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Abstract

As the number of independent countries increases and their economies become more integrated, we would expect to observe more multi-country currency unions. This paper explores the pros and cons for different countries to adopt as an anchor the dollar, the euro, or the yen. Although there appear to be reasonably well-defined euro and dollar areas, there does not seem to be a yen area. We also address the question of how trade and co-movements of outputs and prices would respond to the formation of a currency union. This response is important because the decision of a country to join a union would depend on how the union affects trade and co-movements.

1 Introduction

Is a country by definition an optimal currency area? If the optimal number of currencies is less than the number of existing countries, which countries should form currency areas?

This question, analyzed in the pioneering work of Mundell (1961) and extended in Alesina and Barro (2002), has jumped to the center stage of the current policy debate for several reasons. First, the large increase in the number of independent countries in the world led, until recently, to a roughly one-for-one increase in the number of currencies. This proliferation of currencies occurred despite the growing integration

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of the world economy. On its own, the growth of international trade in goods and assets should have raised the transactions benefits from common currencies and led, thereby, to a decline in the number of independent moneys. Second, the memory of the inflationary decades of the seventies and eighties encouraged inflation control, thereby generating consideration of irrevocably fixed exchange rates as a possible instrument to achieve price stability. Adopting another country's currency or maintaining a currency board were seen as more credible commitment devices than a simple fixing of the exchange rate. Third, recent episodes of financial turbulence have promoted discussions about "new financial architectures." Although this dialogue is often vague and inconclusive, one of its interesting facets is the question of whether the one country/one currency dogma is still adequate.¹

Looking around the world, one sees many examples of movement toward multinational currencies: twelve countries in Europe have adopted a single currency; dollarization is being implemented in Ecuador and El Salvador; and dollarization is under active consideration in many other Latin American countries, including Mexico, Guatemala, and Peru. Six West African states have agreed to create a new common currency for the region by 2003, and eleven members of the Southern African Development Community are debating whether to adopt the dollar or to create an independent monetary union possibly anchored to the South African rand. Six oil-producing countries (Saudi Arabia, United Arab Emirates, Bahrain, Oman, Qatar, and Kuwait) have declared their intention to form a currency union by 2010. In addition, several countries have maintained currency boards with either the U.S. dollar or the euro as the anchor. Currency boards are, in a sense, mid-way between a system of fixed rates and currency adoption, and the recent adverse experience of Argentina will likely discourage the use of this mid-way approach.

Currency unions typically take one of two forms. In one, which is most common, client countries (which are usually small) adopt the currency of a large anchor country. In the other case, a group of countries creates a new currency and a new joint central bank. The second arrangement applies to the euro zone.² The Eastern Caribbean Currency Area (ECCA) and the CFA zone in Africa are intermediate between the two types of unions. In both cases, the countries have a joint currency and a joint central bank.³ However,

¹In principle, an optimal currency area could also be smaller than a country, that is, more than one currency could circulate within a country. However, we have not observed a tendency in this direction.

²Some may argue that the European Monetary Union is, in practice, a German mark area, but this interpretation is questionable. Although the European central bank may be particularly sensitive to German preferences, the composition of the board and the observed policies in its first few years of existence do not show a German bias. See Alesina et al (2001).

³There are actually two regional central banks in the CFA zone. One is the BCEAO, grouping Benin, Burkina Faso, Ivory Coast, Guinea-Bissau, Mali, Niger, Senegal, and Togo, where the common currency is the *franc de la Communauté Financière*

the ECCA currency (Caribbean dollar) has been linked since 1976 to the U.S. dollar (and, before that, to the British pound), and the CFA franc has been tied (except for one devaluation) to the French franc.

The purpose of this paper is to evaluate whether natural currency areas emerge from an empirical investigation. As a theoretical background, we use the framework developed by Alesina and Barro (2002), which discusses the trade-off between the costs and benefits of currency unions. Based on historical patterns of international trade and of co-movements of prices and outputs, we find that there seem to exist reasonably well-defined dollar and euro areas but no clear yen area. However, a country's decision to join a monetary area should consider not just the situation that applies *ex ante*, that is, under monetary autonomy, but also the conditions that would apply *ex post*, that is, allowing for the economic effects of currency union. The effects on international trade have been discussed in a lively recent literature prompted by the findings of Rose (2000). We review this literature and provide new results. We also find that currency unions tend to increase the co-movement of prices but are not systematically related to the co-movement of outputs.

We should emphasize that we do not address other issues that are important for currency adoption, such as those related to financial markets, financial flows, and borrower/lender relationships.⁴ We proceed this way not because we think that these questions are unimportant, but rather because the focus of the present inquiry is on different issues.

The paper is organized as follows. Section 2 discusses the broad evolution of country sizes, numbers of currencies, and currency areas in the post-World War II period. Section 3 reviews the implications of the theoretical model of Alesina and Barro (2002), which we use as a guide for our empirical investigation. Section 4 presents our data set. Section 5 uses the historical patterns in international trade flows, inflation rates, and the co-movements of prices and outputs to attempt to identify optimal currency areas. Section 6 considers how the formation of a currency union would change bilateral trade flows and the co-movements of prices and outputs. The last section concludes.

de l'Afrique or CFA franc. The other is the BEAC, grouping Cameroon, Central African Republic, Chad, Republic of Congo, Equatorial Guinea, and Gabon, with the common currency called the *franc de la Cooperation Financiere Africaine*, also known as the CFA franc. The two CFA francs are legal tender only in their respective regions, but the two currencies have maintained a fixed parity. Comoros issues its own form of CFA franc but has maintained a fixed parity with the other two.

⁴For a recent theoretical discussion of these issues, see Gale and Vives (2002).

2 Countries and Currencies

In 1947 there were 76 independent countries in the world, whereas today there are 193. Many of today's countries are small: in 1995, 87 countries had a population less than 5 million. Figure 1, which is taken from Alesina, Spolaore, and Wacziarg (2000), depicts the number of countries created and eliminated in the last 150 years.⁵ In the period between World Wars I and II, international trade collapsed, and international borders were virtually frozen. In contrast, after the end of World War II, the number of countries almost tripled, and the volume of international trade and financial transactions expanded dramatically. We view these two developments as interrelated. First, small countries are economically viable when their market is the world, in a relatively free-trade environment. Second, small countries have an interest in maintaining open borders. Therefore, one should expect an inverse correlation between average country size and the degree of trade openness and financial integration.

Figure 2, also taken from Alesina, Spolaore, and Wacziarg (2000), shows a strong positive correlation over the last 150 years between the detrended number of countries in the world and a detrended measure of the volume of international trade. These authors show that this correlation does not just reflect the relabeling of interregional trade as international trade when countries split. In fact, a similar pattern of correlation holds if one measures world trade integration by the volume of international trade among countries that did not change their borders. Alesina and Spolaore (2002) discuss these issues in detail and present current and historical evidence on the relationship between country formation and international trade.

The number of independent currencies has increased substantially, until recently almost at the same pace as the number of independent countries. In 1947, there were 65 currencies in circulation, whereas in 2001 there were 169. Between 1947 and 2001, the ratio of the number of currencies to the number of countries remained roughly constant at about 85 per cent. Twelve of these currencies, in Europe, have now been replaced by the euro, so we now have 158 currencies.

The increase in the number of countries and the deepening of economic integration should generate a tendency to create multi-country currency areas, unless one believes that a country always defines the optimal currency area. One implication of Mundell's analysis is that political borders and currency boundaries should not always coincide. In fact, as discussed in Alesina and Spolaore (2002), small countries can prosper in a world of free trade and open financial markets. Nevertheless, these small countries may lack the size needed to provide effectively some public goods that are subject to large economies of scale or to substantial

⁵The initial negative bar in 1870 represents the unification of Germany.

externalities. A currency may be one of these goods: a small country may be too small for an independent money to be efficient. To put it differently, various ethnic, linguistic, or culturally different groups can enjoy political independence by creating their own country. At the same time, this separate country can avoid part of the costs of being economically small by using other countries to provide some public goods, such as a currency.

A country constitutes, by definition, an optimal currency area only if one views a national money as a critical symbol of national pride and identity. However, sometimes forms of nationalistic pride have led countries into disastrous courses of action. Therefore, the argument that a national currency satisfies nationalistic pride does not make an independent money economically or politically desirable. In fact, why a nation would take pride in a currency escapes us; it is probably much more relevant to be proud of an Olympic team. As for national identity, language and culture seem much more important than a currency, yet many countries have willingly retained the language of their former colonizers. Moreover, many countries undergoing extreme inflation, such as in South America, tended to change the names of their moneys frequently, so even a sentimental attachment to the name “peso” or “dollar” seems not to be so important.

In any event, as already mentioned, one can detect a recent tendency toward formation of multi-country monetary areas. In the next decade, the ratio of currencies to independent countries may decrease substantially, beginning with the adoption of the euro in 2002.

3 The costs and benefits of currency unions

We view this analysis from the perspective of a potential client country that is considering the adoption of another country’s money as a nominal anchor.

3.1 Trade benefits

Country borders matter for trade flows: two regions of the same country trade much more with each other than they would if an international border were to separate them. McCallum (1995) looked at U.S.-Canadian trade in 1988 and suggested that this effect was extremely large: trade between Canadian provinces was estimated to be a staggering 2200% larger than that between otherwise comparable provinces and states. More recent work by Anderson and van Wincoop (2001) argues that this effect from the U.S.-Canada border

was vastly exaggerated but is still substantial: the presence of an international border is estimated to reduce trade among industrialized countries by 30% and between the United States and Canada by 44%. The question is what explains why national borders matter so much for trade even when there are no explicit trade restrictions in place. Among other things, country borders tend to be associated with different currencies. Therefore, given that border effects are so large, the elimination of one source of border costs—the change of currencies—might have a large effect on trade.⁶

Alesina and Barro (2002) investigate the relationship between currency unions and trade flows. They model the adoption of a common currency as a reduction of “iceberg” trading costs between two countries. They find that, under reasonable assumptions about elasticities of substitution between goods, countries that trade more with each other benefit more from adopting the same currency.⁷

Thus, *countries that trade more with each other stand to gain more from adopting the same currency. Also, smaller countries should, ceteris paribus, be more inclined to give up their currencies. Hence, as the number of countries increases (and their average size shrinks), the number of currencies in the world should increase less than proportionately.*⁸

3.2 The benefits of commitment

If an inflation prone country adopts the currency of a credible anchor, it eliminates the inflation-bias problem pointed out by Barro and Gordon (1983). This bias may stem from two non-mutually exclusive sources: an attempt to overstimulate the economy in a cyclical context and the incentive to monetize budget deficits and debts.

A fixed exchange rate system, if totally credible, could achieve the same commitment benefit as a currency union. However, the recent world history shows that fixed rates are not irrevocably fixed; thus, they lack

⁶Obstfeld and Rogoff (2000) argue that these border effects on trade may have profound effects on a host of financial markets and may explain a lot of anomalies in international financial transactions.

⁷The intuition for why this result does not hold unambiguously is the following. If two countries do not trade much with each other initially, the likely reason is that the trading costs are high. Hence, the trade that does occur must have a high marginal value. Specifically, if the trade occurs in intermediate inputs, then the marginal product of these inputs must be high, because the trade occurs only if the marginal product is at least as high as the marginal cost. In this case, the reduction of border costs due to the implementation of a currency union would expand trade in the intermediate goods that have an especially high marginal product. Hence, it is possible that the marginal gain from the introduction of a currency union would be greater when the existing volume of international trade is low.

⁸Alesina and Barro (2002) show that, under certain conditions, an even stronger result holds: as the number of countries increases, the equilibrium number of currencies decreases.

full credibility. Consequently, fixed exchange rates can create instability in financial markets. To the extent that a currency union is more costly to break than a promise to maintain a fixed exchange rate, the currency adoption is more credible. In fact, once a country has adopted a new currency, the costs of turning back are quite high, certainly much higher than simply changing a fixed parity to a new one. The ongoing situation in Argentina demonstrates that the government really had created high costs for breaking a commitment associated with a currency board and widespread dollarization of the economy. However, the costs were apparently not high enough to deter eventual renegeing on the commitment.

A country that abandons its currency receives the inflation rate of the anchor plus the change (positive or negative) in its price level relative to that of the anchor. In other words, if the inflation rate in the United States is two percent, then in Panama it will be two percent plus the change in relative prices between Panama and the United States. Therefore, even if the anchor maintains domestic price stability, linkage to the anchor does not guarantee full price stability for a client country.

The most likely anchors are large relative to the clients. In theory, a small but very committed country could be a perfectly good anchor. However, *ex post*, a small anchor may be subject to political pressure from the large client to abandon the committed policy. From an *ex ante* perspective, this consideration disqualifies the small country as a credible anchor.

In summary: *The countries that stand to gain the most from giving up their currencies are those that have a history of high and volatile inflation. This kind of history is a symptom of a lack of internal discipline for monetary policy. Hence, to the extent that this lack of discipline tends to persist, such countries would benefit the most from the introduction of external discipline. Linkage to another currency is also more attractive if, under the linked system, relative price levels between the countries would be relatively stable.*

3.3 Stabilization policies

The abandonment of a separate currency implies the loss of an independent monetary policy. To the extent that monetary policy would have contributed to business-cycle stabilization, the loss of monetary independence implies costs in the form of wider cyclical fluctuations of output.

The costs of giving up monetary independence are lower the higher the association of shocks between the client and the anchor. The more the shocks are related the more the policy selected by the anchor will be appropriate for the client as well. What turns out to matter is not the correlation of shocks, *per se*, but rather the variance of the client country's output expressed as a ratio to the anchor country's output.

This variance depends partly on the correlation of output (and, hence, of underlying shocks) and partly on the individual variances of outputs. For example, a small country's output may be highly correlated with that in the United States. But, if the small country's variance of output is much greater than that of the United States, then the U.S. monetary policy will still be inappropriate for the client. In particular, the magnitude of countercyclical monetary policy chosen by the United States will be too small from the client's perspective.

The costs implied by the loss of an independent money depend also on the explicit or implicit contract that can be arranged between the anchor and its clients. We can think of two cases. In one, the anchor does not change its monetary policy regardless of the composition and experience of its clients. Thus, clients that have more shocks in common with the anchor stand to lose less from abandoning their independent policy but have no influence on the monetary policy chosen by the anchor country. In the other case, the clients can compensate the anchor to motivate the selection of a policy that takes into account the clients' interests, which will reflect the shocks that they experience. The ability to enter into such contracts makes currency unions more attractive. However, even when these agreements are feasible, the greater the association of shocks between clients and anchor, the easier it is to form a currency union. Specifically, it is cheaper for a client to buy accommodation from an anchor that faces shocks that are similar to those faced by the clients.⁹ The allocation of seignorage arising from the client's use of the anchor's currency can be made part of the compensation schemes.

The European Monetary Union is similar to this arrangement with compensation, because the monetary policy of the union is not targeted to a specific country (say Germany) but, rather, to a weighted average of each country's shocks, that is, to aggregate euro-area shocks. In the discussion leading up to the formation of the European Monetary Union, concerns about the degree of association among business cycles across potential members were critical. In practice, the institutional arrangements within the European Union are much more complex than a compensation scheme, but the point is that the ECB does not target the shocks of any particular country but, rather, the average European shocks.¹⁰

In the case of developing countries, the costs of abandoning an independent monetary policy may not be

⁹Note that, in theory, a small country could be an ideal anchor because it is cheaper to compensate such an anchor for the provision of monetary services that are tailored to the interests of clients. However, as discussed before, a small anchor may lack credibility.

¹⁰The European Union also has specific prescriptions about the allocation of seignorage. The amounts are divided according to the share of GDP of the various member countries. For a discussion of the European Central Bank policy objectives and how this policy relates to individual country shocks, see Alesina et al (2001)

that high because stabilization policies are typically not well used when exchange rates are flexible. Recent work by Calvo and Reinhart (2002) and Hausmann, Panizza, and Stein (1999) suggests that developing countries tend to follow procyclical monetary policies, specifically, they tend to raise interest rates in times of distress to defend the value of their currency.¹¹ To the extent that monetary policy is not properly used as a stabilization device, the loss of monetary independence is not a substantial cost (and may actually be a benefit) for developing countries. However, recent work by Broda (2001) shows that countries with floating exchange rate systems show superior performance in the face of terms-of-trade shocks. This pattern may reflect the benefits from independent monetary policies.

To summarize, *the countries that have the largest co-movements of outputs and prices with potential anchors are those with the lowest costs of abandoning monetary independence.*

3.4 Trade, geography, and co-movements

Countries that trade more can benefit more from currency unions for the reasons already discussed. Increased trade may also raise the co-movements of outputs and prices. In this case, there is a second reason why countries that trade more would have a greater net benefit from adopting a currency union.

An established literature on the “gravity model” of trade shows that bilateral trade volumes are well explained by a set of geographical and economic variables, such as the distance between the countries and the sizes and incomes of the countries. Note that the term “distance” has to be interpreted broadly to include not only literal geographical distance, but also whether the countries share a common language, legal system, and so on. In addition, some geographical variables may influence co-movements of outputs and prices beyond their effects through trade. For example, locational proximity and weather patterns may relate to the nature of underlying shocks, which in turn influence the co-movements.

Whether more trade always means more co-movements of outputs and prices is not a settled issue. On the theoretical side, the answer depends largely on whether trade is inter-industry or intra-industry. In the latter case, more trade likely leads to more co-movements. However, in the former case, increased trade may stimulate sectoral specialization across countries. This heightened specialization likely lowers the co-movements of outputs and prices, because industry specific shocks would become country specific shocks.¹²

¹¹A literature on Latin America, prompted mostly by a paper by Gavin and Perotti (1997), has also shown that fiscal policy has the “wrong” cyclical properties. That is, surpluses tend to appear during recessions and deficits during expansions.

¹²See Frankel and Rose (1998) for the argument that more trade favors more correlated business cycles. See Krugman (1993) for the opposite argument. For an extensive theoretical and empirical discussion of these issues, see Ozcan, Sorensen, and Yosha

The type of trade between two countries is also likely influenced by the levels of per capita GDP, for example, intra-industry trade tends to be much more important for rich countries.

In summary, *geographical or gravity variables affect bilateral trade and, as a result, the costs and benefits of currency unions. Some geographical variables may have an affect on the attractiveness of currency unions beyond those operating through the trade channel.*

4 Data and methodology

4.1 Data description and sources

Data on outputs and prices come from the World Bank's *World Development Indicators (WDI)* and Penn World Tables 5.6. Combining both sources, we form a panel of countries with yearly data on outputs and prices from 1960 to 1997 (or, in some cases, for shorter periods). For output, we use real per capita GDP expressed in 1995 U.S. dollars. To compute relative prices, we use a form of real exchange rate relating to the price level for gross domestic products. The measure is the purchasing-power-parity (PPP) for GDP divided by the U.S. dollar exchange rate.¹³ In the first instance, this measure gives us the price level in country i relative to that in the United States, $P_{i,t}/P_{US,t}$. We then compute relative prices between countries i and j by dividing the value for country i by that for country j . Inflation is computed as the continuously compounded (log-difference) growth rate of the GDP deflator, coming from *World Development Indicators*.

Bilateral trade information comes from Glick and Rose (2001), which in turn is extracted from the International Monetary Fund's *Direction of Trade Statistics*. These data are expressed in real U.S. dollars.¹⁴

To compute bilateral distances, we use the great-circle-distance algorithm provided by Gray (2001). Data on location, as well as contiguity, access to water, language, and colonial relationships come from the *CIA World Fact Book 2001*. Data on free-trade agreements come from Glick and Rose (2000) and are complemented with data from the World Trade Organization web page.

(2001, 2002) and Imbs (2000).

¹³ $P_i = \frac{PPP \text{ of } GDP_i}{Ex.rate}$ measures how many units of U.S. output can be purchased with one unit of country i 's output, that is, it measures the relative price of country i 's output with respect to that of the United States. By definition, this price is always one when i is the United States.

¹⁴ Glick and Rose (2001) deflated the original nominal values of trade by the U.S. consumer price index, with 1982-84=100. We use the same index to express trade values in 1995 U.S. dollars.

4.2 The computation of co-movements

We pair all countries and calculate bilateral relative prices, P_{it}/P_{jt} . (This ratio measures the value of one unit of country i 's output relative to one unit of country j 's output.) This procedure generates 21,321 (207·206/2) country-pairs for each year. For every pair of countries, (i, j) , we use the annual time series $\left\{ \ln \frac{P_{it}}{P_{jt}} \right\}_{t=1960}^{t=1997}$ to compute the second-order autoregression:¹⁵

$$\ln \frac{P_{it}}{P_{jt}} = b_0 + b_1 \cdot \ln \frac{P_{i,t-1}}{P_{j,t-1}} + b_2 \cdot \ln \frac{P_{i,t-2}}{P_{j,t-2}} + \varepsilon_{tij}.$$

The estimated residual, $\hat{\varepsilon}_{t,i,j}$, measures the relative price that would not be predictable from the two prior values of relative prices. We then use as a measure of (lack of) co-movement of relative prices the root-mean-squared error:

$$VP_{ij} \equiv \sqrt{\frac{1}{T-3} \sum_{t=1}^T \hat{\varepsilon}_{tij}^2}.$$

The lower VP_{ij} , the greater the co-movement of prices between countries i and j .

We proceed analogously to compute a measure of output co-movement. The value VY_{ij} comes from the estimated residuals from the second-order autoregression on annual data for relative per capita GDP:

$$\ln \frac{Y_{it}}{Y_{jt}} = c_0 + c_1 \cdot \ln \frac{Y_{i,t-1}}{Y_{j,t-1}} + c_2 \cdot \ln \frac{Y_{i,t-2}}{Y_{j,t-2}} + u_{tij}.$$

The estimated residual, \hat{u}_{tij} , measures the relative output that would not be predictable from the two prior values of relative output. We then use as a measure of (lack of) co-movement of relative outputs the root-mean-squared error:

$$VY_{ij} \equiv \sqrt{\frac{1}{T-3} \sum_{t=1}^T \hat{u}_{tij}^2}.$$

The lower VY_{ij} , the greater the co-movement of outputs between countries i and j .

For most countries all of the data are available. However, we exclude from the computation of co-movements

¹⁵We use fewer observations when the full time series from 1960 to 1997 is unavailable. However, we drop country-pairs for which fewer than 20 observations are available.

country pairs for which we do not have at least 20 observations. Note that this limitation implies that we cannot include in our analysis most of central and eastern Europe, a region in which some countries are likely clients of the euro.

5 Which currency areas?

In this section, we sketch “natural” currency areas, based on the criteria discussed above. For anchor currencies, we consider the U.S. dollar, the euro, and the yen. We are not assuming that all countries have to belong to one of the unions centered around these three currencies. In fact, many countries turn out not to be good clients for any of the anchors and seem to be better off by keeping their own currency. Therefore, we are addressing the question of which countries would be better served by joining some currency union, as well as the question of which anchor should be chosen if one is needed.

5.1 Inflation, trade, and co-movements

We begin in Table 1a by showing the average inflation rate, using the GDP deflator, for selected countries and groups in our sample from 1970 to 1990. We stopped at 1990 because, in the 1990s, several countries adopted currency arrangements, such as the EMS, that contributed to reduced inflation. We are interested here mostly in capturing inflation rates that would arise in the absence of a monetary anchor. We take the 1970s and 1980s (that is, after Bretton Woods and before the recent emphasis on nominal anchors) as a period with few true monetary anchors. We show the 20 countries with the highest average inflation rates, along with the averages for industrialized countries and for regional groups of developing countries.

The top 5 average rates of inflation are all Latin American countries, and 7 Latin American countries are in the top 11. The top 5 countries had an average annual inflation rate above 280%. Despite its poor economic performance in other dimensions, Africa does not have a very high average inflation rate. While there are 6 African countries in the top 20, the average for the continent is brought down by the countries in the CFA franc zone, which have relatively low inflation records. The Middle East is the second highest inflation group, with two countries, Israel and Lebanon, in the top 13 with inflation rates of 78% and 44%, respectively. In the euro-zone, Greece and Italy lead in the rankings, with inflation rates of 16% and 13%, respectively. Overall, 11 countries had an average annual inflation rate of more than 50 percent, 30 countries had an average inflation above 20 percent, and 72 countries exceeded 10 percent.

Table 1b shows inflation variability and is organized in the same way as Table 1a. Since average inflation and inflation variability are strongly positively correlated, 16 of the top 20 countries in Table 1a are also in the top 20 of Table 1b. However, in some cases, such as Chile, the high average inflation rate (107 percent) reflected one episode of hyperinflation followed by relative stability. In others, such as Colombia, the fairly high average inflation rate (22 percent) resulted from a long period of moderate, double-digit inflation.

Tables 2a, 2b, and 2c list for selected countries and groups the average trade-to-GDP ratios¹⁶ over 1960-97 with three potential anchors for currency areas: the United States, the euro area (based on the twelve members), and Japan. The GDP value in the denominator of these ratios refers to the country paired with the potential anchor.

The tables show that Japan is an economy that is relatively closed; moreover, in comparison with the United States and the euro region, Japan's trade is more dispersed across partners. Hence, few countries exhibit a high trade-to-GDP ratio with Japan. Notably, industrial countries' average trade share with Japan is below one percent. Among developing countries, oil exporters have a high trade share with Japan, but still below that with the euro-12. Singapore, Malaysia, Hong Kong and Indonesia exhibit a relatively high trade-to-GDP ratio with Japan (above 7 percent), but Singapore and Hong Kong trade even more with the United States. For the United States, aside from Hong Kong and Singapore, a good portion of Latin America has a high ratio of trade to GDP. Canada is notable for trading almost exclusively with the United States: the trade ratio is 18 percent, compared with 1.7 percent for the euro-12 and 1.4 percent for Japan. African countries, broadly speaking, trade significantly more with Europe, but some of them, such as Angola and Nigeria, are also closely linked with the United States.

Tables 3a, 3b, and 3c report our measures of the co-movements of prices for selected countries with the United States, the euro-12 area, and Japan.¹⁷ Remember that a higher number means less co-movement. Panama and Puerto Rico, which use the U.S. dollar, have the highest co-movements of prices with the United States. These two are followed by Canada and El Salvador, which has recently dollarized. Members of the OECD have fairly high price co-movements with all three of the potential anchors (which are themselves members of the OECD). For Japan, the countries that are most closely related in terms of price co-movements lack a clear geographical distribution. For the euro-12, the euro members and other western European countries have a high degree of price co-movement. African countries also have relatively high price co-

¹⁶The trade measure is equivalent to the average of imports and exports. Glick and Rose's (2001) values come from averaging four measures of bilateral trade (as reported for imports and exports by the partners on each side of both transactions).

¹⁷Recall that we compute co-movements only for pairs of countries for which we have at least 20 annual observations.

movements with the euro-12, higher than that with the United States.

Tables 4a, 4b, and 4c report our measures of the co-movements of outputs (per capita GDPs) for selected countries with the United States, the euro-12 area, and Japan.¹⁸ The general picture is reasonably similar to that for prices. Note that all of the OECD countries have relatively high output co-movements with the three anchors, particularly with the euro-12. Japan's business cycle seems to be somewhat less associated with the rest of the world: even developing countries in Asia tend to exhibit, on average, higher output co-movements with the euro-12. The regional patterns show that Africa is generally more associated with the euro-12, whereas there is more ambiguity for Latin America.

Overall, Japan is a worse anchor than the United States and the euro-12 because fewer countries are associated with Japan in terms of price and output co-movements, and trade flows to Japan are more dispersed across partners. Africa is more associated in terms of price and output co-movements with the euro-12 than with the United States, and Africa also trades more with the euro zone. North America is highly associated with the United States. As for Latin America, this region trades overall more with the United States than with the euro zone or Japan. However, co-movements of prices and outputs for this region are not much higher with respect to the United States than they are with the euro-12. An interesting case is Argentina. In terms of co-movements of prices and outputs, Argentina is more associated with the euro area than with the United States. Mexico, in contrast, is much more associated in its price and output co-movements with the United States. In Asia, Hong Kong and Singapore are more associated with the United States than with Japan.

Looking at the tables, the patterns of trade and price and output co-movements suggest geographically connected areas that are linked to the U.S. dollar (North and part of South America) and the euro zone (Europe and Africa). For Japan, at most a small part of east Asia seems to apply.

5.2 Which Currency Unions?

This section brings together the data already presented to discuss which currency unions appear most attractive in terms of the criteria suggested by the underlying theory. The natural clients, with respect to the three proposed anchors, are those countries that have no ability to commit to low inflation (as evidenced by a history of high and variable inflation), that trade a lot (at least potentially) with the anchor, and have high price and output co-movements with the anchor. The implicit assumption here is that the patterns

¹⁸As for prices, we consider only pairs of countries for which we have at least 20 observations.

for trade and co-movements that apply *ex ante* (under monetary autonomy) would also apply at least in a relative sense *ex post* (under a currency union).

We begin in Table 5 by listing the 28 countries in our sample with average inflation rates of at least 15 percent per year from 1970 to 1990.¹⁹ We suggest that these countries are likely to have a high demand for an external nominal anchor because of their evident lack of commitment to low inflation. We then list for these countries their trade shares and measures of price and output co-movements with the three potential anchors.

Table 6 summarizes the information from Table 5 by listing for each of the three criteria (trade, price co-movement, and output co-movement) which of the three anchors is best. A bold entry means that the chosen anchor is “much” superior to the other two, a regular font means that the difference with at least one other anchor is small. More specifically, a bold entry in the trade column means that the highest trade share with one of the three potential anchors is more than four percentage points higher than that of the second of the three. In the case of price co-movements, a bold entry means that the absolute value of the difference between the most associated of the three and the second one is larger than 0.025. For the output co-movement, the same definition applies with a cut off of 0.005. These cut-off choices are arbitrary, but the reader using the data reported in Table 5 can calculate another cut-off. These criteria emphasize the choice among potential anchors, rather than the choice of whether to retain an independent currency.

Several interesting observations emerge from Table 6. First, Japan is not an attractive anchor for virtually any of the high-inflation countries. Out of 96 entries in the table, only 8 (which includes one tie) are for Japan. No case has more than one of the criteria in favor of Japan.

Second, high inflation Latin American countries are by no means a clear dollarization block. In fact, Brazil might be better served by adopting the euro. (Although there is no clear superiority in terms of trade or price co-movements, the euro performs better in terms of co-movement of output.) The case of Argentina is interesting: having one of the highest inflation rates, this country seems to be one of the best examples of a place with a high demand for an external currency anchor. However, as shown in Table 5, Argentina has been highly closed to international trade, and its output and price co-movements are not high with any of the three potential anchors. So, other than its lack of commitment ability, Argentina does not appear to be an obvious member of a currency union with the euro or the U.S. dollar. In contrast, Mexico and Ecuador look much closer to the U.S. dollar than to the euro. The same conclusion applies to the Dominican

¹⁹We restrict this analysis to countries with populations larger than 500,000 in 1997. The analysis is also constrained by data availability: only countries with data on co-movements of output and prices are considered.

Republic. Nicaragua has low co-movements with all three anchors, but its exports go mostly toward Europe. Hence, the euro might be a better choice than the U.S. dollar. Chile and Uruguay have higher exports to Europe, but they have larger co-movements with the United States.

Third, looking at countries at the geographical boundaries of Europe, in some cases their natural anchor is the euro: this conclusion applies to Greece (which has joined the euro zone) and Turkey. Israel might be a good candidate for the euro, although it could also be well served by the U.S. dollar. As for Africa, trade shares are much higher with Europe. Co-movements are, however, just as high with the United States. Ghana, Guinea-Bissau, and Sierra Leone seem to be natural euro clients, but other African countries are less clear.

We have measured lack of ability to commit based on the past inflation experience. One could also look at institutional measures of potential commitment, such as the degree of central bank independence. However, although this measure has some explanatory power for inflation performance among OECD countries, it does not seem to explain much for developing countries.²⁰

High inflation countries are not the only potential clients of an anchor. If a country trades extensively with a potential anchor, then adopting the anchor currency may be a good strategy even if the inflation rate under autonomy were low. In Table 7, we report all the countries that have a trade share with at least one of the potential anchors of at least 9 percent of GDP. In column one we report the name of the anchor that has the highest trade share; when more than one anchor has a value of at least 9 per cent, we report all in decreasing order. For example, if country X's trade share was 15 percent of its GDP with the United States and 9 percent with the euro-12, the column would read USA/Euro. In the next column, we report the name of the anchor with the highest co-movements of prices and output, with the same convention as before concerning the bold entries.

The first inference from Table 7 is that the countries forming the euro-12 area do seem to belong together. The same observation applies to other European countries that are not currently members of the euro-12, such as Sweden and Switzerland. Second, African countries trade more with Europe than with the United States or Japan, so, by and large, the best potential anchor for Africa is the euro. Note that the CFA franc zone is already tied to the euro. Third, Central American countries trade much more with the United States. Fourth, for several East Asian countries, such as Hong Kong and Singapore, the U.S. dollar appears to be superior to the yen as a potential anchor. These Asian countries trade more with the United States and are more closely associated with the U.S. business cycle. Canada is extremely tied to the United States in any

²⁰See Alesina and Summers (1993) for OECD country evidence and Cukierman (1992) for evidence on developing countries.

dimension.²¹

Overall, we find that geographically connected currency areas tend to emerge with the U.S. dollar and the euro as the anchor. However, Japan does not emerge as much of an anchor. Putting together the results from Table 7 with those of Tables 5 and 6, we draw the following conclusions. 1) There seems to be a fairly clear dollar area involving Canada, Mexico, most of Central America, and parts of South America (excluding Argentina and Brazil). Farther afield geographically, the dollar zone seems also to encompass some Asian countries, such as Hong Kong and Singapore. 2) The euro area includes all of western Europe and most of Africa. Argentina might actually be better served by joining the euro area than the dollar area. However, the only criterion for Argentina to be seeking any anchor is her history of high inflation. 3) There does not seem to be any clear yen area. 4) There are several countries that do not appear in Tables 5-7. These are countries with low inflation that do not trade much with any of the three potential anchors. Primary examples are India, Australia, and New Zealand.

It is worthwhile to compare briefly our results with those of Ghosh and Wolf (1994), who use a different approach to assess the pros and cons for regions and countries to form currency unions. They argue that optimal currency areas are typically formed by countries that are geographically disconnected. For example, they conclude that Europe and the states of the United States are not optimal currency areas. We have not examined the U.S. states, but Europe does present a good case for a currency union based on our examination of the patterns of trade and co-movements of prices and outputs. More generally, despite some exceptions, geographical proximity typically fits well with our criteria for currency unions. The differences between our findings and those of Ghosh and Wolf seem to arise because they do not emphasize the link between currency unions and trade and because they assume a very high cost from imperfect synchronization of business cycles.

Ideally, we would go beyond the simple criteria thus far advanced to evaluate the relative costs and benefits of the trade-off leading to the choice of currency adoption. For example, should a country such as Argentina with high inflation but low co-movements with the United States and the euro zone remain autonomous or use the dollar or the euro? How much can trade benefits of a currency union compensate for the loss of monetary autonomy? To answer these questions, we need more quantitative information than we have yet generated.

²¹See Buiters (1999) for a discussion of this point.

6 What changes with currency adoption?

Thus far, we have discussed the possible configuration of currency areas based on the behavior of inflation, trade, and the co-movements of prices and outputs that prevail (in most cases) before the creation of a currency union. In choosing whether to join a monetary area, a potential entrant would have to estimate the values of trade and co-movements that would apply after the entry. In practice, this calculation is difficult—for the potential entrant and also for the econometrician.²² In the next section, we discuss estimates of effects from joining a currency union on international trade flows. Then we discuss some new estimates of effects of currency union on trade and on co-movements of prices and outputs.

6.1 Currency unions and international trade: the available evidence

Most of the existing empirical work on the effects of currency unions on trade flows has been framed in the context of the standard “gravity model.” According to this approach, the bilateral trade between a pair of countries is increasing in their GDPs and is inversely related to their distance, broadly construed to include all factors that create “trade resistance.” The gravity equation is then augmented with a dummy variable indicating whether or not the countries share the same currency. The estimate of the coefficient on this dummy is interpreted as the currency-union effect. In the seminal paper in this area, Rose (2000) reports that bilateral trade between two countries that use the same currency is, controlling for other effects, over two-hundred-percent larger than bilateral trade between countries that use different currencies.

The apparently large effect of currency unions on trade is surprising because estimates of the effect of reduced exchange rate volatility on trade are small (see, for example, De Grauwe and Skudelny [2000], Frankel and Wei [1993], and Eichengreen and Irwin [1995]). Moreover, fees on currency conversion are typically a small percentage of total transaction costs.²³ On the other hand, as already discussed, border effects on trade are large, and perhaps these large effects can be explained by the necessity to use different currencies on the two sides of a border.

Numerous empirical studies, summarized in Table 8, have examined and extended Rose’s research. Pakko and Wall (2001) focus on time-series variation, which involves cases in which currency union is either implemented or abandoned. Their findings reveal a negative, though insignificant, effect of currency union on

²²Issing (2001) argues that one should expect that prices and outputs will move more closely together in the European Union after the adoption of the euro.

²³The argument that currency conversion fees are low may not apply to trade in capital, where the currency turnover is extremely high and, hence, small proportionate costs can translate into large disbursements.

trade. However, Glick and Rose (2002) use an expanded panel data set that includes more episodes of regime switching. With this enlarged data set, they find large and positive estimates from the time-series variation.

Rose (2001) provides new estimates of the effect of currency unions on trade, making use of the time-series as well as cross-sectional variation in the data. This study reports a wide range of estimates, using different samples and techniques. Point estimates range from a negative, though insignificant, effect of - 68%, using fixed effects in the original sample, to a 708% effect using a matching sample technique and a much broader data base.

Rose and Van Wincoop (2001), Nitsch (2002), Melitz (2001), Klein (2002), and Levy (2001) address problems of aggregation bias, arguing that pooling different currency unions may mask differential effects. Yet, all these studies point toward a significantly positive effect on trade. Thom and Walsh (2001) present a case study on Ireland's break with sterling, finding no significant effect on trade. Other studies, including Flandreau and Maurel (2001) and Lopez-Cordova and Meissner (2001), focus on pre-WWI data.

The underlying assumption in the various empirical studies is that currency unions are randomly chosen. Standard endogeneity problems can, however, confound the estimates. For example, the presence of currency union may encourage trade, but the presence or potential for substantial trade may also stimulate the formation of a currency union. The use of country-pair fixed effects, employed in some of the studies, may not alleviate this simultaneity problem because a shift at some point in trade linkages may be related to the change in the propensity to form a currency union.

Similarly, the existence of a currency union may reflect unmeasured characteristics that also influence the volume of bilateral international trade. The currency union dummy can get credit for the effects of these unobserved variables. As examples, compatibility in legal systems, greater cultural links, and tied bilateral transfers may increase the propensity to form a currency union as well as strengthen trade links between two countries. In these cases, the OLS estimate of the currency union effect on trade tends to be biased upward. Other omitted variables may bias OLS estimates in the opposite direction. For example, a higher level of monopoly power means higher mark-ups, which tend to deter trade. At the same time, a greater degree of monopoly distortion may lead to higher inflation rates under discretion and, thereby, increase the desire to join a currency union as a commitment device to reduce inflation.

Persson (2001) voices a different critique based on the potential for self-selection in the decision to form a currency union. Among other distinctive features, countries that have been engaged in currency unions during the past decades are typically small and poor, tend to be geographically close, and are likely to share tight cultural links. Examples are the 15 countries of the CFA-franc zone in Africa, the seven members of

the Eastern Caribbean Currency Area, and the unilaterally dollarized Panama, Puerto Rico, and Bermuda. Systematic differences in observable characteristics can distort OLS estimates when the effect of using the same currency differs across groups or when there are other types of non-linearities in the trade relation that have been ignored. Using semi-parametric methods, Persson’s study finds little support for a currency-union effect on trade; his point estimates, ranging from 13% to 45%, are not statistically significantly different from zero. This result is not surprising, however, because the matching procedure—designed to deal with non-linearities in observable variables—throws out much of the information in the sample. Moreover, as already noted, when Rose (2001) applies the matching approach to a broader data set, he obtains an enormous estimate for the effect of currency union on trade.

Another concern is a mechanical problem caused by sample selection. Previous estimates of the currency union effect were based on a sample of countries with positive bilateral trade flows. Pairs of countries with zero trade flows—typically pairs of small countries—were excluded from the sample to satisfy the log-specification of the gravity equation. This issue may be important because roughly half of the annual country-pair observations exhibit zero trade.

6.2 The effects of currency unions: new results

To address the various estimation issues, Tenreyro (2002) begins by studying the empirical determinants of past and present currency unions.²⁴ She uses a probit analysis for all country pairings from 1960 to 1997 with four potential currency anchors: Australia, France, the United Kingdom, and the United States.²⁵ The anchors used here are different from the hypothetical ones considered before for obvious reasons: the euro did not exist before 2002, and the now defunct French franc was historically an important anchor currency. Interestingly, the yen was never an anchor for anyone.

The main results, reported in Table 9, are that a currency union with one of the four candidate anchors is more likely if the client country is (1) closer geographically to the anchor; (2) has the same language as the anchor; (3) is a former or current colony of the anchor; (4) is poorer in terms of per capita GDP; and (5) is smaller, in terms of population size. The probability is increasing in the per capita GDP of the anchor (among the four considered). Elements that do not matter significantly include island or land-locked status

²⁴Persson (2001) also modeled the choice of currency union, but he did not use this analysis to construct instrumental variables.

²⁵Her analysis, unlike Rose’s (2000), treats the CFA countries as in a currency union with France. She also departs from Rose in treating the ECCA countries as in a currency union with the United States since 1976 and with the United Kingdom before that.

and a common border with the potential anchor.

Our general idea is to use the estimated model for the propensity of a country to enter into a currency union to form an instrumental variable for the currency-union dummy. However, it does not work directly to use the estimates from the probit equation because the determinants of the probability of currency union (such as distance and other gravity variables) also enter directly into the determinants of bilateral trading volume. Hence, Tenreyro (2002) adopts an indirect approach.

Consider any potential client country, i , which is evaluating the adoption of a currency with one of the four anchors considered, denoted by $k = 1, 2, 3, 4$. The probit regression determines the estimated probability, $p(i, k)$, of the currency adoption. This probability depends on the distance between i and k and the other variables mentioned above. If the countries take their currency union decisions independently, then the joint probability that i and j use the currency of anchor k will be given by

$$J^k(i, j) = p(i, k) * p(j, k).$$

Note that $J^k(i, j)$ will be high if countries i and j are both close to potential anchor k . The idea, for example, is that Ecuador and El Salvador currently share a common money (the U.S. dollar) not because they are close to each other but, rather, because each is close to the United States and, hence, each was independently motivated to adopt the U.S. dollar.

The joint probability that i and j use the same foreign currency (among the four candidates considered) will then be given by the sum of the joint probabilities over the support of potential anchors k :²⁶

$$J(i, j) = \sum_{k=1}^4 J^k(i, j) = \sum_{k=1}^4 p(i, k) * p(j, k).$$

One can then use the variable $J(i, j)$ as an instrument for the currency-union dummy, for example, in equations for bilateral trade between countries i and j . The underlying assumption for the validity of this instrument is that the bilateral trade between countries i and j depends on bilateral gravity variables for i and j but not on gravity variables involving third countries, notably those associated with the potential anchor countries k . These gravity variables involving third countries affect the propensity of countries i and

²⁶For a pair of anchors, say, k_1 and k_2 , the probability is $J(k_1, k_2) = p(k_1, k_2) * [1 - p(k_1, k_3) - p(k_1, k_4)] + p(k_1, k_2) * [1 - p(k_2, k_3) - p(k_2, k_4)] + \sum_{s=3}^4 p(k_1, k_s) * p(k_2, k_s)$.

j to be part of the same currency zone and, thereby, influence bilateral trade between i and j through that channel. However, these variables do not (by assumption) directly influence the bilateral trade between i and j .

Tenreyro (2002) uses the new instrument for the currency-union dummy to estimate relations for pairs of countries for trading volume, co-movement of prices, and co-movement of outputs. We present some of these results in Table 10, which, for brevity, reports only the estimated coefficients of the currency-union variable.

For bilateral trade, the results use annual data from 1960 to 1997 for all pairs of countries. Taking account of data availability, this system comprises over 300,000 observations (when we include the roughly half of the sample that has zeroes for bilateral trade). The dependent variable is measured as $\log(\text{trade} + \text{positive constant})$, where the presence of the positive constant allows us to include the zero-trade observations in the regressions. For the results shown in Table 10, the constant is set to 100 1995 U.S. dollars. The system includes as independent variables a set of usual gravity measures—log of geographical distance, membership in a regional trade agreement, common language, former and current colonial relationship, common colonizer, common border, and island and land-locked status—along with the logs of GDP per capita, population, and area for each country in a pair.²⁷ The OLS estimates of the gravity variables are typically significant.²⁸

Table 10 shows that the estimated coefficient on the currency-union dummy variable is 0.75 (s.e.=0.20) when country fixed effects are excluded and 0.91 (0.18) when country fixed effects (not country-pair effects) are included. These results accord reasonably well with those presented by Rose (2000), despite two major differences in the approaches. First, since he used $\log(\text{trade})$ as the dependent variable, he discarded all of the zero trade observations (which, as mentioned, constitute roughly half of the sample). Second, we defined the currency-union dummy more liberally than Rose, in that we treated the CFA franc countries as in a union with the French franc and the ECCA countries as in a union with the U.S. dollar or the British pound (depending on the time period). The estimated effect of the currency-union dummy variable is larger if we adopt Rose’s more restrictive definition of a currency union.²⁹

More interestingly, the estimated effects of currency union on bilateral trade become larger when we estimate by instrumental variables, using the instrument discussed before. As shown in Table 10, the estimated coefficient on the currency-union dummy variable becomes 1.56 (0.44) when country fixed effects are

²⁷See the bottom of Table 10 for the list of independent variables.

²⁸The error terms in the systems are allowed to be correlated over time for a given country pair.

²⁹The OLS estimates become 1.24 (0.25) without country fixed effects and 1.06 (0.23) with country fixed effects.

excluded and 2.70 (0.44) when these fixed effects are included.³⁰ Hence, these results support the argument that currency union has an important positive effect on bilateral trade. Moreover, these instrumental estimates provide some reason to believe that the causality runs from currency union to trade, rather than the reverse.

The co-movement of prices is measured by the negative of the standard error VP_{ij} discussed before. In this case, the sample consists of one observation (estimated for 1960-97) on each country pair for pairs that have the necessary data. We relate this measure of price co-movement to the gravity variables already mentioned and to various measures of country size (logs of per capita GDP, population, and area). Most of the gravity variables turn out to be statistically insignificant in the estimates, although common language and a common colonial heritage are associated with greater price co-movement. Co-movement also rises with the log of per capita GDP of each country but falls with the log of area of each country.

Table 10 shows that the currency-union dummy is significantly positive for price co-movement, with an estimated coefficient of 0.069 (s.e.=0.006) when country fixed effects are excluded and 0.046 (0.003) when these fixed effects are included. These estimated effects are substantial relative to the mean of the co-movement variable (the negative of the price equation standard deviation) of -0.16. The positive estimated effect of currency union on price co-movement may emerge because currency-union countries avoid the sometimes volatile inflation rates and nominal exchange rates that characterize other regimes. The instrumental estimates are even higher than those generated by OLS. In this case, the estimated coefficients are 0.24 (0.02) when country fixed effects are excluded and 0.087 (0.008) when these fixed effects are included.

The co-movement of outputs is measured by the negative of the standard error VY_{ij} discussed before. The sample again comprises one observation (estimated for 1960-97) on each country pair with the available data. The explanatory variables are the same as those used for price co-movements. The main effects from the gravity variables turn out to be positive relationships with a common border, a common language, and with prior and current colonial linkages. However, Table 10 shows that the estimated coefficients on the currency-union dummy variable are typically insignificantly different from zero. These results may arise because, as discussed before, the theoretical link between currency union and output co-movement is ambiguous.

³⁰The estimated effects are even larger if we adopt Rose's (2000) more restrictive definition of currency unions. In the instrumental estimation, the estimated coefficients of the currency-union dummy variable are then 2.72 (0.75) when country fixed effects are excluded and 4.68 (0.79) when these fixed effects are included.

7 Conclusions

The basic message of this paper is two-fold. First, based on the historical data on inflation, trade, and co-movements of prices and outputs, we argued that there exist well-defined dollar and euro areas but no clear yen area. Second, it is likely that the adoption of another's country's currency increases bilateral trade and raises the co-movement of prices. These responses suggest that our examination of the trade patterns and co-movements that applied before the adoption of a common currency would underestimate the potential benefits from joining a currency union.

Several issues should be considered in future empirical research. First, the results of the instrumental estimation for the effects of currency union need to be analyzed more fully. Second, these results can be used to estimate how the introduction of a currency union would affect trade and the co-movements of prices and outputs for individual country-pairs under the hypothetical adoption of a currency union with a specified anchor country. These results would then feed back into our previous analysis of the desirable pattern of world currency unions. Third, using methodologies analogous to those used in this paper, we can assess the formation of currency unions that are not linked to a "major" anchor. For example, we can evaluate a Latin American currency union or the proposed unions in southern Africa and among the Persian Gulf states. Fourth, we expect to make particular use of the evidence that accumulates from the experience of the European Monetary Union.

8 References

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**Table 1a. Mean Annual Inflation Rate (percent per year),
1970-1990***

<i>High-Inflation Countries (ranked by inflation rate)**</i>	
Nicaragua	1168
Bolivia	702
Peru	531
Argentina	431
Brazil	288
Vietnam	213
Uganda	107
Chile	107
Cambodia	80
Israel	78
Uruguay	62
Congo, Dem. Rep.	49
Lebanon	44
Lao PDR	42
Mexico	41
Mozambique	41
Somalia	40
Turkey	39
Ghana	39
Sierra Leone	34
<i>Industrial Countries</i>	
unweighted mean	9.8
<i>Developing Countries, unweighted means</i>	
Africa	16.3
Asia	17.4
Europe	6.9
Middle East	19.6
Western Hemisphere	98.6

*Based on GDP deflators. Source: WDI 2001.

**This group includes only countries with 1997 population above 500,000.

**Table 1b. Inflation Rate Variability (percent per year),
1970-1990***

<i>Countries with High Inflation Variability (ranked by standard deviation of inflation)**</i>	
Nicaragua	3197
Bolivia	2684
Peru	1575
Argentina	749
Brazil	589
Chile	170
Vietnam	160
Israel	95
Cambodia	63
Uganda	63
Mozambique	52
Somalia	50
Oman	46
Lebanon	41
Kuwait	38
Uruguay	38
Guinea-Bissau	37
Mexico	37
Guyana	36
Congo, Dem. Rep.	36
<i>Industrial Countries</i>	
unweighted mean	4.6
<i>Developing Countries, unweighted means</i>	
Africa	13.9
Asia	14.0
Europe	6.6
Middle East	28.4
Western Hemisphere	251.2

*Std. dev. of annual inflation rates, based on GDP deflators. Source: WDI 2001.

**This group includes only countries with 1997 population above 500,000.

**Table 2a. Average Trade-to-GDP Ratio with U.S.
(percent), 1960-1997***

<i>High Trade-Ratio Countries**</i>	
Trinidad and Tobago	29.6%
Honduras	24.3%
Guyana	23.0%
Jamaica	19.4%
Angola	19.0%
Canada	18.3%
Dominican Republic	16.8%
Nigeria	15.0%
Singapore	13.2%
Panama	12.2%
Nicaragua	12.1%
Venezuela	11.7%
Costa Rica	11.3%
Hong Kong	11.0%
Ecuador	9.9%
Haiti	9.6%
Mexico	8.7%
Gabon	8.0%
Congo, Rep.	7.9%
Guatemala	7.5%
<i>Industrial Countries</i>	
unweighted mean	2.5%
<i>Developing Countries, unweighted means</i>	
Africa	3.3%
Asia	3.7%
Europe	0.8%
Middle East	4.2%
Western Hemisphere	12.9%

*Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.) Averages are for 1960-97 (when GDP data are not available, the average corresponds to the period of availability). The equations for co-movement include only one observation for each pair, corresponding to the period 1960-97. The explanatory variables then refer to averages over time. Source: Glick & Rose (trade values); WDI 2001 (GDP).

**This group includes only countries with 1997 population above 500,000.

**Table 2b. Average Trade-to-GDP Ratio with Euro_12,
1960-1997***

<i>High Trade-Ratio Countries**</i>	
Mauritania	34.8%
Congo, Rep.	28.3%
Guinea-Bissau	27.5%
Cote d'Ivoire	24.5%
Algeria	24.4%
Belgium-Lux.	23.4%
Gabon	23.0%
Togo	22.9%
Nigeria	22.8%
Tunisia	20.9%
Gambia, The	20.6%
Senegal	20.4%
Comoros	19.3%
Netherlands	18.2%
Oman	17.7%
Cameroon	17.3%
Congo, Dem. Rep.	17.0%
Slovenia	16.9%
Angola	15.6%
Syrian Arab Republic	15.2%
<i>Industrial Countries</i>	
unweighted mean	7.3%
<i>Developing Countries, unweighted means</i>	
Africa	14.2%
Asia	4.3%
Europe	7.0%
Middle East	11.6%
Western Hemisphere	8.3%

*Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.)

Averages are for 1960-97 (when GDP data are not available, the average corresponds to the period of availability). Source: Glick & Rose (trade values); WDI 2001 (GDP). For a Euro-12 country, the trade ratios apply to the other 11 countries.

**This group includes only countries with 1997 population above 500,000.

**Table 2c. Average Trade-to-GDP Ratio with Japan,
1960-1997***

<i>High Trade-Ratio Countries**</i>	
Oman	16.0%
United Arab Emirates	15.7%
Panama	14.1%
Singapore	12.8%
Kuwait	9.5%
Malaysia	9.5%
Papua New Guinea	9.2%
Bahrain	8.4%
Saudi Arabia	8.0%
Hong Kong, China	7.9%
Indonesia	7.8%
Swaziland	6.5%
Thailand	5.6%
Gambia, The	5.5%
Mauritania	5.4%
Iran, Islamic Rep.	5.4%
Philippines	4.8%
Korea, Rep.	4.1%
Nicaragua	3.9%
Fiji	3.7%
<i>Industrial Countries</i>	
unweighted mean	0.8%
<i>Developing Countries, unweighted means</i>	
Africa	1.4%
Asia	5.5%
Europe	0.3%
Middle East	6.1%
Western Hemisphere	2.0%

*Trade is the average of imports and exports. (Imports is the average of the values reported by the importer and the exporter. Idem for exports.) Averages are for 1960-97 (when GDP data are not available, the average corresponds to the period of availability). Source: Glick & Rose (trade values); WDI 2001 (GDP).

**This group includes only countries with 1997 population above 500,000.

**Table 3a. Co-Movement of Prices with U.S.,
1960-1997***

<i>High Co-Movement Countries**</i>	
Puerto Rico	0.0193
Panama	0.0244
Canada	0.0335
El Salvador	0.0340
Singapore	0.0444
Thailand	0.0529
Guinea	0.0545
Bahrain	0.0563
Hong Kong, China	0.0566
Honduras	0.0571
Malaysia	0.0609
Saudi Arabia	0.0646
Australia	0.0664
Fiji	0.0666
Hungary	0.0673
Egypt, Arab Rep.	0.0681
Cyprus	0.0687
Tunisia	0.0689
New Zealand	0.0691
Norway	0.0671
<i>Industrial Countries</i>	
unweighted mean	0.0830
<i>Developing Countries, unweighted means</i>	
Africa	0.1445
Asia	0.0913
Europe	0.1107
Middle East	0.1348
Western Hemisphere	0.1040

*The table shows the value VP, the standard error of the residual for the AR-2 regression for the log of the real exchange rate. In some cases, the sample differs from 1960-97.

**This group includes only countries with 1997 population above 500,000.

**Table 3b. Co-Movement of Prices with Euro-12,
1960-1997***

<i>High Co-Movement Countries**</i>	
Austria	0.0196
Netherlands	0.0217
Denmark	0.0219
Belgium	0.0242
Germany	0.0328
France	0.0338
Norway	0.0363
Switzerland	0.0395
Ireland	0.0397
Morocco	0.0426
Italy	0.0478
Portugal	0.0480
Sweden	0.0489
Spain	0.0491
Greece	0.0510
Tunisia	0.0529
Cyprus	0.0536
Finland	0.0552
United Kingdom	0.0616
New Zealand	0.0678
<i>Industrial Countries</i>	
unweighted mean	0.0507
<i>Developing Countries, unweighted means</i>	
Africa	0.1403
Asia	0.1103
Europe	0.1152
Middle East	0.1607
Western Hemisphere	0.1350

*The table shows the value VP, the standard error of the residual for the AR-2 regression for the log of the real exchange rate. For a member of the Euro-12, the co-movement is in relation to the other 11 countries. In some cases, the sample differs from 1960-97.

**This group includes only countries with 1997 population above 500,000.

**Table 3c. Co-Movement of Prices with Japan,
1960-1997***

<i>High Co-Movement Countries**</i>	
Switzerland	0.0713
Austria	0.0719
Germany	0.0776
New Zealand	0.0791
Netherlands	0.0805
Denmark	0.0810
Belgium	0.0816
Papua New Guinea	0.0827
Thailand	0.0841
Cyprus	0.0845
Singapore	0.0866
France	0.0883
Norway	0.0883
Morocco	0.0918
United States	0.0924
Australia	0.0940
Panama	0.0944
Malaysia	0.0947
Tunisia	0.0960
Puerto Rico	0.0961
<i>Industrial Countries</i>	
unweighted mean	0.0919
<i>Developing Countries, unweighted means</i>	
Africa	0.1647
Asia	0.1237
Europe	0.1307
Middle East	0.1730
Western Hemisphere	0.1465

*The table shows the value VP, the standard error of the residual for the AR-2 regression for the log of the real exchange rate. In some cases, the sample differs from 1960-97.

**This group includes only countries with 1997 population above 500,000.

**Table 4a. Co-Movement of Outputs with U.S.,
1960-1997***

<i>High Co-Movement Countries**</i>	
Canada	0.0135
United Kingdom	0.0150
Australia	0.0175
Germany	0.0196
Netherlands	0.0197
France	0.0200
Colombia	0.0205
Puerto Rico	0.0216
Denmark	0.0217
Norway	0.0224
Italy	0.0230
Spain	0.0238
Honduras	0.0251
Belgium	0.0253
Sweden	0.0254
Switzerland	0.0256
Costa Rica	0.0258
Austria	0.0261
Japan	0.0265
Guatemala	0.0265
<i>Industrial Countries</i>	
unweighted mean	0.0251
<i>Developing Countries, unweighted means</i>	
Africa	0.0591
Asia	0.0524
Europe	0.0449
Middle East	0.0749
Western Hemisphere	0.0442

Note: The table shows the value VY, the standard error of the residual for the AR-2 regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960-97.

**This group includes only countries with 1997 population above 500,000.

**Table 4b. Co-Movement of Outputs with Euro-12,
1960-1997***

<i>High Co-Movement Countries**</i>	
France	0.0094
Belgium	0.0108
Netherlands	0.0116
Austria	0.0131
Colombia	0.0145
Italy	0.0154
Germany	0.0154
Sweden	0.0165
Spain	0.0165
Switzerland	0.0168
United Kingdom	0.0170
Denmark	0.0177
United States	0.0185
Canada	0.0187
Japan	0.0202
Puerto Rico	0.0205
Norway	0.0210
Guatemala	0.0220
Australia	0.0222
Cyprus	0.0227
<i>Industrial Countries</i>	
unweighted mean	0.0198
<i>Developing Countries, unweighted means</i>	
Africa	0.0557
Asia	0.0500
Europe	0.0421
Middle East	0.0713
Western Hemisphere	0.0426

Note: The table shows the value VY, the standard error of the residual for the AR-2 regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960-97. For a member of the Euro-12, the co-movement is in relation to the other 11 countries.

**This group includes only countries with 1997 population above 500,000.

**Table 4c. Co-Movement of Outputs with Japan,
1960-1997***

<i>High Co-Movement Countries**</i>	
France	0.0214
United Kingdom	0.0217
Germany	0.0229
Austria	0.0234
Netherlands	0.0235
Italy	0.0236
Belgium	0.0243
Colombia	0.0252
Australia	0.0254
Sweden	0.0256
Greece	0.0260
Switzerland	0.0262
Puerto Rico	0.0262
Denmark	0.0265
United States	0.0265
Sri Lanka	0.0271
Spain	0.0272
Thailand	0.0282
Cyprus	0.0286
Canada	0.0296
<i>Industrial Countries</i>	
unweighted mean	0.0282
<i>Developing Countries, unweighted means</i>	
Africa	0.0596
Asia	0.0541
Europe	0.0443
Middle East	0.0748
Western Hemisphere	0.0463

Note: The table shows the value VY, the standard error of the residual for the AR-2 regression for the log of the ratio of real per capita GDPs. In some cases, the sample differs from 1960-97.

**This group includes only countries with 1997 population above 500,000.

Table 5. High-Inflation Countries.* Trade Ratios and Co-Movements with U.S., Euro-12, and Japan

Country Name	Mean Annual Inflation Rate (%)	Trade Ratio with US	Trade Ratio with Euro-12	Trade Ratio with Japan	VP with US	VP with Euro-12	VP with Japan	VY with US	VY with Euro-12	VY with Japan
Nicaragua	1168	0.121	0.079	0.039	0.521	0.530	0.551	0.078	0.077	0.082
Bolivia	702	0.053	0.032	0.014	0.105	0.155	0.150	0.043	0.043	0.049
Peru	531	0.035	0.024	0.011	0.135	0.134	0.157	0.057	0.055	0.060
Argentina	431	0.009	0.017	0.003	0.255	0.230	0.251	0.060	0.056	0.062
Brazil	288	0.015	0.015	0.004	0.122	0.133	0.155	0.042	0.035	0.041
Chile	107	0.047	0.051	0.021	0.116	0.139	0.140	0.050	0.052	0.058
Israel	78	0.052	0.069	0.007	0.092	0.099	0.124	0.038	0.032	0.039
Uruguay	62	0.014	0.027	0.002	0.158	0.154	0.174	0.038	0.038	0.043
Congo, Dem. Rep.	49	0.033	0.170	0.010	0.170	0.163	0.179	0.054	0.052	0.057
Mexico	41	0.087	0.013	0.006	0.111	0.160	0.165	0.036	0.036	0.036
Turkey	39	0.011	0.046	0.003	0.116	0.113	0.138	0.036	0.038	0.042
Ghana	39	0.056	0.108	0.024	0.231	0.248	0.253	0.047	0.042	0.048
Sierra Leone	34	0.049	0.123	0.025	0.207	0.254	0.249	0.058	0.050	0.056
Guinea-Bissau	30	0.014	0.275	0.018	0.156	0.142	0.174	0.063	0.063	0.062
Ecuador	25	0.099	0.043	0.017	0.072	0.114	0.113	0.042	0.040	0.041
Colombia	23	0.045	0.027	0.006	0.071	0.098	0.116	0.020	0.014	0.025
Guyana	22	0.230	0.094	0.035	0.117	0.155	0.151	0.058	0.058	0.062
Costa Rica	20	0.113	0.049	0.013	0.109	0.110	0.141	0.026	0.029	0.040
Venezuela, RB	18	0.117	0.040	0.010	0.112	0.144	0.147	0.044	0.040	0.043
Paraguay	18	0.024	0.034	0.008	0.109	0.119	0.125	0.037	0.034	0.040
Nigeria	18	0.150	0.228	0.025	0.160	0.195	0.213	0.082	0.070	0.079
Jamaica	17	0.194	0.031	0.011	0.113	0.135	0.145	0.050	0.046	0.044
Portugal	16	0.011	0.077	0.003	0.083	0.048	0.096	0.035	0.028	0.030
Iran, Islamic Rep.	16	0.031	0.123	0.054	0.479	0.467	0.497	0.073	0.066	0.069
Oman	16	0.036	0.177	0.160	0.125	0.145	0.162	0.120	0.118	0.112
Greece	16	0.008	0.061	0.006	0.075	0.051	0.097	0.029	0.024	0.026
Dominican Republic	15	0.168	0.031	0.011	0.096	0.114	0.134	0.057	0.053	0.056
Indonesia	15	0.040	0.028	0.078	0.122	0.148	0.151	0.031	0.030	0.033

*Only countries with population above 500,000 are considered. For euro-12 members, co-movements are computed in relation to the other 11 countries. High-inflation countries with no data on VY or VP are not reported in the table.

**Table 6. High-Inflation Countries
Best Anchor Based on the Three Criteria**

Country	Mean Annual Inflation Rate	Trade	VP	VY
Nicaragua	1168.4	US	US	Euro
Bolivia	702.4	US	US	US
Peru	530.7	US	Euro	Euro
Argentina	430.8	Euro	Euro	Euro
Brazil	288.4	US	US	Euro
Chile	106.9	Euro	US	US
Israel	78.2	Euro	US	Euro
Uruguay	62.2	Euro	Euro	US/Euro
Congo, Dem. Rep.	48.7	Euro	Euro	Euro
Mexico	41.0	US	US	Euro/Japan
Turkey	39.4	Euro	Euro	US
Ghana	38.7	Euro	US	Euro
Sierra Leone	34.2	Euro	US	Euro
Guinea-Bissau	30.5	Euro	Euro	Japan
Ecuador	25.0	US	US	Euro
Colombia	22.7	US	US	Euro
Guyana	22.3	US	US	Euro
Costa Rica	20.0	US	US	US
Venezuela	18.5	US	US	Euro
Paraguay	17.8	Euro	US	Euro
Nigeria	17.5	Euro	US	Euro
Jamaica	16.6	US	US	Japan
Portugal	16.2	Euro	Euro	Euro
Iran	16.1	Euro	Euro	Euro
Oman	16.0	Euro	US	Japan
Greece	15.6	Euro	Euro	Euro
Dominican Republic	15.1	US	US	Euro
Indonesia	15.0	Japan	US	Euro

Note: The table excludes countries with 1997 population below 500,000 and countries for which VP or VY are not available. Bold values apply if 1) highest trade share less second highest trade exceeds 0.04; 2) magnitude of difference between lowest VP and next lowest VP exceeds 0.025; or 3) magnitude of difference between lowest VY and next lowest VY exceeds 0.005.

**Table 7. High Trade-Share Countries
Best Anchor Based on the Three Criteria**

Country	Trade*	VP**	VY**
Algeria	Euro	Euro	Euro
Austria	Euro	Euro	Euro
Belgium-Lux***	Euro	Euro	Euro
Benin	Euro	Euro	Euro
Cameroon	Euro	Euro	US
Canada	US	US	US
Central African Republic	Euro	Euro	Euro
Chad	Euro	Euro	Euro
Congo, Dem. Rep.	Euro	Euro	Euro
Congo, Rep.	Euro	Euro	Euro
Costa Rica	US	US	US
Cote d'Ivoire	Euro	Euro	Japan
Cyprus	Euro	Euro	Euro
Dominican Republic	US	US	Euro
Ecuador	US	US	Euro
Gabon	Euro	Euro	Euro
Gambia, The	Euro	US	Euro
Ghana	Euro	US	Euro
Guinea-Bissau	Euro	Euro	Japan
Guyana	US/Euro	US	Euro
Haiti	US	US	Euro
Honduras	US	US	US
Hong Kong, China	US	US	Euro
Iran, Islamic Rep.	Euro	Euro	Euro
Ireland	Euro	Euro	Euro
Jamaica	US	US	Japan
Jordan	Euro	US	Euro
Kenya	Euro	Euro	US/Euro
Madagascar	Euro	Euro	Euro
Malaysia	Japan	US	Euro
Mauritania	Euro	Euro	Euro
Mauritius	Euro	Euro	US
Morocco	Euro	Euro	Euro
Netherlands	Euro	Euro	Euro

**Table 7 (continued). High Trade-Share Countries
Best Anchor Based on the Three Criteria**

Country	Trade*	VP**	VY**
Nicaragua	US	US	Euro
Niger	Euro	Euro	Euro
Nigeria	Euro/US	US	Euro
Oman	Euro/Japan	US	Japan
Panama	Japan/US	US	Euro
Papua New Guinea	Japan	US	Japan
Romania	Euro	US	Euro
Saudi Arabia	Euro	US	US/Euro
Senegal	Euro	Euro	Euro
Sierra Leone	Euro	US	Euro
Singapore	US/Japan	US	Euro
Sweden	Euro	Euro	Euro
Switzerland	Euro	Euro	Euro
Syrian Arab Republic	Euro	US	Euro
Togo	Euro	Euro	Euro
Trinidad and Tobago	US	US	Euro
Tunisia	Euro	Euro	Euro
United Arab Emirates	Japan/Euro	US	Euro
Venezuela, RB	US	US	Euro

*The table excludes countries with 1997 population below 500,000 and countries for which VP or VY are not available. The best anchor according to the trade criterion is shown only when the trade share exceeds 9%. When there is more than one anchor country for which the trade share exceeds 9%, we list the anchors in descending order of the trade shares.

**Bold values apply if the magnitude of the difference between the lowest VP and the next lowest VP exceeds 0.025 or the magnitude of the difference between the lowest VY and the next lowest VY exceeds 0.005.

Table 8
Empirical Studies of the Effect of Currency Union on Trade

Authors	Significance	Point estimate of increased trade from currency union
Rose (2000)	s	around 240%
Frankel and Rose (2002)	s	around 290%
Engel and Rose (2002)	s	around 240%
Persson (2001)	ns	around 40%
Tenreyro (2001)	ns	around 60%
Pakko and Wall (2001)	ns	around -55%
Glick and Rose (2001)	s	around 100%
Rose and van Wincoop (2001)	s	around 140%
Rose (2001)	ns, s	-68%-708%
Lopez-C. and Meissner (2001)	s	around 100%
Levy Y. (2001)	s	around 50%
Nitsch (2002)	s	around 85%
Flandreau and Maurel (2001)	s	around 220%
Klein (2002)	s	around 50%

Note: s=statistically significantly different from zero, ns=not significant.

Table 9. Propensity to Adopt the Currency of Main Anchors

Dependent Variable: Currency Union Dummy			
	Coefficient	Std. Error	Marginal Effect at Mean
min (log of per capita GDP in pair)	-0.1586 *	0.061	-0.0015
max (log of per capita GDP in pair)	1.7167 *	0.385	0.0163
min (log of population in pair)	-0.1352 *	0.048	-0.0013
max (log of population in pair)	0.2372	0.127	0.0023
min (log of area in pair)	-0.0546	0.046	-0.0005
max (log of area in pair)	0.2181 *	0.072	0.0021
regional trade agreement dummy	-0.8864 *	0.277	-0.0032
log of distance (km)	-0.8766 *	0.143	-0.0083
border contiguity dummy	-1.2398 *	0.619	-0.0033
landlocked client dummy	-0.1522	0.242	-0.0013
one island in pair dummy	0.0226	0.240	0.0002
two islands in pair dummy	1.1880 *	0.437	0.0512
common language dummy	0.7487 *	0.216	0.0124
ex colony-colonizer dummy	1.8799 *	0.285	0.1369
current colony (or territory) dummy	0.8491 *	0.239	0.0253
Pseudo R-squared	0.473		
Number of observations	29564		

Notes: The sample consists of country pairs that include the four candidate anchors, Australia, France, U.K., and U.S. The equations are for annual data from 1960 to 1997, include year effects, and allow for clustering over time for country pairs. The definition of currency union treats the CFA franc countries as linked to France and treats the ECCA countries as linked to the U.S. since 1976 and to the U.K. before 1976. The mean of the currency-union dummy for this sample is 0.051. For the sample that regards the CFA countries as unlinked to France and the ECCA countries as unlinked to the U.S. or the U.K., the mean is 0.024. The last column shows the marginal effect, evaluated at the sample mean, of each explanatory variable on the estimated probability of a currency union. For dummy variables, the effect refers to a shift from zero to one.

*statistically significant at 1% level.

Table 10. Estimated Coefficients of Currency-Union Dummy in Various Systems

System	OLS	OLS with country effects	IV	IV with country effects
log (bilateral trade+100), N=348,295	0.75 (0.20)	0.91 (0.18)	1.56 (0.44)	2.70 (0.44)
Co-movement of prices, mean=-0.16, N=9027	0.0690 (0.0058)	0.0456 (0.0028)	0.2433 (0.0243)	0.0874 (0.0080)
Co-movement of outputs, mean=-0.07, N=7610	0.0029 (0.0026)	0.0000 (0.0011)	0.0119 (0.0061)	-0.0020 (0.0022)

Notes: The equations for bilateral trade use annual data from 1960 to 1997, include year effects, and allow for clustering of the error terms over time for country pairs. The dependent variable is $\log(\text{trade}+100)$, where trade is measured in 1995 U.S. dollars. The value 100 is close to the maximum-likelihood estimate of the constant in the expression $\log(\text{trade}+\text{constant})$. The explanatory variables included, aside from the currency-union dummy, are $\log(\text{distance})$; dummy variables for contiguity, common language, colonial relationships, land-locked, and island; and the values for each country in the pair of $\log(\text{per capita GDP})$, $\log(\text{population})$, and $\log(\text{area})$. The definition of currency union treats the CFA franc countries as linked to France and treats the ECCA countries as linked to the U.S. since 1976 and to the U.K. before 1976. Country effects refer to each member of the pair (not to a country-pair). The instrumental variable (IV) systems include as an instrument for the currency-union dummy the variable described in the text.

The equations for co-movement include only one observation for each pair, corresponding to the period 1960-97. The explanatory variables then refer to averages over time. Standard errors are in parentheses.

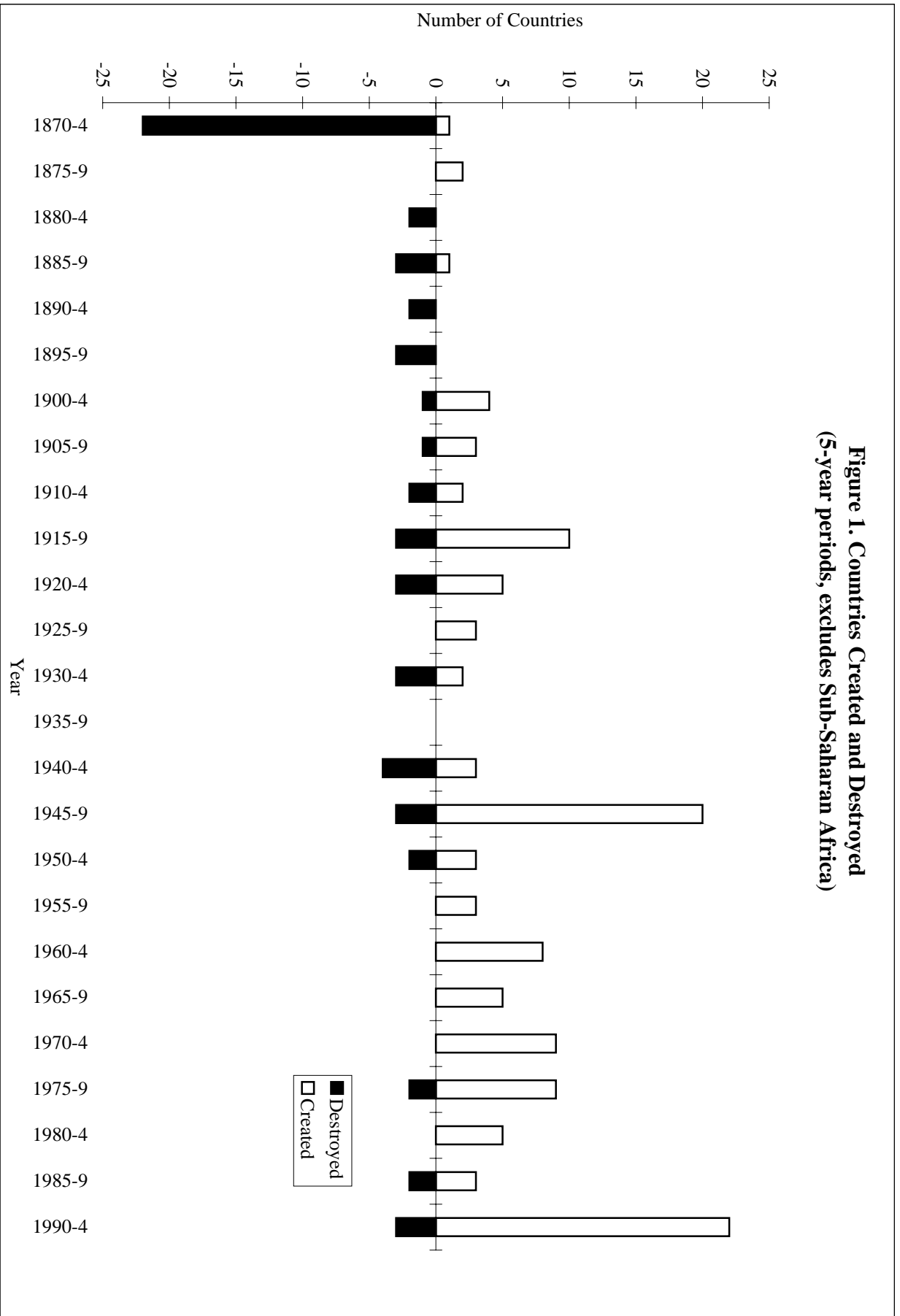


Figure 2. Trade Openness and the Number of Countries

