terms of the other preferential trading arrangements, for PTAs, as before we see that PTAs reduce the extensive margin while positively influencing only the intensive margin of exports. GSP, meanwhile, helps raise both export margins.[11]

In Table 5, we estimate the extensive and intensive margins year-by-year, where every specification included a set of dummies for exporters and another for importers, as well as all pair-specific gravity variables shown in the earlier tables. This specification should also account fully for the multilateral trade resistance terms. Additionally, it gives us some insights into how the effects of WTO and PTAs have evolved over time. (See Carrère (2006) for a similar exposition). We present only

11. As mentioned earlier, in Table 4, the sum of the coefficients for any variable in columns (1) and (2) are exactly equal to the sum of the coefficients for the same variables in columns (3) and (4).

TABLE 5. Coefficient and standard error on WTO and PTA by year for extensive and intensive margins.

Year	Coefficient on WTO		Coefficient on WTO		Coefficient on PTA		Coefficient on PTA	
	Extensive Margin	*Intensive Margin*	*HK Extensive Margin*	*HK Intensive Margin*	*Extensive Margin*	*Intensive Margin*	*HK Extensive Margin*	*HK Intensive Margin*
1988	0.144	1.847	-1.316	3.307***	-0.309***	0.459**	-0.262	0.529***
1989	0.314	-0.211	-0.143	0.246	-0.484***	0.278**	-0.718***	0.530***
1990	0.512*	-0.605	0.253	-0.346	-0.533***	0.113	-0.87***	0.406***
1991	0.192	-0.329	-0.038	-0.099	-0.272**	0.380***	-0.685***	0.688***
1992	0.321***	-0.358**	0.234*	-0.271**	-0.196**	0.406***	-0.695***	0.706***
1993	0.226***	-0.052	0.202	-0.029	0.048	0.300***	-0.405***	0.582***
1994	0.581***	0.116	0.531***	0.167	-0.056	0.092	-0.490***	0.354***
1995	0.561***	0.180*	0.573***	0.169	-0.027	0.049	-0.450***	0.278***
1996	0.575***	0.017	0.471***	0.121	-0.055	0.060	-0.480***	0.292***
1997	0.489***	0.107	0.417***	0.179**	-0.104**	0.063	-0.490***	0.240***
1998	0.397***	-0.016	0.294***	0.087	-0.091*	0.139***	-0.521***	0.365***
1999	0.356***	0.116	0.318***	0.155*	-0.108**	0.164***	-0.515***	0.363***
2000	0.254***	-0.062	0.266***	-0.074	-0.022	0.041	-0.514***	0.378***
2001	0.364***	-0.045	0.231**	0.087	0.024	0.068	-0.384***	0.345***
2002	0.287***	-0.065	0.075	0.147	0.022	-0.020	-0.315***	0.174***
2003	0.240***	-0.139	0.099	0.002	0.047	0.050	-0.311***	0.294***
2004	0.303***	-0.116	0.110	0.077	-0.029	0.046	-0.354***	0.264***
2005	0.363***	0.140	0.243*	0.260*	-0.036	-0.018	-0.372***	0.225***
2006	0.354***	-0.195	0.293**	-0.134	-0.063**	-0.048	-0.351***	0.152***

Standard errors adjusted for clustering on country-pairs (not shown); * significant at 10%; ** significant at 5%; *** significant at 1%
Each regression includes all controls and country dummies (one set for exporters and one for importers) to account for Multilateral Trade Resistance Terms

the coefficient of the WTO dummy for sake of parsimony with asterisks to denote the level of significance. Our results attest to the powerful influence of WTO membership. For 17 out of the 19 years for which we carry out this estimation, common WTO membership within a country pair significantly boosts the extensive margin of exports. Given that the world trade rules were significantly revamped and the WTO officially commenced on January 1, 1995 replacing the General Agreement on Tariffs and Trade (GATT), we observe the magnitude of the effect of the WTO, as largest for the accession years 1994, 1995, and 1996.[12] By contrast, WTO membership increases the intensive margin significantly for only one year. Even here the effect is significant only at the 10% level. For a majority of the years, the intensive margin is not affected by WTO membership. The results with the Hummels–Klenow measure, shown in the next two columns, are very similar - the impact of WTO membership is mainly on the extensive margin with 11 years showing significant and positive impact of WTO membership. In contrast, WTO membership raises the Hummels–Klenow intensive margins in only 4 out of the 19 years and significantly reduces the intensive margin in the year 1992.

The next four columns in Table 5 show the effect of PTAs on the extensive and intensive margins for each of the years in our data. Here the results for the Hummels–Klenow measure are very striking. We see that country pairs who are part of a PTA have a significantly lower extensive margin but a significantly higher intensive margin. In many cases, the magnitude of the coefficient on PTA for the extensive margin is larger in absolute terms than the magnitude of the coefficient on PTA for the intensive margin. This reflects the fragility of estimated PTA effects previously noted in the literature (see Ghosh and Yamarik 2004; Frankel 1997; Frankel et al. 1995; Bergstrand 1985).[13]

5.2. Selection-Bias

A recent paper by Helpman et al. (2008) criticizes the traditional gravity model on the grounds that it includes only those observations where we see strictly positive bilateral trade flows. Helpman et al. (2008) argue that excluding these zeroes, when we take the log of the dependent variable, creates a sample selection bias which biases OLS estimates. In a recent paper, Silva and Tenreyro (2006) argue that log-linearization of the gravity model is not only incompatible with zero trade flows between countries but also yields inconsistent estimates in the presence of heteroskedasticity. They suggest a Poisson pseudo-maximum likelihood (PPML) method. Martin and Pham (2008) use Monte-Carlo simulations to show that while the PPML method deals satisfactorily with the heteroskedasticity issue, it yields severely biased estimates when zero trade values are frequent. In their simulations, Heckman Maximum Likelihood estimators

12. This shift from GATT to WTO saw many countries acceding to the newly formed WTO. However, the WTO website notes their accession dates as 1994. Therefore, we find a string effect for 1994 as well.

13. Baier and Bergstrand (2009) argue that once we recognize the potential endogeneity of PTAs, the effect of PTAs on trade flows quintuples. However, finding good instruments is a non-trivial task.

TABLE 6. Estimates for intensive and extensive margins, corrected for selection effects.

	(1)	(2)	(3)	(4)
	Censored Tobit	Selection equation	extensive margin (log)	intensive margin (log)
Both in GATT/WTO	0.646***	0.063***	0.275***	-0.051***
	(0.020)	(0.012)	(0.009)	(0.015)
Preferential trading arrangement	0.264***	0.410***	-0.155***	0.051***
	(0.038)	(0.039)	(0.011)	(0.017)
GSP	0.540***	0.749***	0.354***	0.293***
	(0.031)	(0.026)	(0.010)	(0.016)
GDP of exporter	0.897***	0.167***	0.165***	0.251***
	(0.004)	(0.015)	(0.010)	(0.017)
GDP of importer	0.629***	0.150***	0.327***	0.479***
	(0.005)	(0.017)	(0.013)	(0.022)
Distance	-0.955***	-0.675***	-0.977***	-0.523***
	(0.014)	(0.006)	(0.004)	(0.006)
Contiguity	0.066	0.125***	0.300***	0.057**
	(0.095)	(0.039)	(0.015)	(0.025)
Common official language	0.526***	0.328***	0.447***	-0.011
	(0.051)	(0.017)	(0.012)	(0.019)
Common language spoken by at least 9% of population	0.150***	0.004	0.110***	0.076***
	(0.051)	(0.017)	(0.012)	(0.019)
Colonial relationship	0.814***	-0.100	0.693***	0.419***
	(0.083)	(0.070)	(0.017)	(0.028)
Common colonizer	0.471***	0.341***	0.573***	0.454***
	(0.041)	(0.013)	(0.010)	(0.016)
Same country	0.922***	0.297***	0.509***	0.144***
	(0.131)	(0.050)	(0.022)	(0.035)
Common religion		0.105***		
		(0.014)		
Observations	364923		364923	364923
Country pairs	28048		28048	28048
Uncensored observations	228465		228465	228465
Joint significance test	3309.65***		643535***	168127***
Time effects	Yes	Yes	Yes	Yes
Country effects	No	Yes	Yes	Yes

Standard errors adjusted for clustering on country-pairs in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%.;
Column 1 presents Tobit estimates; Column 2 presents estimates of the selection equation and uses the common religion variable as the exclusion restriction;
Columns 3 and 4 present Heckman corrected estimates for the extensive and intensive margins. All columns include a constant (not shown).

appear to perform well provided true identifying restrictions are available. The models in Melitz (2003) and Helpman et al. (2008) suggests that trade barriers that affect fixed costs of exporting but do not affect variable trade costs are valid exclusion restrictions and should affect only the probability of trade. The two variables that they use as exclusion restrictions are a common religion index and the fixed cost of starting a firm. Since data on the latter are available only from 2004 onwards, we use only the common religion index as the sole exclusion restriction. Our common religion index for a country pair (o, d) at time t is constructed as

$$\sum \left(\text{proportion of religion}_{ot}^{k}\right) * \left(\text{proportion of religion}_{dt}^{k}\right),$$

where k is an index for a particular religion.[14]

14. The set of religions we use are more comprehensive than that of Helpman et al. (2008). These include Bahais, Buddhist, Chinese Universist, Christianity, Confucian, Ethnoreligionist, Hinduism, Jainism, Judaism, Islam, Shinto, Sikhism, Taoists and Zoroastrian. The data are from Association of Religion Data Archives.

Before performing the Heckman correction, column (1) in Table 6 presents the censored Tobit estimates with time fixed effects. It shows that the positive effect of the WTO on the extensive margin is robust to accounting for the zero-trade flows phenomenon within the Tobit specification. The number of observations here rises to 364,923 which covers 189 exporters and 184 importers. The censored Tobit estimates imply that the marginal effect of WTO membership is to raise the extensive margin by 35.5% which is close to the estimates in Table 2. In other words, the Tobit censored specification yields magnitudes which are very similar to the uncorrected specification in Table 2.

The rest of the columns in Table 6 presents the results for both the probability of trade (selection equation) and the Heckman-corrected extensive and intensive margins. Column (2) shows the estimates for the selection equation, while columns (3)–(6) show the estimates for the extensive and intensive margins. All columns include exporter and importer dummies. The common religion index is the sole exclusion restriction and we see that the common religion index significantly affects the probability of trade in column (2). Not surprisingly, column (2) also shows that, the probability of trade is positively affected by all forms of trading preferences, unilateral (GSP), bilateral (PTAs) and multilateral (WTO). Next, columns 3 and 4 show that the coefficients on our variables of interest (WTO, PTA and GSP) are similar, in terms of sign, significance and magnitude, to our previous estimates, from using the traditional gravity model (column (2) in Tables 2 and 3). The inverse Mills ratio (not reported) is significant at the 1%, so that the hypothesis of independence of the selection and regression equations is easily rejected.

In sum, our results show that the impact of the WTO is mainly along the extensive margin, that PTAs increase the intensive margin of exports while reducing the extensive margin, and GSP has a positive impact on both margins. Moreover, the results obtained in the previous sub-sections are robust to controlling for selection bias.

5.3. Robustness

One of the drawbacks of the decomposition of bilateral exports into the number of products exported and exports per product is that the latter, the intensive margin measure, may decline in a mechanical fashion. This would happen, for example, whenever a country exports a new product, but the export value of the new product is small compared to the value of the previously exported products. This may bias the estimate of the WTO for the intensive margin to be negative. To account for this, we calculate the export per product while holding the set of goods constant, both before and after WTO accession. In Table 7, we present results with the adjusted intensive margin, where the export per product is calculated on the basis of only those products exported over a three-year window before and after the accession date. Each column, except the last, corresponds to one particular year of accession, while the last column pools the data. All columns include exporter and importer fixed-effects. With these adjusted measure of intensive margins, we again see that WTO membership does

TABLE 7. Estimates for corrected intensive margins

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Pooled
	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin	Adjusted intensive margin
Both in GATT/WTO	-0.078	0.108	0.041	-0.028	-0.065	-0.031	-0.107*	-0.048	-0.125	-0.094	-0.260**	-0.084	-0.040
	(0.078)	(0.128)	(0.089)	(0.083)	(0.087)	(0.076)	(0.062)	(0.069)	(0.112)	(0.088)	(0.102)	(0.104)	(0.031)
Free trade area	0.364***	0.236***	0.190***	0.170***	0.183***	0.258***	0.188***	0.131***	0.072	0.065	0.109***	0.087**	0.133***
	(0.068)	(0.056)	(0.059)	(0.055)	(0.053)	(0.054)	(0.049)	(0.048)	(0.047)	(0.044)	(0.042)	(0.043)	(0.033)
GSP	0.352***	0.304***	0.275***	0.234***	0.207***	0.237***	0.175***	0.164***	0.138**	0.156***	0.139**	0.121**	0.200***
	(0.070)	(0.061)	(0.058)	(0.059)	(0.056)	(0.059)	(0.057)	(0.056)	(0.058)	(0.059)	(0.059)	(0.061)	(0.044)
GDP of exporter	0.078	0.022	0.383***	0.172**	0.054	0.234***	0.415***	0.168*	-0.104**	0.274***	0.755***	0.552***	0.145***
	(0.066)	(0.081)	(0.114)	(0.087)	(0.051)	(0.074)	(0.074)	(0.091)	(0.047)	(0.049)	(0.097)	(0.094)	(0.031)
GDP of importer	0.571***	0.533***	0.169	0.422***	0.522***	0.508***	0.300***	0.872***	0.694***	0.788***	1.163***	0.948***	0.410***
	(0.094)	(0.091)	(0.143)	(0.094)	(0.059)	(0.078)	(0.084)	(0.104)	(0.067)	(0.072)	(0.107)	(0.099)	(0.031)
Distance	-0.352***	-0.327***	-0.341***	-0.321***	-0.353***	-0.361***	-0.391***	-0.443***	-0.480***	-0.495***	-0.510***	-0.558***	-0.429***
	(0.029)	(0.024)	(0.023)	(0.021)	(0.021)	(0.021)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)	(0.015)
Observations	13609	17767	20388	23426	24844	25776	27917	29939	30518	31300	31120	29921	306525
R-squared	0.50	0.51	0.50	0.49	0.49	0.48	0.49	0.49	0.49	0.49	0.50	0.50	0.48

Standard errors adjusted for clustering on country-pair; * significant at 10%; ** significant at 5%; *** significant at 1%
Each columns use the adjusted export per product as the measure of adjusted intensive margin as the dependent variable (in logs); The export per product is calculated over a three-year window before and after the accession date; Each column except the last corresponds to one particular year of accession; The last column pools the data
All columns include a constant, all other gravity variables from Table 2, country-specific fixed effects and time fixed-effects (not shown).

not exercise a positive and significant influence. Further, as with the non-adjusted intensive margins, PTAs and GSP positively affect the adjusted intensive margins.

Second, we evaluated whether the effect of the WTO was mainly due to multiple countries joining around the year of the switch from GATT to WTO. We did this by confining our sample to exporters who joined prior to 1993 or after 1996. Again, we find that the extensive margin is positively influenced by WTO membership. Similarly, when we confine our sample to importers who joined prior to 1994 or after 1996, the extensive margin of exports continues to be positively influenced by WTO membership. We also allowed the sample to vary across various GATT/WTO rounds. If we split the sample into pre-Uruguay round vs. post-Uruguay round, none of our results are qualitatively affected. As a final sub-sample check, we dropped all the original members of GATT who signed the original GATT agreement in 1948. Again, this does not alter our conclusions regarding the importance of WTO membership for the extensive margin. Third, we reran all specifications with a second dummy variable that takes the value 1, if exactly one country in a country pair is a member of the WTO. Similar to Rose (2004), in a majority of the specifications this coefficient on this variable is not statistically significant. In a small subset of the specifications, it negatively affects the extensive and intensive margin of exports. Fourth, we followed Tomz et al. (2007) and reclassified de facto members outside the WTO also as WTO members. This does not alter our conclusions either. Finally, we think that reverse causality is less likely to be an issue. While countries may join the WTO in order to participate in world markets and perhaps, increase exports, this is likely to be an overall policy goal. Bilateral exports and margins of exports are less likely to be impacted.

6. Conclusion

Rose (2004) highlights the WTO puzzle - that the biggest changes in international trade rules have failed to have an impact on the volume of trade between pairs of countries. Our paper decomposes the volume of trade into the extensive and intensive margin and shows that WTO membership has been instrumental in raising the extensive margin of trade while its impact on the intensive margin is insignificant and even negative in a few cases. Our results hold across an array of permutations - accounting for the multilateral trade resistance terms, for the prevalence of zeros in trade flows, alternate definitions of WTO membership, for various sub-samples and time periods, and making adjustments to the intensive margin. We also find that PTAs have little or no impact on the extensive margin, and that they operate almost exclusively on the intensive margin of trade. Unilateral preferences granted via the GSP raises both margins of trade. Finally, our decomposition of trade volumes into the extensive and intensive margins also allows us to see how market size, distance, and other traditional gravity variables impact each of the two margins.

While our empirical results (with respect to the WTO) on the extensive margin are in line with the two broad classes of models (Eaton and Kortum 2002; Melitz 2003),

the negligible impact on the intensive margin is at odds with the predictions of Melitz (2003). In that model, as trade barriers go down, exporters reduce prices, capturing a larger market share and increase exports (the intensive margin). At the same time, more firms now find it profitable to export and enter the export market (the extensive margin). Therefore, trade liberalization via the WTO, should raise trade volumes by increasing both margins of trade, a conclusion which is not supported by our results. By contrast, in the Eaton and Kortum (2002) model, the entire adjustment is along the extensive margin, which is more in line with our findings. A third, and perhaps intriguing possibility is that the WTO is not at all about reducing trade barriers, variable or fixed. Rather it serves to resolve uncertainty in the mind of potential exporters regarding the evolution of international trade rules and they respond by exporting newer products into newer markets. As far as we know, none of the standard models in the new-new trade literature explicitly model uncertainty, and this has the potential to be a promising area of future research.

Appendix: A Brief Exposition of Eaton–Kortum

To understand the driving forces behind the movements in the extensive and intensive margins of trade, we analyze the model of Eaton and Kortum (2002), who derive an aggregate gravity equation across heterogeneous Ricardian sectors. The model is a multi-country multi-product model with differences in technologies across countries and differences in trade costs across possible bilateral trade relationships. The model is based on perfect competition and no differentiation of products according to country of origin. In its representation of the gravity relationship, the model resembles the standard gravity model based on monopolistic competition and on the Armington (1969) assumption that products are differentiated by country of origin. However, the underlying forces of gravity in the two models differ. In the Armington model, the set of goods in which each country specializes remains constant and hence a decrease in trade costs increases trade flows only at the intensive margin. In Eaton and Kortum (2002), a fall in trade costs would also lead to an increase in the range of goods that each country exports, that is, to an increase in trade at the extensive margin.

The model is analyzed extensively in Eaton and Kortum (2002); we replicate only key features here to provide the theoretical background for our empirical analysis.

There is a continuum [0, 1] of differentiated goods, indexed by j, and N countries, indexed by i and n. Production uses a single input and has constant returns to scale. The cost of the input in country i is c_i and country i requires $1/z_i(j)$ units of the input to produce one unit of good j. Thus, country i's cost of production of good j is $c_i/z_i(j)$.

Geographic barriers are modeled as "iceberg" costs: to deliver a unit from country i to country n requires producing $d_{ni} > 1$ units of the good in country i. Under perfect competition, the price of good j produced in country i and delivered to country j is

therefore its total cost

$$p_{ni}(j) = \left(\frac{c_i}{z_i(j)}\right) d_{ni}. \tag{A.1}$$

The importer, country n, selects to import from the country that offers good j at the lowest price. Imports of each good are determined by maximization of a CES utility function:

$$U = \left[\int_0^1 Q(j)^{(\sigma-1)/\sigma} dj\right]^{\sigma/(\sigma-1)}, \tag{A.2}$$

with the appropriate budget constraint.

The technological efficiency parameters $z_i(j)$ are generated by i.i.d. draws within a country according to a country-specific Type-II extreme value distribution (Fréchet distribution):

$$F_i(z) = e^{-T_i z^{-\theta}} \tag{A.3}$$

The scale parameter T_i is country-specific and can be interpret as the degree of absolute advantage that a country has. (Compared to a standard distribution $F(z) = ^{-z^{-\theta}}$, each efficiency parameter is multiplied by $T_i^{1/\theta}$.) The parameter θ is the same for all countries and it governs the dispersion of efficiencies with which each good is produced. A large value of θ implies low variability.

Given the distributional assumptions about efficiencies and the price definitions, we can derive the distribution of prices in country n keeping in mind that the country buys good j from the cheapest provider. After some manipulation the distribution of prices is shown to be

$$G_n(z) = 1 - e^{-\Phi_n p^{-\theta}}, \tag{A.4}$$

where

$$\Phi_n = \sum_{i=1}^{N} T_i (c_i d_{ni})^{-\theta}. \tag{A.5}$$

This parameter can be interpreted as a measure of the state of world technology.

A key property of this price distribution is that the probability that country i exports any particular good to country n is the

$$\pi_{ni} = \frac{T_i (c_i d_{ni})^{-\theta}}{\Phi_n} \tag{A.6}$$

of technology (T_i), input costs (c_i), geographical and trade costs (d_{ni}), a price parameter for country n (Φ_n) that reflects technology from around the world discounted by costs, and finally the parameter that governs the dispersion of efficiencies across countries (θ). With a continuum of goods, this probability also measures the fraction of goods that country n buys from country i.

Using the properties of the price distribution, Eaton and Kortum also show that the fraction of goods that country n buys from i (π_{ni}) is the fraction of expenditure on

goods from country i:

$$\frac{X_{ni}}{X_n} = \frac{T_i(c_i d_{ni})^{-\theta}}{\Phi_n} = \frac{T_i(c_i d_{ni})^{-\theta}}{\sum_{k=1}^{N} T_k(c_k d_{nk})^{-\theta}}$$

We denote the total sales of exporter i as Q_i obtain the following gravity equation:

$$X_{ni} = \frac{(d_{ni}/p_n)^{-\theta} X_n}{\sum_{m=1}^{N}(d_{mi}/p_m)^{-\theta} X_m} Q_i \tag{A.7}$$

As trade costs between n and i go down, the expenditure of n on i's goods increases. Going back to the key equation defining the probability π_{ni}, we see that the increase in trade is due to the fact that i will start exporting more goods, i.e. the adjustment is via the extensive margin. This finding is in contrast with the standard gravity equation, where there is no adjustment on the extensive margin.

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