Currency Unions, Trade Flows, and Capital Flows

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Abstract

Trade within currency unions has been shown to be much larger than outside of currency unions, even after factoring in many relevant variables. The existing empirical evidence is based on reduced form models of trade, and therefore indicates that there exists a high correlation between currency union membership and trade, but does not indicate the causality, or the mechanism at work.

This paper argues that the balance of evidence points to a large and statistically significant causal relationship from currency unions to trade, and then considers two possible mechanisms behind this: (1) being a member of a currency union reduces trade resistance; and (2) being a member of a currency union reduces investment resistance. Based on a small theoretical model that incorporates both of these, we argue that both mechanisms are required to explain the observed economic impact of currency union membership.

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1. Introduction

Recent research by Rose (2000), Glick and Rose (2002), Rose and van Wincoop (2001), and Melitz (2001) and others has suggested that participation in a currency union has a large effect on bilateral trade between the members of the currency union. Their results, using a combination of both time-series and cross-section data, suggest that trade between members of a currency union is between 2 and 3.5 times as great as it would otherwise be, absent the currency union. These strong results survive a plethora of sensitivity analyses.

These empirical results are based on the gravity model, which is a reduced-form model of trade. They show that there is a high correlation between currency union membership and trade, but do not indicate the causality, or the mechanism at work. The purpose of this paper is to provide insight on these.

In terms of causality, there are three possibilities: (1) joining a currency union causes trade to increase; (2) currency unions are more likely between countries with high trade (endogeneity bias); or (3) both currency unions and high levels of trade are jointly caused by some third, un-modeled factor (missing variables). In the next section, we summarise the existing evidence for (2) and (3), and argue that the balance of evidence points to a large and statistically significant causal relationship from currency unions to trade.

In terms of mechanism, we then consider two possibilities: (1) being a member of a currency union reduces trade resistance (as suggested by Rose and van Wincoop 2001); and (2) being a member of a currency union reduces investment resistance, and therefore increases the profitability of firms locating production elsewhere in the currency union. We develop a small theoretical model that incorporates both of these, and calculate the predictions of each on trade flows and capital flows. We then present

evidence based on the datasets of Rose (2000) and Glick and Rose (2002), as well as a new dataset of capital flows, that both of these mechanisms are important in explaining the economic impact of currency union membership. Conclusions then follow.

2. Do Currency Unions Cause Trade?

Previous studies have identified a strong positive correlation between currency union membership and trade flows. In this section, we examine alternative explanations to a causal relationship from currency unions to trade.

Endogeneity Bias

A number of authors have argued that the decision to enter a currency union is endogenous and influenced by the level of trade, so that the estimated effect of currency union membership on trade is biased. Several authors have used estimation techniques that are designed to correct for this bias. For example, Persson (2001) uses a two-stage procedure where the first stage identifies pairs of countries that share the same probability of being in a currency union, based on observable characteristics. This probability is then used to match 'similar' countries, one in a currency union and one out, and trade between these and third countries is then used to identify the impact of currency union membership on trade. He finds only a small impact of currency union membership on trade, in the order of 13-66%. However, as Rose (2001) points out, the first stage of the procedure has very low explanatory power when it comes to explaining membership of currency unions membership (since 99% of country-pairs are not in currency unions), and therefore the results from the second stage should be interpreted with caution.

In contrast, Alesina, Barro, and Tenreyro (2002) find a large and significant causal relationship from currency unions to trade even after allowing for reverse causality. They argue that a currency union is more likely if countries (1) are closer; (2) share the same language; (3) include a colony/colonizer; (4) have lower per capita GDP; and (5) have small population. They use an estimated 'propensity to form a currency union' variable as an instrumental variable for the currency union dummy, and actually obtain larger estimates of the effect of currency union membership on trade than Rose (2000).[1]

Missing Variables

An alternative explanation is that trade and currency unions are jointly caused by some un-modeled third variable. This is possible if, for example, countries that have entered currency unions are systematically different from those that have not, and may lead to an overstatement of the impact of entering a currency union on trade.

Rose (2000) and Klein (2002) have noted that the bilateral trading relationships within currency unions in the above studies largely consist of a small, poor, underdeveloped region combined with a large, rich, developed country. While the European Monetary Union is a clear exception to this rule, it is still too early to expect clear evidence here.[2]

Note, however, that others have obtained similar results for earlier periods between countries that do not share this characteristic. For example, Lopez-Cordova

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[1] See also Kenen (2002) and Tenreyro and Barro (2003) for similar results.

[2] One empirical study does exist: Micco, Stein, and Ordonez (2002), using a gravity model, find a statistically significant impact of EMU membership on trade. Even before monetary union, they estimate that trade between EMU members was approximately 60% higher than between other

and Meissner (2003) find that trade between members of currency unions is twice as high, and between gold-standard countries is 60% higher, than would otherwise be expected. Similarly Flandreau and Maurel (2001) argue that arrangements similar to currency unions in 19th century Europe resulted in 3-fold increases in trade between members. Also Estevadeordal, Frantz, and Taylor (2003) find that the gold standard played an important role in the increase in world trade over the 1870-1913 period.[3] Thom and Walsh (2002) argue that the time-series results in Rose (2000) stem in part from the circumstances surrounding the break-down of currency unions, particularly in Africa, which often times coincided with economic chaos. Note, however, that the original studies incorporate a plethora of sensitivity analyses, such as excluding poor countries and countries in Africa.[4]

Nitsch (2002a) focuses on two currency unions (the CFA franc zone and the Eastern Caribbean Currency Union) that incorporate countries of similar size, structure, and geographical area to each other. He finds that membership of the CFA franc zone contributes to a 90% increase in trade, although allowing for country fixed-effects or multiplicative regressors reduces this effect. He finds no significant impact of currency union membership on trade in the Caribbean union.

Taking a different approach, Klein (2002) shows that the above results do not hold for bilateral trade with countries that have adopted the U.S. dollar. He considers only data for the post-Bretton Woods era, where the United States is one of the

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equivalent countries, and their results suggest additional increases since the advent of the union of the order of 15%.

[3] See also Thom and Walsh (2002) and Nitsch (2002b) for counter-examples, where currency union membership does not appear to have resulted in increased trade between Ireland and the United Kingdom, and Belgium and Luxembourg respectively.

[4] See, for example, Rose (2000) Table 2A and 2B. Excluding African observations or very poor countries actually increases the estimate of the effect of currency union membership on trade.

trading partners. His empirical results suggest that dollarization results in only a small increase in bilateral trade, and insignificantly different from a relatively stable pegged exchange rate.[5] By comparison, he finds that the effect on trade for economies adopting the Australian dollar is much stronger.

Summary

The results outlined in this section so far all focus on the fundamental question: does entering a currency union lead to an increase in trade? While not all authors agree, the preponderance of evidence appears to favor an economically significant causal relationship.[6]

3. The Mechanism

Why do currency unions cause trade to increase? We outline two arguments found in the existing literature, along with an additional one.

Common Institutions

Yeyati (2003) hypothesizes that increased trade flows may result from the development of common institutions. If that is the case, then countries that unilaterally dollarize (such as those studied by Klein above, who have adopted the U.S. dollar as their domestic currency) may be fundamentally different from those that form multilateral monetary unions, with the latter being more likely to develop common institutions. This hypothesis is rejected by the data, however. Yeyati finds

[5] This result remains a puzzle that is difficult to reconcile with the rest of the literature.

[6] See also Rose (2002b), for an assessment of the results to date.

that multilateral currency unions are associated with an increase in trade only half as large as countries that unilaterally-dollarize.[7]

Trade Resistance

Rose and van Wincoop (2001) argue that entering a currency union may represent a reduction in trade resistance between currency union members, reducing the effective costs faced by importers and exporters, due to reduced exchange rate volatility. We later outline and test the predictions of this on trade flows and capital flows.

Investment resistance

An alterative explanation that we also explore is that being a member of a currency union reduces the transactions costs of firms choosing a location for production outside of their home country. Firms face less uncertainty as to the returns on their investment, so that if different regions have different comparative advantages in production, a currency union will result in production and firm ownership being less closely linked to national boundaries in equilibrium.

4. A Theoretical Framework

We now develop a simple theoretical framework based on Feenstra (2002) and Anderson and van Wincoop (2003) to characterise the impact of joining a currency union on both trade and capital flows. In addition to Anderson and van Wincoop's "trade resistance, " we incorporate "investment resistance" as outlined above, as a

[7] Edwards and Magendzo (2003) also consider the differences between different forms of currency unions, although they focus on the implications for economic growth and inflation.

variable that may be influenced by joining a currency union. We then assume that country-specific firms optimally choose their production location.

Most papers addressing international trade, as in Feenstra (2002) and Anderson and van Wincoop (2003), assume that the location of production is fixed. This paper follows Helpman and Krugman (1985, Chapter 12) and Head, Mayer and Ries (2002) in assuming that firms explicitly choose the country in which to locate production, independent of the location of the firm.

Casual observation would suggest that production location has become increasingly mobile in recent decades, corresponding to changes in transportation and communications technology, together with institutional changes, that favor trade and foreign investment. One explanation for this is that an increasing share of world trade is conducted via multinational corporations that are less tied to any given country. For example, Murphy (1999) reports that in 1998, total "foreign affiliate sales" of transnational corporations exceeded world exports by 50%, indicating that international production is more important than trade in delivering goods to markets. Clausing (2000) reports that sales by affiliates of multinational corporations exceed total trade flows between the European Union and the United States, and trade linked in some manner with multinationals amounts to 77% of all international trade in the United States. If companies are free to choose production location, it is logical that they do so optimally, and that the optimal location may change in response to changes in the policy environment, such as the creation of a currency union.

One simplification in the analysis is that our model focuses solely on the production of final goods, and ignores explanations for trade and investment associated with the "slicing up of the value chain," where firms locate different stages

of production wherever it is most profitable to do so (see Krugman (1995) for a discussion).

The Model

Suppose that each country j contains a large number of entrepreneurs who have the ability to utilise a country-specific technology to produce a differentiated product. Each entrepreneur is also a consumer, who holds nominal resources of Y_j that he may use to finance consumption, which he is assumed to consume in his home country. However, technology is mobile, and entrepreneurs can produce their product in any country in the world.

Now if consumers in country j consume c_{ij} units of goods produced by country i's entrepreneurs, they enjoy utility of

$$U_j = \left(\sum_i \beta_i^{1/\sigma} c_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}.$$

Utility maximising demand for each good is therefore given by

$$P_{ij} c_{ij} = \beta_i \left(\frac{P_j}{P_{ij}} \right)^{\sigma-1} Y_j,$$

where $\sum_i P_{ij} c_{ij} = P_j c_j = Y_j$ and $P_j = \left(\sum_i \beta_i P_{ij}^{1-\sigma} \right)^{1/(1-\sigma)}$.

Suppose that good c_{ij} is a composite good made up of a large number of differentiated products of country i entrepreneurs, indexed by m, so that

$$c_{ij} = \left(\int_0^1 c_{ij}(m)^{(\lambda-1)/\lambda} dm \right)^{\lambda/(\lambda-1)}.$$

Utility maximisation implies

$$c_{ij}(m) = \left(\frac{P_{ij}}{P_{ij}(m)} \right)^{\lambda} c_{ij},$$

where

$$P_{ij} = \left(\int_0^1 P_{ij}(m)^{1-\lambda} dm \right)^{1/(1-\lambda)}.$$

Firm m, facing this demand, optimally chooses its price and also where to locate its production. Suppose that quantities produced "shrink" during shipping between countries (to incorporate trade resistance), and similar "iceberg" costs affect profit repatriation from one country to another (our interpretation of investment resistance). One interpretation of investment resistance is that entrepreneurs demand higher expected profits from foreign investments as exchange rate volatility increases.

Now suppose that each unit of good m requires $\alpha(m)$ units of labour and $1-\alpha(m)$ units of capital to produce, where $\alpha(m)$ is drawn from a continuous distribution. Further, capital is mobile with nominal cost per unit of I, while labour in country l costs W_l. If a country i entrepreneur chooses to produce y_{ij} units in country l to satisfy country j's demand, profit will be given by

$$\Pi_{ij,l}(m) = r_{il} \left(P_{ij}(m) c_{ij}(m) - [\alpha(m) W_l + (1-\alpha(m)) I] y_{ij}(m) \right),$$

where $r_{il} \leq 1$ represents the reduction in profits being repatriated due to investment resistance, and $c_{ij} = t_{lj} y_{ij}$ is the relationship between consumption and production, where $t_{lj} < 1$ represents the reduction in goods quantity due to trade resistance. Profit maximisation implies that

$$P_{ij}(m) = \frac{\lambda}{\lambda - 1} \frac{[\alpha(m) W_l + (1-\alpha(m)) I]}{t_{lj}},$$

and each entrepreneur's profit will be given by

$$\Pi_{ij,l}(m) = \frac{\beta_i}{\lambda} r_{il} \left(\frac{P_{ij}}{P_{ij}(m)} \right)^{\lambda-1} \left(\frac{P_j}{P_{ij}} \right)^{\sigma-1} Y_j .$$

Suppose that goods from a given country are more readily substitutable than composite goods between different countries, so that $\lambda > \sigma$.[8] Then, other things equal, an increase in ones own price ($P_{ij}(m)$) reduces profit, while an increase in the price of the composite country i good (P_{ij}) or the aggregate good (P_i) raises profit. It is straightforward to verify that profit may be re-written as

$$\Pi_{ij,l}(Y_j, r_{il}, t_{lj}, -t_{-lj}),$$

where t_{-lj} represents the trade resistance between country j and all countries other than l, and profits are increasing in all arguments. This equation serves as the foundation for considering the impact of a currency union on trade flows and capital flows. The fundamental assumption is that firms in country i locate their production of goods to supply country j consumers in the country (l) that maximizes their profits. Further, this is assumed to result in capital flows into country l.[9]

Consider the simplest possible world in which we may have countries forming a currency union while others remain outside of that union. This consists of three countries, denoted i, j, k. For simplicity, suppose that there is no trade resistance if a good is produced and consumed in the same country ($t_{ii} = 1$) and there is no investment resistance if profit is earned in the entrepreneur's home country ($r_{ii} = 1$).

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[8] Corsetti and Dedola (2003), among others, also make this assumption.

[9] While not formally modeled, steady state capital flows may be thought of as resulting from replacement of fixed capital due to depreciation.

Further, trade and investment resistance are symmetric between countries ($t_{ij} = t_{ji}; r_{ij} = r_{ji}$), and the initial trade resistance, capital resistance, wage rates, and distribution of α is such that at least some production by entrepreneurs in each country occurs in each other country.[10]

The location decision of country i entrepreneurs supplying country j solves

$$\Pi_{ij} = \max\left(\Pi_{ij,i}(Y_j, 1, t_{ij}, -t_{-ij}), \Pi_{ij,j}(Y_j, r_{ij}, 1, -t_{-jj}), \Pi_{ij,k}(Y_j, r_{ik}, t_{jk}, -t_{-jk})\right),$$

where the firm locates in country i if the first term is largest, j if the second term is largest, and k if the third term is largest. Thus the location decision is a function of investment resistance between the entrepreneur's country and all other countries, trade resistance between all countries and the consumers' country, and production costs in all countries.

It is now possible to close the model by setting nominal GDP (Y_j) equal to the sum of country i's entrepreneurs' profits and wages earned in country i,

$$Y_i = \sum_l \Pi_{il} + W_i \sum_m \sum_n \alpha_m y_{mn,i} + Is_i \sum_m \sum_n (1-\alpha_m) y_{mn,i},$$

where $y_{mn,i}$ represents production in country i by country m entrepreneurs for country n consumers, and s_i represents the share of world capital owned by country i consumers. Note that given the form of the profit function, nominal GDP in the consumer's country has the same multiplicative impact on profit irrespective of the

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[10] This assumption is sufficient to ensure that a change in trade and/or capital resistance has an impact on trade and capital flows. Otherwise it is possible that production location is already at a corner solution where changes in trade and/or capital resistance have no impact on production location. Violation of this assumption may explain the results of Thom and Walsh (2002), Nitsch (2002b), and

location of production. Therefore production location decisions are independent of the level of GDP of each country. The level of GDP will continue to have a quantitative effect on the level of trade flows and capital movements, but no impact on the location decisions of firms. However, when we examine empirical evidence of the impact of currency unions we may condition on the level of GDP, so that any quantitative effects due to GDP size are taken care of.

Note that one limitation of the analysis is that wages and interest rates are exogenous. Clearly changes in the other parameters of the model would likely influence factor prices, thereby affecting profitability and optimal production location decisions. We hope to take up this point in future analysis.

Predictions

What effect does currency union membership have in this model? Possible candidates include reducing trade resistance (increasing t_{ij}), or reducing investment resistance (increasing r_{ij}). We examine the consequences of each of these on trade and capital flows in the world economy, based on their impact on the location decisions of entrepreneurs.

Suppose that the trade resistance between countries i and j declines. Then the profitability of entrepreneurs from all countries supplying country i consumers using production in j has improved relative to production in i or k; symmetrically, the relative profitability of supplying country j consumers using production in i has improved relative to other production locations. Assuming this effect is large enough

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Klein (2002) reported earlier, who document cases where countries formed currency unions but did not experience increased trade.

for the marginal entrepreneur to change production location, the model would suggest that trade within the currency union would increase, but at the expense of trade between the currency union and other countries. On the converse, there should be no impact on the location decisions of entrepreneurs producing for consumers outside of the currency union. Further, if a change in location results in a flow in capital from the entrepreneur's country to the new location instead of the previous one, capital inflows into the currency union as a whole will tend to increase, as all entrepreneurs will be less inclined to use production outside of the currency union to supply consumers in the currency union. However, this may be partially offset since entrepreneurs within the currency union are more likely to meet the demand of other countries within the currency union with domestic production.

Suppose instead that the investment resistance between i and j declines. Then, in the margin, entrepreneurs within the currency union are more likely to produce in other currency union countries to supply all consumers, both inside and outside of the currency union. As a result, trade within the currency union may not necessarily increase: both c_{ii} and c_{ij} are more likely to be supplied using production in j, and the former represents an increase in trade within the currency union, while the latter represents a decline. However, trade between currency union countries and non-union countries will unambiguously increase. In terms of capital flows, country i entrepreneurs will tend to relocate production to country j and vice versa. Thus there will be an increase in capital flows between currency union countries, a reduction in capital flows from currency union countries to non-currency union countries, and no change in capital flows from non-currency union countries to currency union countries.

To summarize, the model suggests the following: a reduction in trade resistance increases trade flows within the currency union at the expense of trade flows with non-currency union countries, while a reduction in investment resistance has an ambiguous impact on trade flows within the currency union, but will increase trade between currency union countries and other countries. In contrast, a reduction in either trade or investment resistance increases aggregate capital flows into currency union countries.

As a further prediction, consider two countries that are members of different currency unions. If currency unions result in reduced trade resistance within the union, this would suggest that trade between these two countries should be similar to that between a currency union country and a non-union country. In contrast, if currency unions result in reduced investment resistance, then entrepreneurs within each currency union will tend to consolidate all production within the currency union, so that trade between members of different currency unions will increase.

4. The Empirical Evidence

We now examine empirical support for the predictions outlined above.

The Cross-section Evidence

The data used here are the same as in Rose (2000).[11] We first use cross-section data, and estimate the gravity equation in Rose (2000) of

$$\begin{aligned}\ln(X_{ijt}) = {} & \gamma \mathrm{CU}_{ijt} + \delta \mathrm{Volatility}_{ijt} + \beta_1 \ln(Y_{it}Y_{jt}) + \beta_2 \ln(Y_{it}Y_{jt} / \mathrm{Pop}_{it}\mathrm{Pop}_{jt}) \\ & + \beta_3 \ln(\mathrm{Distance}_{ij}) + \beta_4 \mathrm{Border}_{ij} + \beta_5 \mathrm{Language}_{ij} + \beta_6 \mathrm{FTA}_{ijt} \\ & + \beta_7 \mathrm{Country}_{ij} + \beta_8 \mathrm{Colonised}_{ij} + \beta_9 \mathrm{Colony}_{ij} + \varepsilon_{ijt}\end{aligned}$$

where i and j denote countries, t denotes time, and

- X_{ijt} is the value of bilateral trade
- CU_{ijt} is a dummy variable that takes on a value of 1 if i and j are in the same currency union at time t,
- Volatility_{ijt} is the volatility of the nominal exchange rate between i and j in the period before t,
- Y_{it} is real GDP,
- Pop_{it} is population,
- Distance_{ij} is the distance between i and j,
- Border_{ij} is unity if i and j share a land border,
- Language_{ij} is unity if i and j share a common language,
- FTA_{ij} is unity if i and j belong to the same trade agreement,
- Country_{ij} is unity if i and j are part of the same nation,
- Colonised_{ij} is unity if i and j were colonized by the same nation,
- Colony_{ij} is unity if i colonized j or vice versa, and
- ε_{ijt} is an error term.

Table 1 outlines the cross-section evidence. In the first column, the results of Rose (2000) are replicated. Members of currency unions trade more than three times as much as other countries (exp(1.21)-1=235% increase).

If trade resistance alone explains the increased trade, then joining a currency union should have a large positive impact on trade within the currency union, but a negative impact on trade between currency union countries and non-union countries, while investment resistance implies an increase in trade with all trading partners. The second column shows that countries that are members of a currency union trade, on

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[11] The data used in this and the next section are generously made available on Andrew Rose's web page at http://faculty.haas.berkeley.edu/arose/RecRes.htm.

average, 68% more with all their trading partners than other similar countries. However, this is dwarfed by the estimated additional 161% increase in trade within the currency union (for a total of 229%).

Taking this one step further, if both trading partners are members of (not necessarily the same) currency union, do they trade more? The third column reveals that if one trading partner is a member of a currency union, trade is 61% higher. If both countries are members of (potentially different) currency unions, trade is an additional 43% higher (104% combined). And if both countries are members of the same currency union, trade is further increased by 98% (for an estimated combined total of 202%). This is consistent with the investment resistance explanation for the relationship between currency unions and trade, and not trade resistance.

The Time-series Evidence

Moving now to the time-series data, we use the dataset from Glick and Rose (2002) to estimate their gravity equation of

$$\begin{aligned}\ln(X_{ijt}) = {} & \gamma \mathrm{CU}_{ijt} + \beta_1 \ln(\mathrm{Distance}_{ij}) + \beta_2 \ln(Y_{it}Y_{jt}) + \beta_3 \ln(Y_{it}Y_{jt} / \mathrm{Pop}_{it}\mathrm{Pop}_{jt}) + \beta_4 \mathrm{Language}_{ij} \\ & + \beta_5 \mathrm{Border}_{ij} + \beta_6 \mathrm{FTA}_{ijt} + \beta_7 \mathrm{Landlocked}_{ij} + \beta_8 \mathrm{Islands}_{ij} + \beta_9 \ln(\mathrm{Area}_i \mathrm{Area}_j) \\ & + \beta_{10} \mathrm{Colonised}_{ij} + \beta_{11} \mathrm{Current}_{ijt} + \beta_{12} \mathrm{Colony}_{ij} + \beta_{13} \mathrm{Country}_{ij} + \varepsilon_{ijt}\end{aligned}$$

where i and j denote countries, t denotes time, and the variables are as defined before, with the addition of

- $\mathrm{Landlocked}_{ij}$ is the number of landlocked countries,
- $\mathrm{Islands}_{it}$ is the number of island countries,
- Area_i is land mass, and
- $\mathrm{Current}_{ijt}$ is unity if i and j are colonies at time t.

In Table 2, the first column replicates the results of Glick and Rose (2002). Trade within currency unions is estimated to be 266% higher than elsewhere, allowing for year dummies.

Next we include pair-wise fixed effects in column 2 (as in Glick and Rose 2002, Table 5, first column) to allow for any other un-modeled factors that increase trade between each pair of countries, currency unions are estimated to increase trade by 81%.[12] We now use this as our base model for considering the relative importance of trade resistance and investment resistance in explaining the relationship between currency unions and trade.

Column 3 reveals that regions in currency unions trade 31% more with all trading partners and an additional 76% with currency union partners. In column 4, the results indicate that if one trading partner is a member of a currency union, trade is 29% greater. If both countries are members of currency unions, trade is an additional 46% greater (75% combined). And being members of the same currency union is associated with a further 30% increase in trade (for an estimated combined trade increase of 105%). Thus approximately two-thirds of the increase in trade may be attributed to the fact that countries that join currency unions trade more with all trading partners, both in and out of currency unions, pointing to the importance of investment resistance (rather than trade resistance) to explain the relationship between currency unions and trade.

The Capital Flow Evidence

Both of the explanations of trade flows examined above suggest that joining a currency union should result in increased capital flows to currency union members.

[12] Note that this causes all variables that are constant over the sample to drop out of the regression.

With a reduction in either trade resistance or investment resistance, profit-maximizing firms are more likely to locate production facilities within the currency union. We look directly for evidence of this, using foreign direct investment over the 1948-2001 period, in real US dollars, as a measure of capital flows.[13,14] Our estimated equation takes the form

$$\ln(I_{it}) = \gamma \mathrm{CU}_{it} + \delta \ln(\mathrm{Volatility}_{it}) + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{it} / \mathrm{Pop}_{it}) + \beta_3 \Delta \ln(Y_{it}) + \beta_4 \mathrm{FTA}_{it} + \varepsilon_{it}$$

where i denotes countries, t denotes time, and

- I_{it} is capital flow, measured in constant US dollars,
- CU_{it} is a dummy variable that takes on a value of 1 if i is in a currency union,
- $\mathrm{Volatility}_{it}$ is the variance of the nominal exchange rate with the US dollar,[15]
- Y_{it} is GDP (measured in constant US dollars),
- Pop_{it} is population,
- FTA_i is unity if i belongs to a free trade agreement, and
- ε_{it} is an error term.

The dataset contains approximately 2000 country-year observations, of which 20% are members of currency unions.[16] Also year dummies are included to capture the growth rate in overall capital flows over time.[17]

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[13] Rose and Engel (2002) showed that capital flows are higher as a proportion of GDP for currency union members than non-currency union members. Here we show that this is robust to conditioning on relevant explanatory variables.

[14] Elsewhere, bilateral capital flows between pairs of countries have been examined (for example, Gorg and Greenaway (2002) and Portes, Rey and Oh (2001)). While it would be preferable to follow a similar approach here, no comprehensive dataset of this type containing large numbers of observations for currency union members is available as far as far as we are aware. Hence the reliance on aggregate capital flows.

[15] Volatility is constructed using the bilateral exchange rate with the United States. The variance of the monthly percent change in the exchange rate is computed for each year. This variance, or a 5 or 10 year moving average, is then included in the regression.

[16] The exact number depends on the definition of volatility employed, due to availability of data.

The results are given in Table 3 for foreign direct investment. Consider the first three columns of Table 3. First note that exchange rate volatility is barely significant in many cases, and sometimes has the wrong sign, so does not appear to explain foreign direct investment. In contrast output, output per capita, and being a member of a free trade agreement all have a positive and significant impact on foreign direct investment. The growth rate of the economy also has a positive effect, although this is typically insignificant. On top of that, being a member of a currency union is associated with a 54-60% increase in foreign direct investment.

In the next three columns, country fixed-effects ("within") are included to capture any un-modeled country-specific variables. The estimated effect of currency unions on capital flows remains large and significant (57-82%).[18] One other change that results is that the estimated effect of per capita income is larger, while the estimated effect of output is now negative. That is, allowing for fixed-effects, investment flows are increasing in output, but declining in population.

In Table 4, a number of sensitivity analyses are included (dropping the insignificant exchange rate volatility variable from the estimated equation[19]) to establish the robustness of this result. One might argue that Foreign Direct Investment is the appropriate measure of what we wish to measure here: investment for the purpose of producing goods and services. However, as Hausmann and Fernandez-

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[17] Currency union, free trade agreement, and real GDP data are drawn from the Glick and Rose (2002) dataset. All other series are taken from *International Financial Statistics*. The full dataset may be downloaded from http://www.econ.hku.hk/~jyetman/.

[18] Note that while the overall fit of the equation is poor in this case, the model succeeds in explaining 42% of each country's variability about its mean. This is because most of the overall explanatory power comes from the fixed effects.

[19] This increases the sample size to 2427 country-year observations, of which 573 represent members of currency unions.

Arias (2000) argue, FDI should be viewed as only one component of total capital and is influenced by many factors besides the desire to invest in productive capacity. Therefore we also consider total capital flows. Then quadratic terms in the explanatory variables are included. Next the sample is divided between industrial countries and non-industrial countries. Next, motivated by the results reported in Klein (2002) above, the United States, countries in a currency union with the United States, and others are separated. It is interesting to note that while countries in currency unions with the US may not have enjoyed increased trade, they have benefited from increased capital flows.[20] Next countries in currency unions are separated by their geographical location. And finally, the observations are divided into different historical periods. With the exception of the pre-1970 observations, in every case considered, being a member of a currency union is associated with a large, statistically significant increase in capital inflows.

5. Conclusions

Trade within currency unions has been shown to be much larger than outside of currency unions, even after factoring in many variables that are likely to influence trade, using reduced form models. We summarized this literature, and argued that the evidence favors an economically significant relationship running from currency union membership to increased trade.

An existing explanation for this result is that entering a currency union represents a reduction in trade resistance. Here we developed a simple model of firm

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[20] One possible explanation for this is that the predominant impact of currency union membership on these countries is foreign firms investing more in the United States to meet U.S. demand, which is consistent with the investment resistance explanation. If this is the only consequence of currency union membership, it may in principle result in a reduction in trade flows within the currency union.

location that incorporates trade resistance as well as investment resistance, interpreted as the resistance to firms moving productive capacity beyond their national boundaries. We briefly discussed empirical evidence that production mobility is an increasingly important facet of international trade, especially among multinational corporations. We calculated the predictions of the model of a reduction in both trade resistance and investment resistance on trade and capital flows between countries.

We then tested these predictions empirically using three different datasets, and argued that the empirical evidence cannot be explained by either trade resistance or capital resistance singly, but is consistent with both working in concert.

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Table 1: The Cross-section Evidence

Variable	(1)	(2)	(3)
Currency Union (γ)	1.21 (.14)	.96 (.14)	.68 (.14)
One or Both CU Members		.52 (.03)	.47 (.03)
Both CU Members			.36 (.06)
Exchange Rate Volatility (δ)	-.017 (.002)	-.013 (.002)	-.013 (.002)
Output (β_1)	.80 (.005)	.82 (.006)	.82 (.006)
Output/Capita (β_2)	.66 (.01)	.62 (.01)	.62 (.01)
Distance (β_3)	-1.09 (.02)	-1.10 (.02)	-1.10 (.02)
Border (β_4)	.53 (.08)	.58 (.08)	.59 (.08)
Language (β_5)	.40 (.04)	.40 (.04)	.39 (.04)
FTA (β_6)	.99 (.08)	.95 (.07)	.94 (.08)
Same Country (β_7)	1.29 (.26)	1.43 (.26)	1.41 (.26)
Same Coloniser (β_8)	.63 (.06)	.65 (.06)	.65 (.06)
Colonial Relationship (β_9)	2.20 (.07)	1.96 (.08)	1.91 (.08)

Note: Pooled panel OLS gravity estimates. Year controls not recorded. Robust standard errors are in parentheses.

Table 2: The Time-Series Evidence

Variable	(1)	(2)	(3)	(4)
Currency Union (γ)	1.30 (.04)	.59 (.05)	.56 (.05)	.26 (.05)
One or Both CU Members			.27 (.01)	.26 (.01)
Both CU members				.38 (.02)
Distance (β_1)	-1.11 (.006)			
Output (β_2)	.93 (.003)	.46 (.02)	.44 (.02)	.44 (.02)
Output/Capita (β_3)	.46 (.004)	.53 (.02)	.54 (.02)	.54 (.02)
Language (β_4)	.32 (.01)			
Border (β_5)	.43 (.03)			
FTA (β_6)	.99 (.03)	.84 (.05)	.83 (.05)	.84 (.05)
Landlocked (β_7)	-.14 (.01)			
Islands (β_8)	.05 (.01)			
Land Area (β_9)	-.09 (.002)			
Same Coloniser (β_{10})	.45 (.02)			
Current Colony (β_{11})	.82 (.07)	.23 (.09)	.27 (.09)	.25 (.09)
Colonial Relationship (β_{12})	1.31 (.02)			
Same Country (β_{13})	-.23 (.20)			

Note: Pooled panel OLS gravity estimates. Year and country-pair controls not recorded. Robust standard errors are in parentheses.

Table 3: The Investment Evidence: Foreign Direct Investment

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Currency Union (γ)	.43 (.09)	.46 (.08)	.47 (.08)	.45 (.20)	.60 (.19)	.60 (.19)
Volatility- current year	-.04 (.02)			-.05 (.01)		
Volatility- 5 year MA		-.004 (.02)			-.03 (.01)	
Volatility- 10 year MA			.03 (.02)			.005 (.02)
Output (β_1)	.63 (.02)	.65 (.02)	.66 (.02)	-1.0 (.34)	-1.2 (.32)	-1.1 (.31)
Output/Capita (β_2)	.76 (.04)	.76 (.04)	.77 (.04)	2.1 (.33)	2.2 (.31)	2.2 (.29)
Growth Rate (β_3)	.07 (.37)	1.01 (.78)	1.04 (.70)	.08 (.20)	.57 (.38)	.33 (.36)
FTA (β_4)	.51 (.07)	.45 (.07)	.51 (.07)	.30 (.13)	.29 (.12)	.30 (.12)
R^2	.93	.93	.93			
R^2 **within**				.42	.42	.41
R^2 **between**				.03	.09	.08
R^2 **overall**				.00	.02	.01

Note: Year controls (all columns) and country controls (columns 4-6) not recorded.

Robust standard errors are in parentheses.

Table 4: The Investment Evidence: Sensitivity Analysis

Total Capital Flows	.37 (.07)
Quadratic Terms	.45 (.02)
No Industrial Countries	.44 (.08)
Only Industrial Countries	.54 (.09)
US	.48 (.16)
In Currency Union with US	.39 (.19)
Neither	.47 (.07)
Africa	.30 (.12)
America's / Caribbean	.41 (.10)
Asia / Pacific	.79 (.20)
Europe	.50 (.12)
Before 1970	.14 (.24)
1970-1980	.64 (.12)
1980-1990	.46 (.11)
After 1990	.37 (.10)

Note: Robust standard errors are in parentheses.