What Determines Bilateral Trade Flows?

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Abstract

This paper undertakes an exhaustive search for robust determinants of international trade, where "robustness" is tested using three popular empirical methods. The paper is frankly atheoretical: our goal is solely to establish statistically robust relationships. Along the way, however, we relate our results to the empirical results obtained by prior researchers and to the received theory of international trade. We find that robust variables include a measure of the scale of factor endowments; fixed exchange rates; the level of development; and current account restrictions. Variables that are robust under certain methods and sample periods include exchange rate volatility, an index of sectoral similarity, and currency union. However, the estimated coefficient on currency union is much smaller than estimates obtained by prior researchers.

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1 Introduction

This investigation undertakes an exhaustive search for robust determinants of international trade, where "robustness" is tested using three popular empirical methods. The paper is frankly atheoretical: our goal is solely to establish statistically robust relationships. Along the way, we relate our results to the empirical results obtained by prior researchers and to the received theories of international trade. However, we stop well short of testing any particular theory of international trade.

Our dataset includes 92 countries. We collected data on 24 variables that measure a wide range of economic, geographic, and policy environments. Our data span six five-year intervals from 1970 to 1995. Our list of potential trade determinants includes the following: the standard gravity variables (distance, common language, common border, etc.), endowments of the factors of production, including land, labor, and capital; the level of economic development; various measures of barriers to trade; exchange rate volatility; currency union; and similarity of industrial structure. We follow prior research in the measurement of variables insofar as this is possible.

We consider three methods for testing the robustness of the relationship between bilateral trade and the candidate explanatory variables listed above. First, we employ the method proposed by Leamer (1983, 1985). Second, we employ the method subsequently proposed by Sala-i-Martin (1997). Third and finally, we use an approach recently suggested by Hendry (1995). We compare the results obtained with these different approaches to measuring robustness. We find that the Sala-i-Martin and Hendry approaches are more 'permissive' than the Leamer method, in the sense that variables found *not* to be robust under the Leamer approach *can* be robust with the Sala-i-Martin and Hendry approaches. There is no clear ordering between the Sala-i-Martin and Hendry methods in the sense that variables that are not robust under one approach can be robust with the other.[1]

The paper is structured as follows. Section 2 describes our data sources and the

[1] Hoover and Perez (2004) find, in their study of the determinants of long-term growth, that the Leamer approach is the least permissive, while the Sala-i-Martin approach is the most permissive. They show, through Monte-Carlo experiments, that the Leamer approach tends to reject variables that are in the true model, while the Sala-i-Martin approach tends to include variables that are not in the true model. This reflects size and power distortions associated with these approaches. The Hendry approach is shown to have near normal size and power, which implies that it includes variables that are in the true model and rejects those that are not.

construction of each of the variables that will be considered as a potential determinant of bilateral trade. Section 3 provides a detailed description of each of the three empirical methods for determining robustness. Section 4 begins the presentation of our empirical results with analysis of benchmark econometric models. Specifically, this section presents regressions of trade on gravity variables alone in order to provide a point of comparison for econometric models that include additional regressors. This section also provides benchmark regressions of bilateral trade on each potential explanatory variable, one variable at a time. These benchmark regressions are repeated with the set of gravity variables included, in addition to the single additional explanatory variable.

Section 5 is the heart of the paper, containing the robustness tests for each potential determinant of trade. The results are presented in groups by variable. For each variable (or group of variables), we present the results and compare our results to those obtained in the prior literature. We offer possible interpretations of the results in light of received theories of international trade. Section 6 concludes with a brief summary of our results.

2 Data and Measurement

This section describes the measurement and construction of variables used in this study. The measure of bilateral trade between countries i and j in period t, T_{ijt}, is defined as follows:

$$T_{ijt} = \ln(X_{ijt} + X_{jit})$$

where X_{ijt} denotes exports from country i to country j in period t.[2] The variables that may explain bilateral trade fall naturally into several distinct groups, as described below.

[2]This specification is motivated by the standard gravity model of bilateral trade and for that reason is typically the focus of studies of the determinants of trade (see the survey by Rose (2004)).

2.1 Gravity variables

The so-called "gravity variables" have been the primary focus of empirical studies of international trade for over 50 years.[3] The gravity variables are included in every 'robustness' regression that we run. The reason for the universal inclusion of the gravity variables is that we wish to determine which variables, in addition to the gravity variables, can explain bilateral trade. Our gravity variables consist of the following group:

2.1.1 Distance

The greater is the distance between two countries, the higher are the costs associated with transporting goods, thereby reducing the gains from trade and reducing trade itself. We use Glick and Rose's (2002) estimate of the log of the distance between two countries.

2.1.2 Common border

Many researchers have shown that the influence of distance on trade is non-linear, with trade between bordering countries being significantly greater than countries that are positioned at similar distances, but do not share a border. We use Glick and Rose's (2002) indicator variable of common borders, which takes the value 1 if a country pair shares a border and zero otherwise.

2.1.3 Cultural distance

Measures of 'cultural distance' have also been considered as determinants of international trade (see, for example, Glick and Rose (2002)). The most commonly used measure of 'cultural distance' is an indicator of common language, which takes the value 1 if the country pair shares the same language and zero otherwise.

2.1.4 Colonial ties

In recent work, Glick and Rose (2002) investigate the importance of colonial ties for international trade. They provide two measures of this variable. The first measure

[3] See Anderson and van Wincoop (2003) for a recent contribution in this area and a comprehensive list of references.

is an indicator variable equal to 1 if the country pair includes a colonizer and one of its current or past colonies, and is zero otherwise. The second variable is also an indicator variable, set equal to 1 for country pairs that had the same colonizer.

2.1.5 Economic scale

Empirical gravity models have shown that measures of economic scale are important determinants of bilateral trade. We follow much of the empirical literature by including the log of the product of the two countries' levels of GDP as a scale variable in the group of gravity variables. The inclusion of population is also widespread in the empirical trade determinants literature. In many cases, it is included indirectly through the natural logarithm of the product of countries' per capita levels of GDP. We therefore include per capita GDP as an additional measure of economic scale.

2.2 Factor Endowments

A country's factor endowments are thought to be important determinants of the country's pattern of trade. The longstanding belief in the importance of factor endowments is a consequence of the widespread acceptance of the Heckscher-Ohlin model of international trade. Specifically, the Heckscher-Ohlin theory predicts that country pairs should trade more, the more different are their factor endowments.

There is a voluminous literature that bears on the importance of factor endowments for international trade, and we will mentioned only a few contributions to this literature in order to motivate the inclusion of the factor endowment variables in our investigation. Early empirical investigations based on the Heckscher-Ohlin theory were quite negative; the classic paper is by Bowen, Leamer, Sveikauskas (1987). More recently, Frankel, Stein and Wei (1995, Table 4), in their study of regional trading blocks, find weak to no support for the Heckscher-Ohlin hypothesis. Frankel, Stein and Wei include, along with other variables differences in capital-labor ratios, educational attainment and land-labor ratios in a standard gravity equation. They find that the coefficients on these variables are positive as predicted by the theory but are not statistically significant. In contrast, a recent study by Ghosh and Yamarik (2005) finds that differences in per capita land are positively related to bilateral trade flows and are robust to the inclusion of other variables in their dataset, while differences in educational attainment and capital-labor ratios are significant in their

base regressions, but fragile to the inclusion of indicators of stage of development. Recent papers by Debaere (2003) and Romalis (2004) also find strong empirical support for Rybczynski and Heckscher-Ohlin predictions on factor abundance and factor content.

We measure the endowments of three factors of production: human capital, physical capital, and land. The details of the measurement of these variables is summarized below.

2.2.1 Human capital

We use a measure of human capital as our measure of labor input. Human capital is measured using the Barro-Lee (1996, 1997) data on average years of schooling in the population over age 15. We construct two measures of human capital in a bilateral setting. The first is the log of the product of education in the two countries, where F_{it} stands for the factor endowment in country i in period t:

$$\text{Factor Intensity Measure 1: } \ln(F_{it} * F_{jt}) \tag{1}$$

This variable has not been used in prior studies of the determinants of bilateral trade. We included it in our investigation because we viewed it as an indicator of the 'scale' of human capital in the two countries, similar to the way that the product of GDP measures is a scale variable in the standard gravity equation. Obviously, this measure is higher the higher is human capital in either of the two countries. But another interesting aspect of this measure is that it is higher the more equal are the levels of human capital in the two countries, holding fixed the aggregate amount of human capital in the country pair.

Our second measure of human capital is more commonly used, and is given by the log of the ratio of the highest to the lowest levels of education in the two countries:

$$\text{Factor Intensity Measure 2: } \ln[\max(F_{it}, F_{jt}) / \min(F_{it}, F_{jt})] \tag{2}$$

This indicator has been used in a number of empirical trade studies, including those discussed earlier.

2.2.2 Physical capital

In parallel with our measure of human capital, we construct two measures of a country's endowment of physical capital per worker, using data from Easterly and Levine

(2001). The first measure is the log of the product of physical capital per worker in the two countries; the second is the absolute value of the log of the ratio.

2.2.3 Land

Our measure of land is arable land per capita, since we feel that arable land is more closely related to a country's productive capacity than is total land. We construct two measures of bilateral land variables, in parallel with the measures for human and physical capital described above.

2.3 Stage of development

The levels of development within the two countries that comprise a country pair may affect trade within the country pair. Following IMF classifications reported in the World Economic Outlook (2000) we split countries into two groups, "developed countries" and "developing countries". We then construct an indicator variable that takes on the value 1 if both countries are from the same group, and zero otherwise.[4]

Theory alone is not definite on the sign of the relationship between this variable and the extent of bilateral trade. On the one hand, the "New View" of international trade developed by Helpman and Krugman (1985) stressed the large and growing trade between developed countries, with the bulk of this trade occurring in goods produced under monopolistic competition. On the other hand, Ricardian and Heckscher-Ohlin-Samuelson models would predict more trade between countries that are different from one another.

Frankel, Stein and Wei (1995), Thursby and Thursby (1987) and Yamarik and Ghosh (2005) measure relative development as differences in log real per capita GDP. Yamarik and Ghosh use two additional measures. The first is differences in the share of manufacturing in total GDP, the idea being that more developed countries should have larger manufacturing shares. The second is differences in the share of manufacturing in total merchandise trade. We approach the measurement of industrial structure more directly by constructing an index of industrial similarity (defined below) first suggested by Shea (1996).

[4] Because of constraints imposed by the inclusion of the country fixed effects, we cannot separately identify (i) a coefficient for a pair of two developed countries and (ii) a coefficient for a pair of developing countries.

Frankel, Stein and Wei (1995), Thursby and Thursby (1987) and Yamarik and Ghosh (2005) find that differences in per capital GDP enter the gravity model with a negative sign. All 3 measures used by Yamarik and Ghosh had estimated coefficients whose significance levels were sensitive to the inclusion of other variables. No clear conclusion could therefore be drawn.

The absolute level of development in a country pair is typically measured as the log of the product of per capita GDPs. Although the size of its coefficient estimates vary across studies, this measure of absolute development positively, and statistically significantly related to explaining bilateral trade. The Yamarik and Ghosh (2005) analysis includes the average share of manufacturing in GDP and average share of manufacturing in merchandise exports. They find that both variables are robust, each with a positive sign.

With the exception of Klein and Shambaugh (2004), we did not find studies that look at discrete indicators of the stage of development. Klein and Shambaugh run separate regressions for industrial-industrial, industrial-developing, and developing-developing pairs. There is some variation in coefficient estimates across these bilateral pairs, but no clear pattern of results emerges from their study.

2.4 Industrial similarity

We explore the importance of the stage of development on bilateral trade from another angle by comparing the industrial structure of bilateral trading partners. We use the following measure of industrial similarity suggested by Shea (1996):

$$ISI_{ij} = \frac{\sum_{i=n}^{N} s_{in} s_{jn}}{\sqrt{\sum_{i=n}^{N} s_{in}^2} \sqrt{\sum_{i=n}^{N} s_{jn}^2}} \tag{3}$$

where s_{in} is industry n's share of country i's GDP. This indicator takes on values between 0 and 1. If a bilateral pair have the same sectoral structure this indicator is 1. The indicator takes on the value zero if both countries are specialized in production, i.e., $s_{in} = 0$ whenever $s_{jn} > 0$.

2.5 Impediments to flows of goods and capital

There are a wide range of explicit trade barriers used by the countries in our dataset. They can be roughly broken down into two groups. The first group measures barriers to flows of goods. Most of these barriers are non-tariff barriers, such as quotas, which explicitly limit the flows of goods. Tariff barriers are typically levied as an ad valorem tax (i.e., proportional to the value of an imported good). Due to data limitations, most prior studies of the determinants of bilateral trade have not used explicit measures of ad valorem tariffs or tariff-equivalent estimates of non-tariff barriers. In some cases, researchers have used country-specific or country-pair fixed effects to capture these trade barriers. In general, summary measures of trade liberalization are used, such as indicator variables that are one if country pairs are members of a free trade area and zero otherwise.

The Klein and Shambaugh (2004) study estimates the relationship between membership of a regional free trade area and bilateral trade flows. They find that, on average, members of free trade areas have trade flows that are 50 percent higher than trading partners that are not part of a free trade area. Ghosh and Yamarik (2004) use a large set of indicator variables that are specific to membership in a particular free trade area (e.g., NAFTA) in their Bayesian extreme bounds analysis of free trade areas. They find that the relationship between this large set of regional free trade agreements and bilateral trade is fragile. We follow this approach by employing Glick and Rose's (2002) indicator variable that captures all free trade areas and customs unions. This variable takes the value 1 if such an agreement exists between the bilateral pair during the sample period, and 0 otherwise.

The second set of trade barriers deals with restrictions on capital flows or current account transactions. Perturbations of a country's capital/financial account has effects on the country's current and future trade flows. For example, factors that restrict capital flows may restrict the size of the current account and net export balance. Therefore, current account restrictions may be an important determinant of the level of trade between countries.

2.5.1 Multiple exchange rate arrangements

There are numerous exchange rate arrangements employed by the countries in our dataset. These arrangements range from (i) membership in a currency union (in

which the members share the same legal tender and monetary policy, as in the European Monetary Union) to (ii) a policy under which the exchange rate is determined by market forces (as in the United States). In some cases, countries have multiple exchange rate arrangements. For example, Nigeria has four exchange rates: (i) the official exchange rate which results from auctions of foreign exchange by the Nigerian Central Bank; (ii) the interbank rate at which commercial banks transact among themselves; (iii) the retail "bureau de change" rate; and (iv) the parallel market rate. We explore the extent to which these multiple arrangements are barriers to trade. Specifically, we construct an indicator variable using data from Milesi-Ferretti (1998) that takes the value 2 if both countries have multiple exchange rate arrangements, takes the value 1 if only one country has a multiple exchange rate arrangement and is zero otherwise.[5]

2.5.2 Controls on current account transactions

Many countries place restrictions on current account transactions. These restrictions affect, among other things, (i) the way in which payments must be made on merchandise and service imports and (ii) the repatriation of proceeds of merchandise and service exports. These restrictions can also affect 'invisible' transactions, such as (i) investment related transactions (interest, profits/dividends, and rent/lease payments), and (ii) payments to non-resident labor. We explore the extent to which these restrictions on current account transactions affect bilateral trade flows by employing an indicator variable takes the value 2 if both countries impose controls, 1 if only one country imposes controls, and zero otherwise.

2.5.3 Specific surrender requirements

Countries sometimes impose "specific surrender" requirements on proceeds from exports or invisible transactions when these transactions exceed a specified value or if the transaction involves particular goods or services. In most cases, the exporter must surrender the proceeds from a transaction to the monetary authority which exchanges the proceeds at a regulated rate of exchange. This type of arrangement is common in countries that have adopted a currency board. For example, during the period under which Argentina had a currency board, surrender requirements were imposed on export proceeds exceeding $200,000. We assess the impact of the

[5] We are grateful to Dr. Milesi-Ferretti for sharing his data with us.

restrictions on bilateral trade by using an indicator variable takes the value 2 if both countries have specific surrender requirements, 1 if only one country does, and is zero otherwise.

2.5.4 Controls on the capital account

Most countries employ some form of capital control that regulates the inward and outward flow of capital. These restrictions include prohibitions; need for prior approval, authorization and notification; discriminatory taxes; reserve requirements; interest penalties; and limits on the holding of assets at home by non-residents and abroad by residents. We explore the implications of these controls for bilateral trade by employing an indicator variable that takes the value 2 if both countries impose capital controls, 1 if only one country imposes capital controls, and zero otherwise.

2.6 Currency Union

There is much current interest in determining the effect of currency union on trade. Indeed, one important reason for forming a currency union is the promotion of trade within the union. Consequently, there is a large literature on the effects of currency union on trade.[6] Most studies indicate a positive effect of currency union on trade, so it is a natural candidate for our investigation of robust determinants of bilateral trade. Because a currency union can be explicit (a shared currency or a formal treaty) or implicit (a unilateral fixing of the exchange rate), we construct two measures of currency union.

2.6.1 Explicit and implied currency union

We employ an indicator variable constructed by Glick and Rose (1992) that takes on the value 1 if the country pair is part of an explicit or implied currency union. In an explicit currency union, the currency of one country circulates in the second country as the sole legal tender. Alternatively, the two countries may both be members of a union in which the same legal tender is shared by the members of the union. Adopting such systems generally requires the complete surrender of monetary policy to another

[6] This literature is summarized in Rose (2004).

nation's monetary authority (US Federal Reserve in the case of "dollarization") or an independent international monetary authority (ECB, for EMU members).

Implied currency unions are defined as situations in which at least one of the two countries maintains a formal exchange rate peg to another country's currency. This may take the form of a currency board arrangement. A less restrictive alternative is a conventional peg in which a country agrees to peg its currency at a fixed rate to another currency or a basket of currencies. Implied unions do not include crawling pegs, crawling bands, horizontal bands or managed floating arrangements since they allow the bilateral rate of exchange to vary over time.

2.6.2 Fixed exchange rate

We constructed an indicator that takes the value 1 if the country pair maintained a constant monthly nominal exchange rate during a five year interval, and 0 otherwise. This variable includes all explicit and implicit currency unions, as well as informal pegging arrangements and any other policy that, ex post, meant that the exchange rate between the two countries did not vary during the sample. This variable is obviously broader than the variable used by Glick and Rose. We include this variable because we wish to investigate whether the formal nature of the currency unions selected by the Glick/Rose variable are more strongly related to bilateral trade than this alternative, broader measure.

2.7 Exchange Rate Variability

There are numerous exchange rate arrangements employed by the countries in our dataset, as discussed above. The wide range of exchange-rate policies implies wide variation in the levels of exchange-rate volatility among the country pairs in our dataset. According to theoretical analyses, the relationship between exchange rate volatility and bilateral trade is ambiguous and typically depends on the source of exchange rate fluctuations (see, for example Bacchetta and van Wincoop (2000), and Sercu and Uppal (2003)).

The empirical literature is less ambiguous. There is a large body of empirical research which finds that higher exchange rate volatility is associated with lower trade volumes. Klein and Shambaugh (2004) , in their comprehensive analysis of the effect of fixed versus floating exchange rates on trade flows, find that direct exchange rate pegs have a statistically significant positive relationship with the volume of bilateral

trade flows. In contrast, they find that indirect pegs do not have a statistically significant relationship with trade flows.[7] Exchange rate volatility is explored further in their paper by including an indicator of the level and square of the volatility of bilateral exchange rates, where volatility is measured as the standard deviation of monthly exchange rates over a fixed period. They find that the level of exchange rate volatility has a statistically significant negative relationship with trade flows. However, Tenreyro (2004) argues that Klein and Shambaugh use econometric methods that lead to biased estimates. She argues that, in the absence of these biases, exchange rate volatility does not have a significant impact on trade flows.

Although the jury is still out on the empirical importance of exchange rate variability as a determinant of trade volumes, it deserves inclusion in our study. We therefore investigate the importance of exchange rate volatility on trade flows using a measure of exchange rate volatility defined as the standard deviation of the growth rate of the nominal monthly bilateral exchange rate over the preceding five-year period.

3 Methodology

The goal of this paper is to determine which economic variables are important determinants of bilateral trade. To accomplish this, we employ three methods that have been proposed as appropriate for isolating robust relationships. This section describes these three methods.

3.1 The "Extreme Bounds Analysis" (EBA) of Leamer

This sub-section describes the extreme-bounds analysis (EBA) suggested by Leamer (1983). The general form of the regression used for the EBA is follows. The variable T_{ijt} measures log bilateral trade between countries i and j in period t:

$$T_{ijt} = \beta_A A_{ijt} + \beta_M M_{ijt} + \beta_Z Z_{ijt} + v_{ijt}. \tag{4}$$

The independent variables are of three types, as follows. A denotes a set of variables that appear in every regression, thus these are referred to as "always included

[7] An indirect peg is defined as follows. If countries A and B have explicit pegs with C, then A and B have an indirect peg. To take another example, if A is pegged to B, and B is pegged to C, then A and C have an indirect peg.

variables". This set may be empty. In our application, however, A includes the gravity variables. M is the variable which is being tested for robustness. Z contains one or more other variables that prior studies have suggested may be an important determinant of bilateral trade flows. The EBA is performed by varying the set of variables included in Z for a particular M-variable. Following Levine and Renelt (1992), we include three Z-variables in each regression, drawn from the complete set of potential Z-variables, denoted C. Let N denote maximum number of sets of three Z-variables that can be drawn from C. The extreme bounds of an M-variable are established by ordering from lowest to highest the 90 percent confidence intervals of the N estimates of β_M from the exhaustive set of Z-variable draws from C. We will say that an M-variable is robust if the lower and upper bounds of this ordering are the same sign.

3.2 The "Extreme Bounds Analysis" of Sala-i-Martin

Sala-i-Martin (1997) proposed an alternative application of the extreme-bounds concept. Sala-i-Martin's methodology is derived from Leamer's (1983) EBA methodology and uses the same regression model (4). However, Sala-i-Martin's approach differs in the way the extreme bounds of the variable of interest are calculated. In this case, the extreme bounds of an M-variable are based on a weighted average of the N point estimates of β_M from the exhaustive set of Z-variable draws from C.

Let $\widehat{\beta}_{Mn}$ denote the estimate of β_M from regressing bilateral trade on the A-variables, on the variable M, and on the n^{th} Z-variable, Z_n. Let ω_n denote the weight (defined below) attached to the estimate β_{Mn}. Then the Sala-i-Martin's point estimate of β_M from this set of N regression models is defined as:

$$\widehat{\beta}_M \equiv \sum_{n=1}^{N} \omega_n \widehat{\beta}_{Mn}. \tag{5}$$

The weights, ω_n, are constructed as follows. Let L_{Mn} denote the likelihood function of the regression model evaluated at $\widehat{\beta}_{Mn}, T, M$ and Z_n. The weight ω_n is then computed as

$$\omega_n \equiv \frac{L_{Mn}}{\sum_{n=1}^{N} L_{Mn}}. \tag{6}$$

The variance of $\widehat{\beta}_M$ is computed as follows:

$$\widehat{\sigma}^2_{\beta_M} \equiv \sum_{n=1}^{N} \omega_n \widehat{\sigma}^2_{\beta_{Mn}} \tag{7}$$

where $\widehat{\sigma}^2_{\beta_{Mn}}$ is the estimated variance of $\widehat{\beta}_{Mn}$. According to Sala-i-Martin's approach, an M-variable is robust if the t-statistic of $\widehat{\beta}_M$ exceeds the critical value associated with the researcher's desired level of significance.

3.3 The "General to Specific" approach of Hendry

We use a version of Hendry's (1995) general-to-specific approach. Our method begins with a regression of the dependent variable (i.e., log bilateral trade) on all potential explanatory variables. Next we break the set of explanatory variables into two groups: a set S of variables with statistically significant coefficients; and the set of remaining variables, NS, with coefficients that are not statistically significant, which includes a variable, L, with the lowest t-statistic. After partitioning the variables in this way we drop the variable L and regress the dependent variable on the remaining set of explanatory variables. If there is a new L-variable, we drop it from the set of explanatory variables and regress the dependent variable on the further reduced set of explanatory variables. This process repeats until there are no variables in NS.

4 Benchmark Results

This section begins the presentation of the results of our empirical investigation. We present first the results for the gravity variables alone, as a benchmark for comparison with the results of including other variables. Next, we present regressions for each potential explanatory variable, with one variable per regression. Finally, we combine the gravity variables with the other potential explanatory variables, introducing the additional explanatory variables one at a time.

4.1 Gravity variables only

We begin our investigation with estimation of the effects of the gravity variables on trade:

$$T_{ijt} = D_{ijt} + \beta_A A_{ijt} + v_{ijt} \tag{8}$$

where T_{ijt} is bilateral trade between countries i and j, D_{ijt} is a matrix of country and year fixed effects, and A_{ijt} is the vector of gravity variables. Since we have data on one important variable–sectoral similarity–only for a subset of countries, throughout the paper we run each regression for the full sample and again for the restricted sample. The results are shown in Table 1-A (full sample) and Table 1-B (restricted sample).

The results are, for the most part, independent of the sample and have the expected sign. For example, distance has a negative coefficient: countries located closer to each other trade more. A common border and a common language are associated with higher trade. Trade is higher if the two countries had a common colonizer or are in a colonial relationship. There is a negative estimated coefficient on the variable indicating a current colonial relationship, but this variable is not significant. The log product of GDP is positive and significant in both samples. However, the log product of per capita GDP is positive and significant in the full sample, but negative and not significant in the restricted sample.

4.2 Other variables only

Next, we explore the importance of the non-gravity variables–our "M-variables"– in explaining bilateral trade when considered one at a time. We run the following regression for each M-variable, including in each regression country and year fixed effects, denoted D_{ijt}:

$$T_{ijt} = D_{ijt} + \beta_M M_{ijt} + v_{ijt}. \tag{9}$$

Table 2 summarizes the results from these regressions. As in the case of Table 1, there are two panels corresponding to the large sample (which includes all available data) and the restricted sample (which includes only observations for which the sectoral similarity variable can be constructed). The results are similar across the two panels. Beginning with measure 1 for factor intensity (see equation (1), we find that education and capital per worker are both significantly related to bilateral trade. This means that trade is higher between country pairs for which the products of endowments of human and physical capital are higher. By contrast, measure 1 for

arable land per worker is not significant in the full sample, although it is significantly less than zero in the restricted sample.

Measure 2 of the factor intensity variables measures the difference between factor endowments in the two countries–see equation (2). Here, we find that education, capital, and arable land are all significantly, negatively related to bilateral trade. Thus, the more dissimilar are the two countries in terms of all three factor endowments, the less they trade.

The development-indicator variable takes on the value 1 if both countries are at the same stage of development: either both are developed countries or both are developing countries.[8] This indicator is strongly significant across both samples. The variable measuring industrial similarity, which is 1 if countries have identical sectoral shares and zero if they have no similarities, is positive and significant in the smaller sample. Thus, countries trade more, the more similar is the industrial structure in the two countries.

We considered four measures of capital controls. In the full sample, each measure of controls carries a negative estimated coefficient, although only two are significantly different from zero: (i) multiple exchange rates and (ii) restrictions on the current account. In the restricted sample, only the variable measuring restrictions on the current account is significant–the coefficient is negative, as in the full sample. These findings suggest that most types of capital controls have little effect on bilateral trade, even when considered in isolation. The only variable that has a significant effect across both samples is the variable measuring restrictions on the current account. This is quite understandable, as this restriction is directly targeting bilateral trade. The full-sample coefficient of 0.09 means that trade is 9% lower if one country of the pair under consideration has trade restrictions, and trade is 2*0.09=0.18 or 18% lower if both countries have current account restrictions. In economic terms, this is a very significant effect.

We turn next to measures of currency union. A large and growing literature has found that currency union is associated with higher trade among members of the union. Our measure of currency union is the same measure used in Glick and Rose (2002). This variable has a significant, positive coefficient in both the large and restricted samples. We also include the 'fixed exchange rate' variable defined earlier–

[8] Because we include country and year fixed effects, we cannot independently estimate the effects of "two developed countries" and "two developing countries."

this variable takes on the value 1 if the pair of countries had a fixed exchange rate over the sample period, regardless of whether there was an explicit currency union or currency board in place. This variable is also significantly, positively related to bilateral trade.

Membership in a customs union is significantly, positively related to trade in both samples, as one would expect and as policymakers hope is the case when they establish a customs union or free trade area. Finally, bilateral exchange rate volatility is negatively, significantly related to trade. This result adds weight to the theoretical and empirical literatures that argue exchange rate volatility lowers bilateral trade.

4.3 Combining gravity and 'other' variables

Next, we explore the importance of the non-gravity variables–our "M-variables"– in explaining bilateral trade when considered one at a time in a regression that also includes the gravity variables, A_{ijt}. We run the following regression for each M-variable, including country and year fixed effects, D_{ijt}, in each regression:

$$T_{ijt} = D_{ijt} + \beta_A A_{ijt} + \beta_M M_{ijt} + v_{ijt} \tag{10}$$

Table 3 summarizes the results from these regressions. As in the case of Table 1 there are two panels, corresponding to the large sample (which includes all available data) and the restricted sample (which includes only observations for which the sectoral similarity variable can be constructed). The results are broadly similar across the two panels.

Our main findings are as follows. Measure 1 of the capital and education variables remain positive and significant, although the estimated coefficient on capital per worker is much smaller once the gravity variables are included. None of the measure 2 factor intensity variables is significant, although all three were significantly negative in Table 2 in which the gravity variables were omitted.

The indicator for same stage of development is now negative and strongly significant–recall this variable was significantly, positively related to trade in Table 2. Evidently there are important interactions between this variable and one or more of the gravity variables. The results for the capital controls are similar to the results in Table 2–in fact, the coefficient estimates are larger when the gravity is included. Thus, restrictions on the current account are still significantly, negatively related to bilateral

trade.

The coefficients on the currency union variable and the fixed exchange rate variable are still positive and significant, although the size of the coefficients is much smaller once the gravity variables are included. For example, in Table 2 the full-sample estimate of the currency union coefficient was 2.62, but falls to 0.47 once the gravity variables are included (Table 3). Similarly, the full-sample estimate of the fixed-exchange-rate variable was 1.90 in Table 2, but is only 0.43 in Table 3.

The customs union variable is no longer significant once the gravity variables are included–it was positive and significant in Table 2. The measure of exchange rate volatility also loses statistical significance when the gravity variables are included.

Table 3-B contains results for the sectoral similarity variable. The coefficient is negative and statistically significant when the gravity variables are included. This means that countries trade less, the more similar are their industrial structures. Recall that, in Table 2, the coefficient was *positive* and statistically significant, implying more trade the more similar are industrial structures.

Overall, we find that only a few variables retain their statistically significant relationship to bilateral trade once the gravity variables are included. Of those that remain significant, several had estimated coefficients that are markedly smaller once gravity is taken into account. The development indicator and the sectoral similarity variable are both still significant once gravity variables are included, but the sign of the coefficients change from negative to positive. Our conclusion from this section is that the statistical significance of economic determinants of trade is strongly influenced by the inclusion of gravity variables.

5 Results: Robustness

In this section, we study each group of variables in turn, discussing their 'robustness' and how this varies across the three empirical methodologies. Robustness the three approaches are contained in three tables, corresponding to the approaches of Leamer (Table 4), Sala-i-Martin (Table 5), and Hendry (Table 6). Table 7 summarizes our results, showing which variables and methods lead to findings of robustness for specific variables.

5.1 Factor Endowments

We consider three factors: human capital (education); physical capital per worker; and arable land. As discussed in Section 2, we have two measures of each variable: see equations (1) and (2). Our baseline results in the prior section showed that measure 1 for education and capital-per-worker were significantly, positively related to trade even when gravity variables were taken into account. Measure 2 was significant only for some variables and some sample periods.

The results for the Leamer approach are shown in shown in Table 4. As with previous tables, there are separate panels for the full sample (Panel A) and for the restricted sample (Panel B). In the full sample, measure 1 for education, capital-per-worker, and arable-land-per-worker are robustly, positively related to bilateral trade. None of the measure 2 variables is significant. The results for the restricted sample are similar, with the exception that measure 1 for arable land is no longer robust. In general, the Leamer test is considered the most restrictive of the robustness tests, so we are interested to learn how our results change when we consider other tests.

The results for the Sala-i-Martin test is reported in Table 5. These results are the same as the Leamer results, with just one exception: measure 2 for capital-per-worker is now robust (with a negative coefficient), although only in the full sample and only with a 10% significance level.

The Hendry results are reported in Table 6. Measure 1 for education and capital-per-worker are robust, as they were with the Leamer and Sala-i-Martin tests. Measure 1 for arable land is not robust with the Hendry approach, although it was robust in the full sample with both prior tests. The Hendry results differ from Leamer and Sala-i-Martin for the measure-2 variables. In the large sample, all three endowment measures are significant: education and land carry positive coefficients, while capital has a negative coefficient. In the small sample, only capital per worker is robust, and continues to have a negative coefficient.

Overall, our results indicate that measure 1 endowment variables, which measure the product of the endowments, are robust, especially human capital and physical capital. There is less support for the measure-2 variables, which measure differences in endowments, and which have been the traditional variables included in studies of the determinants of trade. Thus, our results have apparently uncovered a new measure of factor endowments which has significant role in explaining (in a statistical sense) bilateral trade. This measure, being the product of endowments in the two

countries, is higher the higher is the sum of endowments in the two countries. Holding fixed the level of the sum of endowments, this measure is higher the more equal are the endowments across the two countries.

5.2 Development indicator

We considered the stage of development as a possible determinant of international trade. Since our focus is on bilateral trade, our development indicator takes on the value 1 if the two countries share the same level of development (either developed or developing), and takes on the value 0 if one country is developed while the other is developing.[9] Economic theory is largely silent on the potential importance of development levels as determinants of trade volume. However, our empirical investigation suggests that the level of development is strongly associated, in a statistical sense, with bilateral trade. We turn now to the results.

Tables 2A and 2B gives the baseline estimates for the development indicator coefficient for the full and restricted samples. In both sample periods the coefficient estimate is positive and significantly different from zero. However, Table 3 shows that the point estimates in both samples become negative and significant when the gravity variables are added to the regression of bilateral trade on the development indicator: the baseline estimates are -0.61 in the large sample, and -0.63 in the restricted sample. Evidently, the development indicator is correlated with some variables in the set of gravity variables, and the coefficient estimate for development is thus highly sensitive to the inclusion of the gravity variables.

Table 4 presents robustness tests using the Leamer method. In both samples, the development indicator is robust and has a negative coefficient. This means that, other things held constant, a pair of countries at the same level of development experiences less bilateral trade than a pair of countries with differing levels of development.

It is plausible that the level of development might be highly correlated with the sectoral structure of economic activity. For example, highly developed economies tend to produce and trade manufactured goods, while developing countries tend to produce and trade agricultural goods and commodities. Thus, it is notable that the presence of the variable that measures industrial similarity (ISI) in Table 4-B does not reduce the significance of the development variable. The industrial similarity

[9] Because of the presence of country and year fixed effects, it is not possible to separately estimate coefficients for (i) two developed countries and (ii) two developing countries.

variable, by contrast is not robust, as we discuss further in the next sub-section.

Tables 5 and 6 present robustness results for the Sala-i-Martin and Hendry methods. With both methods and for both sub-samples, the development indicator continues to be robust with a negative coefficient. Further, the coefficient estimates are very similar to those obtained with the Leamer approach. Overall, the results are very clear for the development variable: other things held constant, two countries at a similar level of development have lower bilateral trade.

5.3 Industrial Similarity

Industrial structure has long played an important role in theories of international trade. Although theories differ on the determinants of production and trade, the central questions investigated by theoretical and empirical studies of international trade remain "who produces what" and "who trades what." Therefore, we constructed a variable that measures similarity in two countries' industrial structures and investigate the importance of industrial structure as a determinant of bilateral trade. Unfortunately, the necessary data for computation of the sectoral similarity variable is available only for a subset of country pairs. This reduces our sample from 10947 observations to 7274 observations. Thus, we present results throughout for the full sample (Tables 2A through 7A) and for the restricted sample for which the sectoral similarity variable can be computed (Tables 2B through 7B).

Table 2B shows that sectoral similarity is positively, significantly related to bilateral trade when considered on its own (together with country and year fixed effects.) Table 3B, however, shows that the inclusion of the gravity variables changes this result dramatically: the coefficient estimate for sectoral similarity is now significantly negative.

The robustness results are as follows. With the Leamer approach (Table 4B), the sectoral similarity variable has a negative and significant coefficient (-0.58) in the baseline case, but the variable is not robust. With the less restrictive Sala-i-Martin approach, the sectoral similarity variable continues to carry a negative coefficient (-0.45) and is found to be robust. Sectoral similarity is also found to be robust under the Hendry approach, with a coefficient estimate of -0.71.

Overall, our findings indicate that similarity of the sectoral structure of production is negatively related to bilateral trade: country pairs with similar patterns of production trade less than country pairs for which the pattern of production differs between

the two countries. These findings lend support to theories of international trade which highlight country-level differences as important for trade (e.g., the Ricardian and Heckscher-Ohlin theories), and cast doubt on theories that predict that trade will rise with increased industrial similarity (e.g., the theory presented in Helpman and Krugman (1989)).

5.4 Capital controls

We turn next to investigation of the importance of policies that directly or indirectly interfere with international trade. As described in Section 2, we consider four policies: (i) multiple exchange rate arrangements; (ii) restrictions on current account transactions; (iii) restrictions on capital account transactions; and (iv) specific surrender requirements.

The baseline univariate regressions, reported in Table 2, can be summarized as follows. In the large sample, both (i) multiple exchange rates and (ii) restrictions on the current account, have a significant (negative) effect on bilateral trade. In the restricted sample, only current account restrictions are significant. When the gravity variables are included (Tables 3A-B), only the variable measuring current account restrictions continues to be significantly, negatively related to bilateral trade. This is true for both samples. The significance of this variable is easy to understand, since current account restrictions, in their various forms, are all designed to affect external trade.

But are these restrictions robust? Table 4 reports that the current account restrictions are robustly, negatively related to bilateral trade in both sample periods. None of the other capital controls considered is robust. The Sala-i-Martin and Hendry approaches confirm the findings of the Leamer approach–the estimated coefficients for current account restrictions are negative and robust. Across all of these methods, the point estimates of the coefficient lies in the range -0.08 to -0.12. Thus, if one of the two countries has current account restrictions trade is reduced by 8%-12%, while if both countries have current account restrictions, trade is reduced by 16%-25%.

5.5 Fixed Exchange Rates and Currency Union

One of the most compelling arguments for currency union and other fixed-exchange-rate arrangements is that these arrangements facilitate international trade by remov-

ing exchange-rate uncertainty. Fixed exchange rate arrangements may be made through public announcements and codified through explicit currency union, or they may be more informal through fixing arrangements that are not part of a publicly announced exchange-rate policy.

We attempt to distinguish between these two types of arrangements in the following way. We say that a pair of countries has fixed exchange rates vis-a-vis each other if the bilateral exchange rate does not change over the course of the 5-year sample period. This definition thus includes both explicit and implicit fixing arrangements. A subset of these country pairs is engaged in an explicit currency union, and we code this arrangement separately by assigning to the currency union variable the value 1 to country pairs in a currency union, and the value 0 to country pairs not in a currency union, even if they have fixed exchange rates.

There are only 48 observations out of a possible 10947 in which there is a currency union. (A particular country pair can appear as an 'observation' more than once if the currency union was in place for more than one five-year period). There are 131 additional observations in which there is a fixed exchange rate for the country pair for that sample period, but for which there was no currency union, either explicit or implicit. The country pairs in our sample that have currency union or a fixed exchange rate are concentrated mainly in two groups. The first group, accounting for 17 of the 49 observations, is characterized by a large, developed country paired with a less-developed country (e.g., the US paired with Panama, Dominican Republic, and Guatemala, for a total of 13 observations); and the UK paired with Ireland, Cypress, and Malawi, for a total of 4 observations). The second group consists of pairs of developing countries, primarily African countries. The second group includes a few cases in which a country pair has an implied union through each of these countries' currency union with the US. Aside from this, the remaining 26 observations are country pairs from the group that includes Togo, Cameroon, Benin, Senegal, Barbados, Mali, and Guyana.

There are many more country pairs for which there is a fixed exchange rate but no explicit or implicit currency union. However, these country pairs typically do not involve two developed countries. The only example in which two OECD countries had a fixed bilateral exchange rate for one or more 5-periods is the US-Mexico. Thus, we suggest great caution be exercised in interpreting the results of our investigation as shedding light on the potential results of currency union between developed coun-

tries. More bluntly, our results may not have much to say about the trade effects of the European Monetary Union. Since our data is the same as data used by prior researchers, a similar caution may apply to interpretation of results obtained in this prior work.

5.5.1 Currency union

The currency union variable takes on the value 1 if the country pair has an explicit currency union, and zero otherwise. Thus, the currency union variable selects a subset of the country pairs that had a value of 1 for the fixed-exchange-rate variable. Frankel and Rose (2000, Table 1) report a coefficient in the range 1.22-1.72 in a regression of bilateral trade on gravity variables and the currency union variable, which they report is consistent with the earlier estimate of Rose (2000), and is also consistent with Glick and Rose (2002).

Under the Leamer approach, currency union is fragile. Although the baseline point estimates are 0.47 (large sample) and 0.71 (restricted sample), the standard errors of these estimates are large enough that the estimates are barely significant in the baseline case, and are fragile when we allow for combinations of Z-variables. Under the Sala-i-Martin approach, by contrast, currency union is robust, although just barely so. In the large sample, the coefficient estimate is 0.44 with a standard error of 0.22. With the restricted sample, the estimate is 0.66 with a standard error of 0.32. The point estimates are thus similar to those obtained under the Leamer approach, and are much smaller than the estimates obtained by Frankel and Rose (2000). The less-restrictive nature of the Sala-i-Martin approach leads to a result of robustness, with t-statistics of about 2.05, while the Leamer approach finds that currency union is not robust. Turning to the Hendry approach, we find that currency union does not appear as a robust determinant of bilateral trade in either sample.

Overall, our results cast serious doubt on the hypothesis that currency union plays an important, independent role in determining bilateral trade. The significant role of the currency union variable uncovered by previous studies is not robust to the inclusion of other variables. Of course, this is a purely statistical result and it is possible that currency union is important for bilateral trade but in a way that is too subtle to be detected using these methods.

5.5.2 Fixed exchange rate

The fixed-exchange-rate variable takes on the value 1 if the country pair has an exchange rate that does not change during the sample period. This will include both explicit currency unions and informal fixing arrangements. Looking first at the Leamer approach, the baseline coefficient estimate for the fixed exchange rate variable is 0.43 for the large sample, and is found to be robust. In the restricted sample, however, the baseline point estimate is 0.30 with a standard error of 0.16, and is therefore not robust.

Turning to the Sala-i-Martin approach, we find that fixed-exchange-rate variable is robust in both the large and the restricted samples, with coefficient point estimates of 0.42 and 0.27, respectively. With the Hendry approach, the fixed exchange rate variable is significant in the large sample. as it was with the Leamer approach. The point estimate is 0.30 with a standard error of 0.12. In the restricted sample, however, the fixed-exchange-rate variable is not significant, which again is what was found with the Leamer approach.

Overall, the fixed-exchange-rate variable is robust with all methods in the large sample, but is only robust under the Sala-i-Martin approach in the restricted sample. In all cases, the coefficient estimate is in the range 0.25-0.45, with standard errors about 0.12-0.16.

5.6 Free trade areas/customs union

The next variable considered is an indicator variable that takes on the value 1 if the country pair was in a free trade area or customs union. Theory would predict a positive relationship between the level of bilateral trade and the existence of a customs union, since the object of a customs union is to enhance trade within the union by reducing trade barriers among members. It is surprising, therefore, that our robustness analysis gives a very mixed view of the relationship between free trade areas and the level of bilateral trade.

Beginning with the Leamer method, we find that the free trade area variable is not robust. This is true whether one considers the large sample or the restricted sample. Further, the point estimates in the baseline cases are actually negative–we expected a positive coefficient. Using the Sala-i-Martin method, we find that the free trade area variable has a positive, but fragile coefficient in the full-sample and a

robust negative coefficient in the small sample. Turning to the Hendry approach, the free trade area variable has a positive coefficient and is robust in the full sample, but is fragile in the small sample.

5.7 Exchange rate volatility

Exchange rate volatility is widely believed to reduce bilateral trade, as it adds an additional source of price uncertainty to goods sold abroad. Our baseline regressions in Table 2 supported this view: the coefficient estimate ranges from -0.63 (large sample) to -0.82 (restricted sample) and are strongly significant in both samples. When the gravity variables are included (Table 3), the coefficient estimates are still negative, but are much smaller in absolute value and are no longer stastistically significant.

The robustness results are as follows. With the Leamer approach, as shown in Table 4, the baseline estimates for exchange rate volatility are negative but insignificant, implying that exchange-rate volatility is not robust in either sample. The Sala-i-Martin and Hendry approaches yield similar results: exchange rate volatility is not robust in the large sample, although it is robust in the restricted sample. In the restricted sample, however, the robustness result is not strong, in the sense that the t-statistic is -1.70 with the Sala-i-Martin approach (the normal CDF is 0.96), and is -1.69 with the Hendry approach. Thus the finding of robustness would not hold if the test were more stringent with, for example, a 1% significance level. Overall, we find that exchange rate volatility is robustly, negatively related to trade, but this finding of robustness is not strong, relying as it does on particular methods, particular sample periods, and particular significance levels.

6 Conclusion

This paper was intended to be a purely empirical investigation, attempting to draw together several methods for assessing robustness, and applying these methods a longstanding question: "What determines international trade?" We attempted to be quite inclusive in our approach to selecting variables as potential determinants of international trade. In this concluding section, we will simply summarize the salient results. For reference, we have collected all the robustness results into a single table, Table 7.

First, we find that one particular measure of bilateral factor endowments are robust determinants of trade. Specifically, the product of endowments in the two countries is positively related to bilateral trade. Holding fixed the level of the sum of endowments, trade is higher the more equal are the endowments across the two countries. This measure had not generally been included in prior studies of the empirical determinants of international trade. The more commonly-used measure, involving bilateral differences in factor endowments, was not robust.

Second, we found that bilateral trade was lower if two countries shared the same stage of development, and that this result is robust across all three methods. Bilateral trade was also found to be lower the more similar are industrial structures in the country pair: this variable was not robust with the Leamer approach but was robust with the Hendry and Sala-i-Martin approaches. We studied a variety of capital controls, and found that the only robust restriction was restriction on current account transactions which, as expected, is negatively related to trade.

We explored the importance of currency union and also the importance of a fixed exchange rate (which includes currency unions). We found that fixed exchange rates were positively related to bilateral trade, but were robust only in the full sample (and in the restricted sample under the Sala-i-Martin approach). The results for currency union were weaker: although the point estimates of the coefficients were always positive, they were robust only under the Sala-i-Martin approach. Further, the point estimates of the coefficient on currency union were much smaller than those reported in earlier research.

The results on customs unions are mixed. This variable has a positive coefficient and is robust under the Hendry method in the full sample, but in the restricted sample the coefficient estimate is negative and is robust only for the Sala-i-Martin approach. It is impossible to draw any conclusions from this pattern of results. Finally, there is weak evidence that exchange rate volatility is negatively related to trade. Although the coefficient point estimates are negative, as is consistent with prior research, the variable is robust only in the restricted sample.

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Table 1: Gravity Variables Only

Includes Country and Year Fixed Effects

	A. Full Sample				B. Restricted sample			
	10947 observations				7274 observations			
Variables	**β**	**se(β)**	**t-stat**	**R-sq.**	**β**	**se(β)**	**t-stat**	**R-sq.**
Distance (DIST)	-1.26	0.02	-51.47	0.81	-1.28	0.03	-42.44	0.82
Common Border (BRDR)	0.32	0.11	3.00		0.30	0.13	2.27	
Common Language (LANG)	0.71	0.05	15.30		0.66	0.06	11.71	
Common Colonizer (COMCOL)	0.27	0.07	3.71		0.47	0.09	5.22	
Current Colony (CURCOL)	-0.84	0.59	-1.43		-0.86	0.59	-1.45	
Colonial Relationship (COLONY)	1.03	0.09	11.39		1.21	0.11	10.59	
GDP (GDP)	0.83	0.13	6.46		1.09	0.16	6.72	
Per Capita GDP (GDPPC)	0.39	0.13	3.01		-0.04	0.17	-0.21	

Table 2-A: Basic Regressions including one M-Variable, Country and Year Fixed Effects
Large Sample: No Sectoral Similarity

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq
Factor Intensity, Measure 1:	Education (EDUC1)	0.50	0.11	4.59	0.72
Log[F_i*F_j]	Capital per Worker (CAP1)	0.84	0.07	12.73	0.72
	Arable Land Per Worker (LAND1)	-0.11	0.10	-1.04	0.72
Factor Intensity, Measure 2:	Education (EDUC2)	-0.60	0.05	-11.38	0.72
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker (CAP2)	-0.31	0.02	-17.20	0.73
	Arable Land Per Worker (LAND2)	-0.11	0.03	-4.04	0.72
Development Indicator	Same Stage of Development (DEV)	0.36	0.04	8.72	0.72
Capital Controls	Multiple Exchange Rates (CC1)	-0.09	0.04	-2.22	0.72
	Restrictions on Current Account (CC2)	-0.09	0.04	-2.23	0.72
	Restrictions on Capital Account (CC3)	-0.01	0.05	-0.16	0.72
	Specific Surrender Requirements (CC4)	-0.04	0.05	-0.98	0.72
Currency Union	Fixed exchange rate (FE)	1.90	0.14	13.56	0.72
	Currency Union (CU)	2.62	0.26	10.24	0.72
Customs Union	Free Trade Area or Equivalent (FTA)	2.46	0.12	20.08	0.73
Financial	Bilateral Exchange Rate Volatility (ERV)	-0.63	0.07	-8.52	0.72

Table 2-B: Basic Regressions including one M-Variable, Country and Year Fixed Effects
Restricted Sample: Includes Sectoral Similarity

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq
Factor Intensity, Measure 1:	Education (EDUC1)	0.79	0.14	5.56	0.74
Log[F_i*F_j]	Capital per Worker (CAP1)	0.76	0.08	9.31	0.74
	Arable Land Per Worker (LAND1)	-0.41	0.14	-2.99	0.73
Factor Intensity, Measure 2:	Education (EDUC2)	-0.53	0.07	-7.73	0.74
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker (CAP2)	-0.25	0.02	-11.35	0.74
	Arable Land Per Worker (LAND2)	-0.09	0.03	-3.03	0.73
Development Indicator	Same Stage of Development (DEV)	0.28	0.05	5.62	0.74
	Sectoral Similarity (ISI)	0.98	0.20	4.88	0.74
Capital Controls	Multiple Exchange Rates (CC1)	-0.08	0.05	-1.47	0.73
	Restrictions on Current Account (CC2)	-0.12	0.05	-2.30	0.73
	Restrictions on Capital Account (CC3)	0.04	0.06	0.74	0.73
	Specific Surrender Requirements (CC4)	0.04	0.06	0.72	0.73
Currency Union	Fixed exchange rate (FE)	1.08	0.19	5.59	0.74
	Currency Union (CU)	2.49	0.38	6.48	0.74
Customs Union	Free Trade Area or Equivalent (FTA)	1.79	0.16	11.04	0.74
Financial	Bilateral Exchange Rate Volatility (ERV)	-0.82	0.11	-7.78	0.74

Table 3-A: Regressions including one M-Variable, Gravity Variables, Country and Year Fixed Effects
Large Sample: No Sectoral Similarity

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq
Factor Intensity, Measure 1:	Education (EDUC1)	0.57	0.10	5.97	0.81
Log[F_i*F_j]	Capital per Worker (CAP1)	0.30	0.07	4.52	0.81
	Arable Land Per Worker (LAND1)	0.17	0.09	1.79	0.81
Factor Intensity, Measure 2:	Education (EDUC2)	0.07	0.05	1.47	0.81
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker (CAP2)	0.01	0.02	0.88	0.81
	Arable Land Per Worker (LAND2)	2.46E-03	0.02	0.11	0.81
Development Indicator	Same Stage of Development (DEV)	-0.57	0.04	-15.58	0.81
Capital Controls	Multiple Exchange Rates (CC1)	-0.02	0.04	-0.67	0.81
	Restrictions on Current Account (CC2)	-0.08	0.03	-2.55	0.81
	Restrictions on Capital Account (CC3)	0.01	0.04	0.35	0.81
	Specific Surrender Requirements (CC4)	0.02	0.04	0.57	0.81
Currency Union	Fixed exchange rate (FE)	0.43	0.12	3.61	0.81
	Currency Union (CU)	0.47	0.22	2.19	0.81
Customs Union	Free Trade Area or Equivalent (FTA)	-0.01	0.11	-0.07	0.81
Financial	Bilateral Exchange Rate Volatility (ERV)	-0.04	0.07	-0.68	0.81

Table 3-B: Regressions including one M-Variable, Gravity Variables, Country and Year Fixed Effects
Restricted Sample: Includes Sectoral Similarity

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq
Factor Intensity, Measure 1:	Education (EDUC1)	0.62	0.13	4.85	0.82
Log[F_i*F_j]	Capital per Worker (CAP1)	0.28	0.08	3.28	0.82
	Arable Land Per Worker (LAND1)	0.10	0.14	0.74	0.82
Factor Intensity, Measure 2:	Education (EDUC2)	0.12	0.06	2.11	0.82
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker (CAP2)	0.05	0.02	2.38	0.82
	Arable Land Per Worker (LAND2)	1.42E-02	0.02	0.57	0.82
Development Indicator	Same Stage of Development (DEV)	-0.61	0.04	-13.69	0.82
	Sectoral Similarity (ISI)	-0.58	0.17	-3.39	0.82
Capital Controls	Multiple Exchange Rates (CC1)	-0.04	0.04	-0.95	0.82
	Restrictions on Current Account (CC2)	-0.13	0.04	-3.03	0.82
	Restrictions on Capital Account (CC3)	0.00	0.05	-0.03	0.82
	Specific Surrender Requirements (CC4)	0.02	0.05	0.47	0.82
Currency Union	Fixed exchange rate (FE)	0.30	0.16	1.86	0.82
	Currency Union (CU)	0.71	0.32	2.20	0.82
Customs Union	Free Trade Area or Equivalent (FTA)	-0.58	0.14	-3.99	0.82
Financial	Bilateral Exchange Rate Volatility (ERV)	-0.16	0.09	-1.69	0.82

Table 4-A: Robust regression using Leamer Approach
Large Sample: Industrial Similarity Variable Not Included

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq	ZVAR1	ZVAR2	ZVAR3	Robust/ Fragile
Factor Intensity, Measure 1:	Education (EDUC1)	0.70	0.10	6.99	0.81	LAND2	EDUC2	FE	Robust
Log[F_i*F_j]		0.57	0.10	5.97	0.81				
		0.45	0.10	4.43	0.82	DEV	EDUC2	CAP2	
	Capital per Worker (CAP1)	0.33	0.07	4.91	0.81	LAND2	CAP2	FE	Robust
		0.30	0.07	4.52	0.81				
		0.16	0.07	2.27	0.82	DEV	EDUC1	CAP2	
	Arable Land Per Worker (LAND1)	0.25	0.09	2.67	0.81	EDUC1	CAP1	ERV	Robust
		0.17	0.09	1.79	0.81				
		0.15	0.09	1.66	0.81	EDUC1	CC2	CC2	
Factor Intensity, Measure 2:	Education (EDUC2)	0.17	0.05	3.56	0.81	EDUC1	CAP1	FE	Fragile
Log[Max(F_i, F_j)/Min(Fi, Fj)]		0.07	0.05	1.47	0.81				
		-0.18	0.05	-3.82	0.82	DEV	LAND1	FTA	
	Capital per Worker (CAP2)	0.03	0.02	1.83	0.81	EDUC1	CAP1	FE	Fragile
		0.01	0.02	0.88	0.81				
		-0.16	0.02	-8.76	0.82	DEV	CAP1	FTA	
	Arable Land Per Worker (LAND2)	0.03	0.02	1.31	0.82	DEV	LAND1	CAP1	Fragile
		0.00	0.02	0.11	0.81				
		0.00	0.02	-0.01	0.81	EDUC1	CAP1	CU	
Development Indicator	Same Stage of Development (DEV)	-0.59	0.04	-15.15	0.82	EDUC1	EDUC2	FE	Robust
		-0.57	0.04	-15.58	0.81				
		-0.80	0.04	-18.26	0.82	CAP2	CC2	FTA	

Table 4-A (continued): Robust regression using Leamer Approach
Large Sample: Industrial Similarity Variable Not Included

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq	ZVAR1	ZVAR2	ZVAR3	Robust/ Fragile
Capital Controls	Multiple Exchange Rates (CC1)	0.02	0.04	0.60	0.81	CAP1	CC2	FE	Fragile
		-0.02	0.04	-0.67	0.81				
		-0.03	0.04	-0.86	0.81	LAND1	CC4	CU	
	Restrictions on Current Account (CC2)	-0.06	0.03	-1.97	0.81	EDUC1	EDUC2	FE	Robust
		-0.08	0.03	-2.55	0.81				
		-0.10	0.03	-2.93	0.82	DEV	CAP2	CC4	
	Restrictions on Capital Account (CC3)	0.04	0.04	1.00	0.81	CAP1	CC2	FE	Fragile
		0.01	0.04	0.35	0.81				
		-0.01	0.05	-0.17	0.81	LAND1	CAP1	CC4	
	Specific Surrender Requirements (CC4)	0.06	0.04	1.43	0.81	CAP1	CC2	FE	Fragile
		0.02	0.04	0.57	0.81				
		0.00	0.04	0.05	0.81	EDUC1	CAP2	CC3	
Currency Union	Fixed exchange rate (FE)	0.49	0.12	4.08	0.81	EDUC1	EDUC2	CAP1	Robust
		0.43	0.12	3.61	0.81				
		0.26	0.12	2.19	0.82	DEV	CAP2	CC2	
	Currency Union (CU)	0.54	0.22	2.50	0.81	EDUC1	EDUC2	CAP1	Fragile
		0.47	0.22	2.19	0.81				
		0.10	0.22	0.45	0.82	DEV	CAP2	ERV	
Customs Union	Free Trade Area or Equivalent (FTA)	0.41	0.11	3.68	0.82	DEV	CAP2	CU	Fragile
		-0.01	0.11	-0.07	0.81				
		-0.02	0.11	-0.14	0.81	EDUC1	CAP1	FE	
Financial	Bilateral Exchange Rate Volatility (ERV)	0.02	0.07	0.31	0.81	EDUC1	CC2	FE	Fragile
		-0.04	0.07	-0.68	0.81				
		-0.10	0.07	-1.52	0.82	DEV	LAND1	CAP1	

Table 4-B: Robust regression using Leamer Approach
Restricted Sample: Industrial Similarity Variable Included

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq	ZVAR1	ZVAR2	ZVAR3	Robust/ Fragile
Factor Intensity, Measure 1: Log[F_i*F_j]	Education (EDUC1)	0.75	0.13	5.69	0.82	LAND1	EDUC2	FTA	Robust
		0.62	0.13	4.85	0.82				
		0.47	0.13	3.52	0.83	DEV	EDUC2	CAP1	
	Capital per Worker (CAP1)	0.33	0.09	3.88	0.82	CAP2	CC4	ERV	Robust
		0.28	0.08	3.28	0.82				
		0.16	0.08	1.89	0.83	DEV	EDUC1	CAP2	
	Arable Land Per Worker (LAND1)	0.17	0.14	1.20	0.82	EDUC1	CAP2	CAP1	Fragile
		0.10	0.14	0.74	0.82				
		0.04	0.14	0.27	0.83	DEV	CAP2	CC2	
Factor Intensity, Measure 2: Log[Max(F_i, F_j)/Min(Fi, Fj)]	Education (EDUC2)	0.22	0.06	3.57	0.82	EDUC1	CU	ERV	Fragile
		0.12	0.06	2.11	0.82				
		-0.26	0.06	-4.15	0.83	DEV	LAND2	CC2	
	Capital per Worker (CAP2)	0.06	0.02	3.02	0.82	EDUC1	CAP1	CU	Fragile
		0.05	0.02	2.38	0.82				
		-0.20	0.03	-7.38	0.83	DEV	ERV	ISI	
	Arable Land Per Worker (LAND2)	0.04	0.02	1.52	0.83	DEV	EDUC1	CAP2	Fragile
		0.01	0.02	0.57	0.82				
		0.01	0.02	0.44	0.82	EDUC2	CAP1	ISI	
Development Indicators	Same Stage of Development (DEV)	-0.61	0.05	-12.61	0.83	CU	FTA	ISI	Robust
		-0.61	0.04	-13.69	0.83				
		-0.84	0.05	-15.28	0.83	EDUC2	CAP2	ISI	
	Industrial Similarity Index (ISI)	0.12	0.18	0.67	0.83	DEV	LAND2	CC2	Fragile
		-0.58	0.17	-3.39	0.82				
		-0.78	0.21	-3.74	0.83	DEV	EDUC2	CAP2	

Table 4-B (continued): Robust regression using Leamer Approach
Restricted Sample: Industrial Similarity Variable Included

Variable Group	"M-Variable" (abbreviation)	β	se(β)	t-stat.	R-sq	ZVAR1	ZVAR2	ZVAR3	Robust/ Fragile
Capital Controls	Multiple Exchange Rates (CC1)	0.02	0.05	0.38	0.82	EDUC1	CAP1	CC2	Fragile
		-0.04	0.04	-0.95	0.82				
		-0.05	0.05	-1.10	0.82	LAND1	CC4	ISI	
	Restrictions on Current Account (CC2)	-0.12	0.05	-2.53	0.82	CC1	ERV	ISI	Robust
		-0.13	0.04	-3.03	0.82				
		-0.15	0.04	-3.36	0.83	DEV	CAP2	CC4	
	Restrictions on Capital Account (CC3)	0.03	0.05	0.56	0.82	CAP1	CC2	ERV	Fragile
		0.00	0.05	-0.03	0.82				
		-0.04	0.06	-0.69	0.82	CAP1	CC4	FTA	
	Specific Surrender Requirements (CC4)	0.07	0.05	1.33	0.82	CAP1	CC2	FE	Fragile
		0.02	0.05	0.47	0.82				
		-0.01	0.05	-0.11	0.82	EDUC1	EDUC2	ISI	
Currency Union	Fixed exchange rate (FE)	0.33	0.16	2.03	0.82	LAND1	CAP1	ISI	Fragile
		0.30	0.16	1.86	0.82				
		0.14	0.16	0.89	0.83	DEV	CAP2	CC2	
	Currency Union (CU)	0.76	0.32	2.36	0.82	CAP2	CAP1	CC2	Fragile
		0.71	0.32	2.20	0.82				
		0.31	0.32	0.98	0.83	DEV	CAP2	ERV	
Customs Union	Free Trade Area or Equivalent (FTA)	-0.04	0.15	-0.24	0.83	DEV	CAP2	ISI	Fragile
		-0.58	0.14	-3.99	0.82				
		-0.60	0.14	-4.15	0.82	EDUC1	CAP1	ERV	
Financial	Bilateral Exchange Rate Volatility (ERV)	-0.10	0.09	-1.03	0.82	EDUC1	CC2	FE	Fragile
		-0.16	0.09	-1.69	0.82				
		-0.21	0.09	-2.24	0.83	DEV	CAP1	CC4	

Table 5-A. Robust Determinants of International Trade: Sala-i-Martin Approach
Large Sample: Sectoral Similarity Variable Not Included

Variable Group	Independent Variables	β	se(β)	t-stat	Normal CDF	Robust/ Fragile
Factor Intensity, Measure 1	Education	0.57	0.10	5.91	1.00	Robust
Log[F_i*F_j]	Capital per Worker	0.29	0.07	4.34	1.00	Robust
	Arable Land Per Worker	0.19	0.09	2.01	0.98	Robust
Factor Intensity, Measure 2	Education	0.04	0.05	0.93	0.82	Fragile
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker	-0.02	0.02	-1.26	0.90	Robust
	Arable Land Per Worker	0.01	0.02	0.34	0.63	Fragile
Development Indicator	Same Stage of Development	-0.63	0.04	-16.17	1.00	Robust
Capital Controls	Multiple Exchange Rates	-0.01	0.04	-0.38	0.65	Fragile
	Current Account Restrictions	-0.08	0.03	-2.47	0.99	Robust
	Capital Account Restrictions	0.02	0.04	0.38	0.65	Fragile
	Specific Surrender Requirements	0.03	0.04	0.67	0.75	Fragile
Currency Union	Fixed Exchange Rate	0.42	0.12	3.52	1.00	Robust
	Currency Union	0.44	0.22	2.05	0.98	Robust
Customs Union	Free Trade Area or Equivalent	0.08	0.11	0.73	0.77	Fragile
Financial	Exchange Rate Volatility	-0.04	0.07	-0.64	0.74	Fragile

Table 5-B. Robust Determinants of International Trade: Sala-i-Martin Approach
Restricted Sample: Sectoral Similarity Variable Included

Variable Group	Independent Variables	β	se(β)	t-stat	Normal CDF	Robust/ Fragile
Factor Intensity, Measure 1	Education	0.63	0.13	4.88	1.00	Robust
Log[F_i*F_j]	Capital per Worker	0.28	0.08	3.32	1.00	Robust
	Arable Land Per Worker	0.11	0.14	0.81	0.79	Fragile
Factor Intensity, Measure 2	Education	0.05	0.06	0.77	0.78	Fragile
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker	0.00	0.02	-0.02	0.51	Fragile
	Arable Land Per Worker	0.02	0.02	0.72	0.76	Fragile
Development Indicators	Same Stage of Development	-0.66	0.05	-13.79	1.00	Robust
	Industrial Similarity Index	-0.45	0.18	-2.49	0.99	Robust
Capital Controls	Multiple Exchange Rates	-0.03	0.05	-0.64	0.74	Fragile
	Current Account Restrictions	-0.13	0.04	-2.93	1.00	Robust
	Capital Account Restrictions	0.00	0.05	-0.10	0.54	Fragile
	Specific Surrender Requirements	0.03	0.05	0.58	0.72	Fragile
Currency Union	Fixed Exchange Rate	0.27	0.16	1.70	0.96	Robust
	Currency Union	0.66	0.32	2.04	0.98	Robust
Customs Union	Free Trade Area or Equivalent	-0.47	0.15	-3.25	1.00	Robust
Financial	Exchange Rate Volatility	-0.16	0.09	-1.70	0.96	Robust

Table 6: Robust Determinants of International Trade: Hendry Approach

A. Large Sample: Sectoral Similarity Variable Not Included

Significant Independent Variables	β	se(β)	t-stat	R-sq.
Education, Measure 1	0.55	0.10	5.45	0.82
Capital per Worker, Measure 1	0.15	0.07	2.25	
Education, Measure 2	0.11	0.06	1.96	
Capital per Worker, Measure 2	-0.16	0.02	-7.77	
Arable Land per Worker, Measure 2	0.22	0.09	2.42	
Same Stage of Development	-0.78	0.04	-17.48	
Restrictions on Current Account	-0.07	0.03	-2.28	
Fixed Exchange Rate	0.30	0.12	2.54	
Free Trade Area or Equivalent	0.40	0.11	3.55	

B. Restricted Sample: Sectoral Similarity Variable Included

Significant Independent Variables	β	se(β)	t-stat	R-sq.
Education, Measure 1	0.54	0.13	4.27	0.83
Capital per Worker, Measure 1	0.16	0.08	1.86	
Capital per Worker, Measure 2	-0.19	0.03	-6.84	
Same Stage of Development	-0.81	0.05	-14.92	
Sectoral Similarity	-0.71	0.21	-3.41	
Restrictions on Current Account	-0.12	0.04	-2.79	
Exchange Rate Volatility	-0.16	0.09	-1.69	

Table 7-A: Summary of Results
Large Sample: Industrial Similarity Variable Not Included

Variable group	Specific Variable	Leamer	Sala-i-Martin	Hendry
Factor Intensity Variables:	Education	**0.57 ***	**0.57 ***	**0.55 ***
Log[F_i*F_j]	Capital per Worker	**0.30 ***	**0.29 ***	**0.15 ***
	Arable Land per Worker	**0.17 ***	**0.19 ***	**0.22 ***
Factor Intensity Variables:	Education	0.07	0.04	**0.11 ***
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker	0.01	**-0.02 ****	**-0.16 ***
	Arable Land per Worker	0.00	0.01	--
Development Indicator	Countries at Same Stage of Development	**-0.57 ***	**-0.63 ***	**-0.78 ***
Capital Controls	Multiple Exchange Rates	-0.02	-0.01	--
	Restrictions on Current Account Transactions	**-0.08 ***	**-0.08 ***	**-0.07 ***
	Restrictions on Capital Account Transactions	0.01	0.02	--
	Specific Surrender Requirements	0.02	0.03	--
Currency Union	Fixed Exchange Rate	**0.43 ***	**0.42 ***	**0.30 ***
	Currency Union	0.47	**0.44 ***	--
Customs Union	Free Trade Area or Equivalent	-0.01	0.08	**0.40 ***
Financial Variables	Bilateral Exchange Rate Volatility	-0.04	-0.04	--

Notes: * indicates variable is robust at 5% level of statistical significance
** indicates variable is robust at 10% level of statistical significance
-- indicates variable is eliminated in general to specific reduction

Table 7-B: Summary of Results
Restricted Sample: Industrial Similarity Variable Included

Variable group	Specific Variable	Leamer	Sala-i-Martin	Hendry
Factor Intensity Variables:	Education	**0.62 ***	**0.63 ***	**0.54 ***
Log[F_i*F_j]	Capital per Worker	**0.28 ***	**0.28 ***	**0.16 ***
	Arable Land per Worker	0.04	0.11	--
Factor Intensity Variables:	Education	0.12	0.05	--
Log[Max(F_i, F_j)/Min(Fi, Fj)]	Capital per Worker	0.05	0.00	**-0.19 ***
	Arable Land per Worker	0.01	0.02	--
Development Indicators	Countries at Same Stage of Development	**-0.61 ***	**-0.66 ***	**-0.81 ***
	Industrial Similarity	-0.58	**-0.45 ***	**-0.71 ***
Capital Controls	Multiple Exchange Rates	-0.04	-0.03	--
	Restrictions on Current Account Transactions	**-0.13 ***	**-0.13 ***	**-0.12 ***
	Restrictions on Capital Account Transactions	0.00	0.00	--
	Specific Surrender Requirements	0.02	0.03	--
Currency Union	Fixed Exchange Rate	0.30	**0.27 ***	--
	Currency Union	0.71	**0.66 ***	--
Customs Union	Free Trade Area or Equivalent	-0.58	**-0.47 ***	--
Financial	Bilateral Exchange Rate Volatility	-0.16	**-0.16 ***	**-0.16 ***

Notes: * indicates variable is robust at 5% level of statistical significance
** indicates variable is robust at 10% level of statistical significance
-- indicates variable is eliminated in general to specific reduction