Has the Euro Increased Trade?

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Abstract

A great deal of debate in academic, business, and political circles precipitated the introduction of the Euro. Until recently, however, a lack of data rendered quantifying the impact of the single currency upon members' trade impossible. This paper is one of the first to explore such issues. At best the Euro has been responsible for an 11 percent increase in Eurozone members' trade over the period 1999-2004. There appears to be an inverse relationship between a country's initial openness to trade and its trade activity following its participation in the European Monetary Union. There is also evidence that during the period prior to the introduction of the Euro, trade increased in anticipation of the single currency's introduction. Finally, Eurozone members appear to trade less with non-members in the wake of the European Monetary Union.

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I. Introduction

The debate as to whether a country should join a currency union was once cast as a struggle between competing political ideals. The left argued for monetary union but had little supporting evidence of possible gains. The right was in staunch opposition since such a step would emasculate domestic monetary policy and expose the economy to business cycle fluctuations. Recently a new topic of enquiry has emerged in the economic debate focusing on the effect monetary union has upon trade. This is the topic I address in this paper.

Initially, monetary union was perceived to have mainly microeconomic effects through ease of price comparison and the removal of exchange rate transaction costs. Now authors, such as Rose (2000), have begun to explore the macroeconomic dimension, claiming that joining a currency union can lead to increases in trade of almost 400 percent.[2] Others, such as Persson (2001), found the effect to be approximately 13 percent.[3] The lack of data from well developed countries engaged in monetary union posed a problem for these investigations. However, with the introduction of the Euro as the official currency of 11 European Union countries in 1999 and the subsequent decision of two more countries to join the 'single currency', data is becoming available upon which to test the currency union effect on trade for large, well developed countries.

The structure of the paper is as follows. Section 2 presents a literature review of monetary union. I describe the contributions of some of the most important works in the field such as Mundell (1961)[4] and Rose (2000)[5]. Section 3 contains a gravity model built upon optimising decisions by firms that will be used to estimate whether the Euro has had an effect upon trade in the member countries. Section 4 details the data set I use, and basic summary statistics and features of the data. Section 5 deals with an estimation of the currency union effect. A model similar to that employed by Rose (2000) is used before moving on to panel data estimators, dynamic panel data models and a difference-in-difference estimator. Further sensitivity tests are performed to analyse whether the inclusion of openness to trade measures affects the results and whether there is any evidence of trade diversion arising from the implementation of the Euro. Conclusions are offered in section 6.

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[2] Rose, Andrew. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." Economic Policy 15.30 (2000): 7-45.

[3] Persson, Torsten. "Currency Union and Trade: How Large is the Treatment Effect?" Economic Policy 33 (2001): 433-448.

[4] Mundell, Robert. "A Theory of Optimal Currency Areas." American Economic Review 51 (1961): 509-517.

[5] Rose, Andrew, Ibid.

II. Literature Review

2.1 Background

It is important to stress that the introduction of the Euro constitutes the third stage of the Economic and Monetary Union (EMU) of the European Union. During the first stage (1990-93), countries agreed upon the complete abolishment of capital controls amongst European Economic Community members. Economic convergence criteria relating to inflation rates, public finances, interest rates and exchange rate stability were also negotiated. The second stage of EMU (1994-1998) witnessed the signing of the Stability and Growth Pact (SGP). This was designed to enforce fiscal discipline by prohibiting member countries from running annual budget deficits in excess of 3 percent of GDP. The European Central Bank (ECB) was also established during this epoch. It now has responsibility for setting interest rates for the Eurozone.

The convergence criteria outline rules that future Euro members must fulfil if they are to adopt the single currency, which constitutes the third stage. These include the following. A country's inflation rate must be no more than 1.5 percent higher than that of the three euro zone countries with the lowest rates of inflation. The long-term nominal interest rate must not be more than two percentage points higher than in the three lowest inflation member states. The ratio of gross government debt to GDP must not exceed 60 percent at the end of the year preceding accession. Finally, countries must have joined the Exchange Rate Mechanism (ERM II) for two consecutive years and must not have devalued their currency during this period. One should also note that while Euro members coordinate monetary policy, they also cooperate on some other economic policies. For example, tariffs are set for the EU as a whole.

2.2 The Optimal Currency Area

The origins of the optimal currency area (OCA) theory may be traced to Mundell (1961).[6] An OCA may be deemed to be a region where, in the presence of a perfectly effective monetary policy, asymmetric real shocks would be handled in such a way that full employment and zero inflation would ensue. Consequently the nation state may not represent an OCA. Rather an OCA may comprise:

1. A country
2. A region, or regions, within a country
3. Regions within separate countries

[6] Mundell, Robert. "A Theory of Optimal Currency Areas." American Economic Review 51 (1961): 509-517.

4. Multiple countries

Mundell (1961)[7] goes on to demonstrate that a country which does not constitute an OCA will react sub-optimally to a negative real shock.

The following example helps to illustrate this. Imagine that two countries are identical in every respect, that they share a border, that the east of each country produces paper and that the west produces aeroplanes. A negative shock to the demand for paper will result in higher unemployment in the eastern regions of both countries. To counter this, the central bank could relax monetary policy in order to restore full employment in the paper industry. In so doing, inflationary pressures would be created in the west. Thus there exists a trade-off between lower unemployment in one region and higher inflation in the other. This is clearly sub-optimal. If the regions of each country were to adopt their own currency, a Pareto improvement would follow as each region could optimally respond to an asymmetric shock. However, this is not the first-best solution and could be improved upon because this arrangement involves more transaction costs due to there being four currencies. If the eastern and western regions of each country were to join in monetary union, the costs of international trade would be minimised and shocks to the terms of trade could be dealt with in such a way that full employment would not come at the price of higher inflation.

From this it is eminently clear that a key consideration when deciding whether or not to join a currency union is the extent to which the business cycles of the regions overlap. The greater the degree of synchronisation, the greater will be the effectiveness of monetary policy in the enlarged region. This will be more likely when more intra-industry trade takes place as opposed to inter-industry trade. Under the former, industries in the regions are broadly similar; for example, they are predominantly engaged in the production of paper. Hence when real shocks hit the economy, monetary policy can respond in the appropriate, counter-cyclical manner. Where trade takes place on an inter-industry basis, real shocks are less likely to be off-set according to the first-best solution, as the trade-off between inflation and unemployment again exists.

The extent of integration is, thus, a key consideration when deciding upon joining a currency union. This, however, may be endogenous as sharing a currency could lead to greater levels of trade and thus greater integration. Despite this, the decision to join a currency union could then be seen as the extent to which the business cycles of different countries are synchronised. Foregoing the national currency entails a loss of monetary autonomy thus

[7] Mundell, Robert. "A Theory of Optimal Currency Areas." American Economic Review 51 (1961): 509-517.

preventing a policy-maker from dampening business cycle fluctuations. The degree of synchronisation between a group of countries will then depend upon the nature of trade between them.[8] Theoretically, pan-national business cycles could either become more or less integrated. If countries were to become more specialised in the areas in which they hold a comparative advantage, closer trading relations would lead to more idiosyncratic business cycle patterns. Consider, for example, a two country scenario where country A is relatively more efficient in producing apples while country B holds an advantage in the production of bananas. Post trade liberalisation, each country could specialise in the production of the good they produce most efficiently and then trade apples for bananas. The effect of trade then increases the degree of industrial specialisation. Business cycles would become more idiosyncratic since each country is buffeted by different real shocks.

However, several authors have found that the greater the extent of integration, the more trade will increase, leading to more highly correlated business cycles between the countries involved. Frankel and Rose cite Eichengreen (1992),[9] Kenen (1969),[10] and Krugman (1993)[11] as having all noted this feature of closer integration. Frankel and Rose use instrumental variables to estimate empirically whether trade intensity results in greater income correlation. The regression they use is of the following form:

$$\mathrm{Corr}\left(v,s\right)_{i,j,\tau} = \alpha + \beta \mathrm{Trade}\left(w\right)_{i,j,\tau} + \varepsilon_{i,j,\tau} \qquad (1)$$

The motivation for using instruments is twofold. Firstly, the error component is likely to be correlated with the trade variable in either the time or spatial dimension. For example, the Spanish-Portuguese trade observation for December may not be independent of that for November, or independent of the French-Spanish observation. Secondly, ordinary least squares (OLS) is inappropriate as countries are more likely to peg their currency to that of their main trading partners in order to eliminate exchange rate instability more effectively; that is, members join in a non-random manner. The instruments used are the natural logarithm of distance between business hubs, a dummy variable for geographic adjacency and a dummy variable that indicates a common language. Frankel

[8] Frankel, Jeffrey, and Andrew Rose. "The Endogeneity of the Optimum Currency Area Criteria." Economic Journal 108 (1998): 1009-1025.

[9] Eichengreen, Barry. "Should the Maastricht Treaty be Saved?" In Frankel, Jeffrey, and Andrew Rose. Economic Journal 108 (1998): 1009-1025.

[10] Kenen, Peter. "The Theory of Optimum Currency Areas: an Eclectic View." In Frankel, Jeffrey and Andrew Rose. Economic Journal 108 (1998): 1009-1025.

[11] Krugman, Paul. "Lessons of Massachusetts for EMU." In Frankel, Jeffrey and Andrew Rose. Economic Journal 108 (1998): 1009-1025.

and Rose found that, regardless of whether they normalised by trade or GDP, greater intensity of international trade led to higher correlations between income. This effect was strongly positive and statistically significant.

Another channel through which adjustment may occur in response to a real shock is labour mobility. If labour is sufficiently mobile, it could move from an area stuck in recession to one where job opportunities exist. This would help dampen business cycles and is often mooted as the reason why the United States constitutes an OCA while the European Union does not. The language barrier, which exists between the European nations, is not present in the United States. Despite this, labour mobility in the US is not of a sufficient magnitude to dampen business cycle fluctuations at regional level.

2.3 Reasons for Adopting/Maintaining a National Currency

The post-World War II era has seen the number of countries more than double, accompanied by an unprecedented increase in economic integration and interdependence. It is somewhat surprising, therefore, that the number of national currencies in circulation through out the world has increased dramatically since the greater the level of integration the greater the level of synchronisation. This reduces the opportunity cost of removing a currency. However, greater economic integration would imply that the costs of a national currency would be higher arising from exchange rate transaction costs. One would have to believe that the national unit is chosen to correspond with the OCA. This would seem to be incidental. It is possible that the growth in the number of countries has resulted in interregional trade being relabelled as international trade and that this process has allowed independent monetary policy to be used to stabilise the (smaller) economy. Alesina et al (2000) refute this idea.[12]

Numerous authors have suggested that pride and sovereignty are the principle motives for maintaining a national currency. However, citizens do not appear to mind when the national currency is renamed following an inflationary crisis. In fact one would have thought that national sports teams inspire greater devotion and euphoria than does a currency. Inflation aversion could be a disguise for national pride. Decimalisation and the introduction of the Euro were associated with increases in prices. This theoretically could have been caused by menu-cost effects. According to the Barro-Gordon model of monetary policy, agents may prefer decisions to be made nationally because the preferences of the policy maker are more representative of attitudes towards inflation. This could be the reason for some countries' citizens being so op-

[12] Alesina, Alberto, Robert Barro, and Silvana Tenreyro. "Optimal Currency Areas." NBER Working Paper Series Working Paper 9072 (2002).

posed to the adoption of a foreign currency as the new policy maker may have a different attitude towards the trade-off between inflation and output.

Irrespective of the number of currencies in circulation, Mundell (1961) noted that the use of multiple currencies results in a deadweight loss because of the higher transaction costs agents must bear when they engage in international trade[13]. Mundell then goes on to state that while the optimal number of currencies is not infinite, although this would mitigate a 'perfect' response to a real shock, the transactions costs arising from trade would be overwhelming. Equally the optimal number would not be one as this could be welfare decreasing due to the inability to stabilise the domestic economy.

2.4 Public Goods, Inflation and Monetary Union

Small countries may not be big enough to provide public goods efficiently as they cannot exploit economies of scale in the way that larger countries can.[14] Two areas that illustrate this idea are military defence and national currency. With both, the expense of 'going it alone' is high due to the fixed costs involved. Small countries have overcome the problem of military defence by forming alliances. The decision of the Baltic states to join NATO is an example. Regarding currency, countries that have seceded from others have been notably reluctant to adopt the currency of a large trading partner. Montenegro and East Timor are recent exceptions. This, presumably, is because the only viable currency of the newly independent country would be that of the nation from which it has just seceded. In this case, nationalist sentiment or revulsion for the former occupier may preclude monetary union.

A second, more powerful argument for monetary union than the public goods case is the conduct of monetary policy. Let us suppose that there exists a country that is particularly prone to expansionary monetary policy. An inflation bias as demonstrated by Barro and Gordon (1983)[15] may exist. This bias could be eliminated or reduced by pegging the national currency to that of a country with monetary discipline and an aversion to inflation. The monetary policy of the inflation-prone country would then effectively be determined by the disciplined central bank. This would eliminate the tendency to follow a persistently expansive, monetary policy and, consequently, the inflation bias.

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[13] Mundell, Robert. "A Theory of Optimal Currency Areas." American Economic Review 51 (1961): 509-517.

[14] Alesina, Alberto, Enrico Spolaore, and Romain Wacziarg. "Trade, Growth, and the Size of Countries." Harvard Institute of Economic Research Working Papers Working Paper 1995 (2002).

[15] Barro, Robert, and David Gordon. "A Positive Theory of Monetary Policy in a Natural Rate Model." Journal of Political Economy 91 (1983): 589-610.

One could argue that short run considerations, such as recessions, provide support for maintaining monetary autonomy. Policy makers could then (theoretically) end a recession. A classic example of this was the UK's exit from ERM in 1992 (although one could argue currency speculation was a major factor). It could be further argued that a country with a preference towards expansionary monetary policy would never want to forego monetary autonomy as it could always raise welfare by increasing output beyond its natural rate. While this is feasible in the short run, such a policy is unsustainable over a longer horizon. Agents would rationally expect consistent monetary expansion and respond by raising their inflation expectations. Prices would persistently increase with no offsetting gains in output. The gains to eliminating the inflation bias would then be large.

One means of eliminating an inflation bias might be through the use of fixed exchange rates. These, however, tend to create imbalances in financial markets. The currency crises of the 1990s demonstrated that developed countries were just as susceptible to attack as developing nations. Numerous authors have noted that, when the costs of maintaining the fixed exchange rate were too high or where the domestic economy could benefit through the use of domestic monetary policy, a speculative attack would force an end to a peg. Hence fixed exchange rates lack full credibility. Over the past 40 years, they have not been fixed irrevocably,[16] and many have been eliminated, which may provide the stimulus for a speculative attack.

A currency union represents a more durable commitment that delivers the same outcome. The costs of abandoning the new currency are very high. In this situation, the domestic inflation rate is as in 2.

$$\pi_i = \pi_j + \Delta\rho \qquad (2)$$

Inflation in country *i* is composed of the inflation rate in the anchor country, *j*, plus or minus the change in relative price level between the domestic and anchor economy.[17] As noted previously, the higher the correlation between business cycle shocks, the greater the capacity for monetary policy to be used in a counter-cyclical manner to achieve stabilisation.

2.5 Trade Benefits

The public goods and inflation arguments for joining a currency

[16] Alesina, Alberto, Robert Barro, and Silvana Tenreyro. "Optimal Currency Areas." NBER Working Paper Series Working Paper 9072 (2002).

[17] Alesina, Alberto, Ibid.

union are attractive. However, the empirical literature that began to emerge during the mid-1990s suggests that perhaps the most important consequence of common currency areas was the increase in trade.

One of the first publications in this area was McCallum (1995).[18] This paper examined whether the US-Canadian border had had a substantial effect upon trade between states and provinces using 1988 import and export data on the 10 Canadian provinces and the 30 US states that accounted for more than 90 percent of Canada-US trade. To estimate this, a simple gravity model was used,

$$x_{ij} = a + by_i + cy_j + dDIST_{ij} + eDUMMY_{ij} + u_{ij} \qquad (3)$$

where x_{ij} is the logarithm of trade between region i to region j, y_i and y_j are the logarithms of GDP in region i and j respectively, $DIST_{ij}$ is the logarithm of the distance between i and j, $DUMMY_{ij}$ is a dummy variable equal to 1 for state-to-province trade and equal to zero otherwise, and u_{ij} is an error term.

McCallum's headline-grabbing finding was that province-to-province and state-to-state trade was 22 times greater than province-to-state trade. This was even more remarkable as, at that time, the US-Canadian border was seen as being one of the most open in the world since a free trade agreement had been signed in 1988. In addition, both countries used the same language and had solid laws governing the enforcement of contracts. One of the reasons advanced as a possible explanation for such a large difference in trade volumes was the use of different currencies.

However, the findings of McCallum were not as robust as first thought due to omitted variable bias and the failure to take into account the small size of the Canadian economy. The simple specification of equation 2 fails to acknowledge multilateral resistances as well as bilateral resistances. The bilateral barriers to trade between countries are manifested through tariffs, non-tariff barriers and the currencies used, to list just a few of the impediments to trade. Anderson (1979) defines multilateral resistance as the resistances to trade arising between country i and all other countries except j.[19] Multilateral resistances to trade affect the trade between country i and j because the resistances to trade between i and all countries other than j will indirectly determine how much i trades with j. For example, if a given country, k, has lower trade barriers with i than the average barrier between i and j, firms in i can deal more

[18] McCallum, John. "National Borders Matter: Canada-U.S. Regional Trade Patterns." American Economic Review 85 (1995): 615-623.

[19] Anderson, James. "A Theoretical Foundation for the Gravity Equation." American Economic Review 69 (1979): 106-116.

cheaply with firms from *k* than from *j*, making them more likely to trade with *k*. In summary, after controlling for size, interregional trade is a decreasing function of the bilateral trade barrier between *i* and *j,* relative to the average barrier to trade of *i* and *j* with all other regions. Anderson and van Wincoop (2003) cite multilateral resistances as being the omitted variables which drive McCallum's results.[20]

The second factor leading to bias in the estimates was the failure to account for the small, open nature of the Canadian economy. Small economies tend to engage in trade to a much greater extent than large ones because their domestic markets tend to be constrained by their small population. Consequently, a small economy must engage in international trade if it is to buy and sell goods and services. Anecdotal evidence exists to support this. For example, Ireland and Belgium, which are both small and open economies, exhibit openness to trade ratios well in excess of 100 percent. This means that the ratio of trade to GDP is greater than 1. It was, therefore, almost inevitable that the Canadian economy would be more susceptible to barriers to trade because, unlike the United States, a much greater percentage of its trade was conducted outside the country rather than inside. A small barrier between Canada and the rest of the world has large effects on the multilateral resistances to trade as the economy is more exposed to international trade. However, the effect of the border on the US is much smaller because a large percentage of its trade is conducted between its own states. This explains why the border affects it to a lesser degree.

In an attempt to ascertain the accuracy of McCallum's findings, Anderson and Van Wincoop (2001) first derived a theoretical gravity model based on constant elasticity of substitution (CES) preferences[21] In so doing and controlling for size and distance, they incorporated multilateral resistance terms. Using 1993 data they estimated that the Canadian-US border reduced trade between the countries by 44 percent. They also found that the border reduced trade with other industrialised nations by 30 percent. The within-country increase in trade after imposing the border was also much lower; a 6- fold increase and a 25 percent increase for Canada and the US respectively.

2.6 Trade and Currency Unions

The period prior to the introduction of the Euro saw numerous publications attempting to quantify the possible effect of monetary union on trade. In a seminal paper in this area, Rose (2000) used data drawn from existing cur-

[20] Anderson, James, and Eric Van Wincoop. "Gravity with Gravitas: A Solution to the Border Puzzle." Boston College Working Papers Working Paper 485 (2000).

[21] Ibid.

rency union members.[22] It was found that currency unions raised trade between members by approximately 400 percent using an OLS estimator. Further papers by Rose established that the effect was robust and statistically significant to various model specifications.

Rose and van Wincoop (2001) espoused the view that currency unions had such an impact because of the efficiency gains associated with using one, rather than multiple, currencies.[23] This was puzzling since the cost of hedging was low due to the prevailing, extensive derivative markets. The authors then hypothesised that a shared currency could lead to a deepening of trading relations and increased price transparency across countries. This could prove to be trade enhancing. The central weakness of this finding was, however, that it was based on a very small sample of observations drawn from countries which were either small, poor or remote or, in some instances, all three. Several were also island nations and therefore, more likely to engage in trade. Hence the conclusions of this paper, while seemingly robust and highly significant, could not automatically be applied to the large, developed nations that were about to introduce the Euro as their currency. The currency unions used by Rose (2000)[24] tended to comprise nations that were geographically disparate and usually had within them one large developed country and a number of small and/or poor nations or colonies. France and Reunion is a typical example. Quah (2000) remarked that of the 33903 bilateral trade observations, a mere 320 were between currency union members.[25] This meant that the results were drawn from a sub-sample which constituted less than 1 percent of the total observations.

An ambitious attempt to resolve the 'true' effect of currency unions on trade entailed the use of a non-parametric matching technique by Persson (2001).[26] This was prompted by the small number of changes in the monetary regime of most countries. The currency union effect could, therefore, only be gauged through cross-sectional variation rather than through observation of

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[22] Rose, Andrew. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." Economic Policy 15.30 (2000): 7-45.

[23] Rose, Andrew, and Eric Van Wincoop. "National Money as a Barrier to International Trade: The Real Case for Currency Union." American Economic Review 91.2 (2001): 386-390.

[24] Rose, Andrew. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." Economic Policy 15.30 (2000): 7-45.

[25] Quah, Danny. "One Money, One Market: Estimating The Effect of Common Currencies on Trade*."* In Rose, Andrew. Economic Policy 15.30 (2000): 7-45.

[26] Persson, Torsten. "Currency Union and Trade: How Large is the Treatment Effect?" Economic Policy 33 (2001): 433-448.

the difference before and after monetary union. Persson also argued that if the currency union variable was correlated with any of the other regressors, or if selection into a currency was non-random, then the linear regression framework used in Rose might have produced biased results.

Using this methodology, Persson was able to construct a treated group (members of a currency union) and a control group (non-members) which were comparable in that they had the same regressors. The results were then generated using non-parametric estimators which yielded a treatment effect ranging between a 15 and 63 percent increase in trade. The standard errors, however, were of a magnitude that rendered the results statistically insignificant.

III. The Gravity Model

In this section I outline the gravity model I will use to estimate the currency union effect of the Euro. The empirical literature has tended to remain silent regarding the theoretical foundations of such models. This may be partly explained by how well the models work empirically despite their lack of microeconomic foundations. The theoretical literature reveals a great deal of variety as to how these models were derived. For example, Anderson's (1979) model is constructed using goods distinguished by their region of origin.[27] Bergstrand (1989) derives the gravity equation from an economies of scale trade model.[28] Deardorff (1995) demonstrates that a Heckscher-Ohlin model may be used as a premise for deriving a gravity equation.[29] One unifying element among all these papers is the use of CES preferences.

3.1 The Model

Traditionally, it has been the case that empiricists have used gravity models to estimate the effect of monetary union on trade. An example of this model is:

$$\ln T_{ij} = \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 DIST_{ij} + \beta_4 \ln S_i + \beta_5 \ln S_j + \beta_6 X_{ij} + \beta_7 cu_i + \varepsilon_{ij} \quad (4)$$

where T_{ij} represents trade between i and j, Y_i and Y_j stand for GDP in i and j, respectively, $DIST_{ij}$ is the distance between the regions, S_i and S_j are measures of the size of i and j, usually taken as meaning either population or land mass,

[27] Anderson, James. "A Theoretical Foundation for the Gravity Equation." American Economic Review 69 (1979): 106-116.

[28] Bergstrand, Jeffrey. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." Review of Economics and Statistics 67 (1985): 474-481.

[29] Deardorff, Alan. "Determinants of Bilateral Trade: Does Gravity work in a Neoclassical World?" NBER Working Paper Series Working Paper 5377 (1983).

X_{ij} is a matrix that contains a number of other possible determinants of trade such as a free trade dummy variable, a common language dummy variable and a dummy variable indicating a shared colonial history, and so on, cuij is a dummy variable equal to one if the countries share the same currency and ε_{ij} is a well behaved error term.

3.2 Features of the Model

The main ideas behind the model are that countries with a high GDP will trade more because they have/demand a greater number of goods, while distant countries are assumed to trade less because the greater the distance, the greater the costs regarding transportation and creation of trading contacts and relationships. However, while the models work well empirically with R-squared values of approximately 0.80 reported in Bergstrand (1985)[30] for the years 1965, 1966, 1975 and 1976, the theoretical foundations underpinning them tend to be simplistic and based upon intuitive arguments rather than on microeconomic fundamentals.

Owing to the lack of a single unifying framework, omitted variable bias and model uncertainty arise. As noted previously, omitted variables in the shape of multilateral resistance terms, was one of the principle reasons why McCallum (1995) found the Canada-US border to have had such a large impact on trade between the countries.[31] Similarly, authors often include a battery of dummy variables to control for determinants of trade such as free trade, colonial heritage and language.

IV. Data and Methodology

4.1 Data Sources and Definitions

This paper uses a large panel data set, constructed from a variety of sources, resulting in 51,831 observations drawn from 12 Eurozone and 3 non-Eurozone countries' trade with 187 countries. A complete list of the trade partner countries in the data set is provided in Table 10 in Appendix 1.1. The Eurozone members in the sample are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain, while the non-Eurozone members are Denmark, Sweden and the United Kingdom. All of these countries adopted the Euro in 1999 with the exception

[30] Bergstrand, Jeffrey. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." Review of Economics and Statistics 67 (1985): 474-481.

[31] McCallum, John. "National Borders Matter: Canada-U.S. Regional Trade Patterns." American Economic Review 85 (1995): 615-623.

of Greece, which joined in 2001. Other currency unions present in the data set are between France and French Guiana through the use of the French franc and between Belgium and Luxembourg through a fixed exchange rate. For each of these currency unions, the member countries are engaged in monetary union for the entire period covered by the sample. As with several of France's overseas Departments, French Guiana adopted the Euro as its official currency at the same time as France. Similarly, Belgium and Luxembourg also adopted the Euro as their official currency in 1999.

For the period 1980-2004, the real GDP per capita data are constructed using Penn World Tables 6.2 edition. Real GDP per capita is expressed in thousands of US dollars with 2000 prices acting as the base year. For the same period, the population data is also constructed using the Penn World Tables 6.2 edition data. The distance between countries is based on the great circle distance between the two countries, with the central point in each country being its capital city.

Data on bilateral trade between countries comes from the United Nations Statistics Division's Common Database. As is usual in this literature, bilateral trade is taken to be the sum of imports and exports during a given year. One point to be noted in the dataset is that the value of exports from country *i* to country *j* is not necessarily the same as the value of imports into *j* from *i* for any given observation, that is

$$x_{ij} \neq m_{ij}$$

To overcome this measurement error problem, I take a simple mean of the trade statistics for each country. However, since there is a danger that the differences between the reported trade statistics could be large, I will also use a weighted least squares (WLS) estimator.

The common language dummy variable is assigned a value of 1 when country *i* shares the same language as *j* and 0 otherwise. This information is taken from the CIA World Factbook. A common language is assumed when one of the official languages of country *i* is the same as that used in country *j*. Consequently, a country may share a common language with more than one trading partner despite its trading partners using a different language. A good example of this is Belgium which has three official languages.

The free trade dummy is equal to one if a country is a member of the European Free Trade Association (EFTA), the European Union or the European Economic Community. Otherwise, it is equal to zero. For simplicity, I assume that a free trade agreement (FTA) is in place if two countries have signed a bilateral trade agreement. The shared colonial history dummy takes a value of 1 if the trading partners were engaged in a colonial relationship at any point in

the post-1945 period. Otherwise it assumes a value of zero.

Finally, the currency union dummy takes a value of 1 from the year that a country adopts the Euro as its national currency or the currency of another country. Otherwise the variable assumes a value of zero. Despite the introduction of the Euro in physical form in 2001, all Eurozone members, except Greece, are taken to be engaged in monetary union from 1999 since this was the year in which all national currencies were unilaterally fixed at their agreed exchange rate. This, in effect, made the Euro each member's national currency and the ECB responsible for monetary policy throughout the bloc.

4.2 Description of the Data

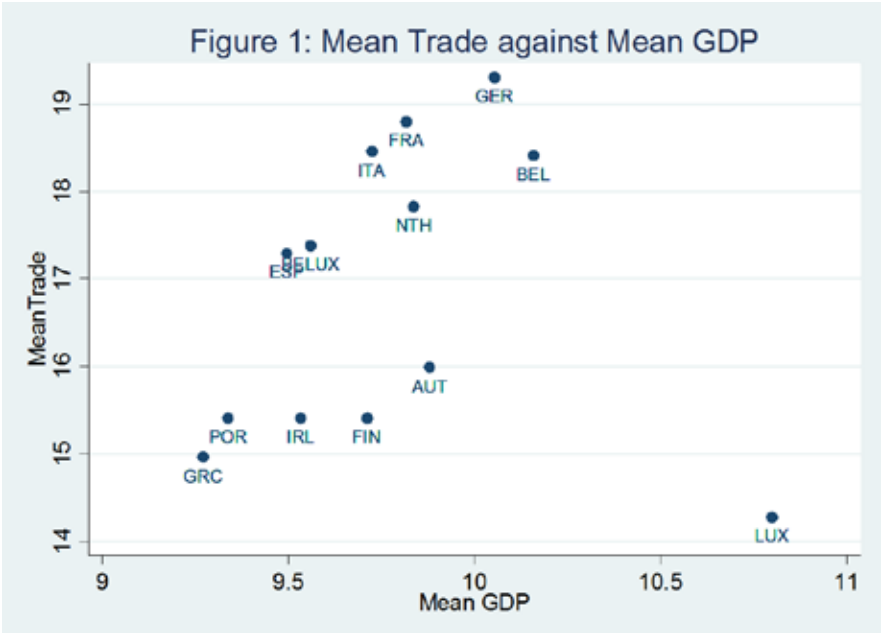
With the data collected, I have assembled a large unbalanced panel data set. The unbalanced panels are caused, in some cases, by poor records and misreporting of the actual data, which might lead to measurement error and thus biased results. Secession has also meant that many countries have entered the panel over the period while the unification of a few countries has led to some dropping out. The Soviet Union and other command-based communist countries are excluded because they bear little resemblance to the market economies with which I am concerned.

Belgian statistics are only reported for 1998 to 2004 and Luxembourgian statistics for 1999-2004. Prior to 1998, all data for the two countries are reported as though they were one country, an artefact of their economic and monetary union agreement that has been in place since 1921. A consequence was that trade statistics were produced for Belgium-Luxembourg rather than for each country. Data are available for the separate entities post-1998 as a result of a ruling by the EU which demanded that individual countries report trade and GDP on a country specific basis.

There is a danger that the inclusion of Luxembourg could bias the results of the estimation procedure. This is caused by the small size of Luxembourg in both the geographical and economic sense and also by its very high GDP and openness to trade. To establish whether Luxembourg should be omitted from the sample, I perform a series of robustness checks.

From Figure 1, it is clear that Luxembourg's very high GDP and low relative level of trade could potentially bias the results downwards or even impose a negative relationship upon any linear regression. To verify whether this is the case, I perform robustness checks to see whether the inclusion of Luxembourg seriously affects the regression estimates. This is achieved using a pooled OLS regression on the entire period.

I find that the inclusion of Luxembourg does have an influence on the



results. However, this is not to the extent that the coefficients depart hugely from the results derived when only the other 11 countries are included. Indeed none of the variables change in sign when Luxembourg is included and the largest change in the estimated results is a meagre 0.05 reduction in the GDP per capita coefficient. With this said, I turn my attention to summary statistics and correlations amongst the variables prior to embarking upon any regression analysis. The correlations between each of the variables are shown in Table 1 below.

It is clear from this that trade is strongly correlated with many of the variables since five of them have correlation values in excess of 0.20. There also appears to be a modest relationship between the currency union dummy variable and trade with a correlation of approximately 0.20. Indeed, currency unions in the sample seem to exhibit correlations with most of the variables, with the exception of language and colonial history. This is unsurprising since the sample covers the Eurozone countries which have bilateral trade agreements through their membership of the European Union and tend to be fairly rich, geographically close.

4.3 Estimation Procedure

The gravity equation from the previous section serves as the basis of the estimation procedure that will be used to quantify the effect of the Euro

upon its members' trade. However, I shall append the model with the dummy variables detailed above. This is similar to the approach implemented by Rose and van Wincoop (2001).[32] It would be unwise to assume that the sole determinants of bilateral trade flows are GDP, prices and distance given the extent to which some of the variables are correlated with trade demonstrated in Table 1. For example, free trade agreements, colonial histories, a shared language, a shared border and the same currency all affect whether countries engage in trade through the removal of tariff boundaries and the establishment of relations between individuals and firms, and so on.

Table 1: Correlations

Variable	Trade	GDP_iGDP_i	GDPiGDPj per capita	Distance	Border
Trade	1.00				
GDP_iGDP_i	.8137	1.00			
GDPiGDPj per ca	.4871	.4724	1.00		
Distance	-.4440	-.2467	-.2515	1.00	
Border	.2467	1.564	.1613	-.3866	1.00
Language	.0010	-.0924	-.0518	.0592	.0732
FTA	.3362	.2410	.3630	-.3900	.2472
Colonial History	.0636	-.0162	-.1117	.0015	-.0202
Currency Union	.2023	.1677	.2284	-.2144	.1708

	Language	FTA	Colonial History	Currency Union
Language	1.00			
FTA	-.0336	1.00		
Colonial History	.3275	-.0355	1.00	
Currency Union	.0010	.5212	-.0190	1.00

V. Empirical Analysis

I shall now consider empirical testing of the currency union effect upon trade using the gravity equation to quantify the effects of the Euro upon trade in the 1999-2004 period.

5.1 Difference-in-Difference Estimation

A simple means of estimating the effect of the Euro upon trade would be to analyse how trade responded in the cases where a country did and did not join the single currency. However, one of the main difficulties in resolving the currency union effect upon trade is that we do not know what the level of trade would have been had a specific country not engaged in monetary union. In a laboratory experiment, this could be accomplished through administering treatment to one specimen (the treated group) while holding conditions con-

[32] Rose, Andrew, and Eric Van Wincoop. "National Money as a Barrier to International Trade: The Real Case for Currency Union." American Economic Review 91.2 (2001): 386-390.

stant in all regards for an identical specimen that does not receive the treatment (the control group). This provides a natural experiment since conditions are the same in every way for both the treated and the control group. One could then gauge whether the treatment had an effect and quantify its magnitude.

Ideally, one could use a similar procedure to ascertain the currency union effect on trade. However, finding a control group for the experiment is difficult. There are inherent differences in government policy, culture and the model of capitalism between the countries which adopted the Euro as their currency and the rest of the world. Despite this, there are a number of countries that could be considered for use in a control group. One possible control group could be the non-Eurozone OECD countries. There are many similarities between these well developed, rich countries which have similar institutions to those nations using the Euro. Most OECD members also have free trade agreements in place and similar GDP (although mainly through multilateral rather than bilateral agreements). Although there are similarities, there are also reasons to believe that the OECD would not constitute a good control group. Many of these, such as Japan and Mexico, are geographically distant, not just from the EU but from one another. Secondly, OECD countries do not tend to be integrated to the same extent politically or economically as is the Eurozone.

However, the decision of Denmark, Sweden and the United Kingdom to remain outside the Euro presents a potential control group which has much in common with the Eurozone countries.[33] They are EU members and thus share in the political and economic agreements of the supranational organisation. They are geographically close and conduct a large amount of trade with Euro members (for example, the UK conducts approximately 60% of its trade with Eurozone countries). One could also argue for the inclusion of some of the Eastern European countries such as the Czech Republic and Poland, but these are excluded since they only became EU members in 2004.

The object of difference-in-difference (DD) estimation is to uncover the effects of a change in policy, in this case the effect of the Euro upon trade. DD estimates are found by applying an OLS estimator to the cross-sectional panel data in the data set for the years prior to the change and then to the post-treatment period for both the treated and control groups. First, I compute average trade for each treated and control country for the pre-1999 and 1999-2004 periods. Baier et al. (2002) recommend using aggregation of the data in the before-and after-treatment periods in order to overcome problems of serial

[33] A possible downside to including Denmark is that the Krone was pegged to the Euro over the period under inspection.

correlation which often afflict DD estimators.[34] The direction of the bias in the standard errors that serially correlated observations will have depends upon whether there is positive or negative serial correlation. Positive serial correlation will result in under-reported standard errors while the opposite will occur if negative serial correlation is present.

To obtain the DD estimator I generate three dummy variables. The first is called *post*, which is equal to one if the observation comes from the post-1999 period. The second dummy is *treatment*, which is equal to one if the observation comes from the group that engaged in monetary union. Finally, I generate an interaction term, *post*treatment*, which is the result of multiplying *post* and *treatment* together. This is the coefficient of interest because it shows the estimated effects of changing the currency to the Euro. It is then possible to estimate the following equation to obtain the treatment effect:

$$T_i = \beta_1 post_i + \beta_2 treatment_i + \beta_3 post*treatment_i + \nu_i \quad (5)$$

The DD estimate is then $\hat{\beta}_3$. The results of this regression are given in Table 2.

Table 2: Difference-in-Difference Estimates

Dependent Variable: Bilateral Trade	
post	-.006
	(.06)
treatment	-1.36
	(.06)
post*treatment	.78
	(.07)
R^2	.0194
Number of observations	51831

Robust standard errors in parentheses

The results indicate that trade decreased for the control group between the two periods by 0.006 percent but this is both economically and statistically insignificant. The coefficient on treatment shows that among the countries that adopted the Euro, trade was initially on average less than among the control group, but this increased markedly in the post-1999 period as demonstrated by the *post*treatment* coefficient. Indeed, the treatment effect of the Euro is found to be colossal, with a coefficient of 0.78. The estimate is also highly significant

[34] Baier, Scott, Jeffrey Bergstrand, and Peter Egger. "The New Regionalism: Causes and Consequences." Économie Internationale 109 (2007): 9-29.

with a t-statistic greater than 11. This would appear to suggest that the currency union effect on trade is large regardless of whether countries are small, poor and remote or large, well developed and geographically centric. However, the results in Table 2 should be treated with caution. Regardless of whatever concerns one may have about the practical uses of the R^2 in applied economics, a value of .0194 is hardly robust. Indeed, this casts doubt upon whether the estimates are correct given that, at best, they explain a mere 2 percent of the variation in the dependent variable, trade. This leads me to question whether the results are in fact a product of a statistical rather than an economic relationship.

It is important to note that the DD estimates fail to take into account the endogeneity of the treatment effect. This could lead to biased estimates since the assignment of countries into the treatment and control groups is non-random. If the results were to be unbiased, then firms and agents in the period prior to 1999 must be unaware that the treatment will occur. However, this is unlikely to be the case as the Maastricht Treaty, signed in 1993, would have signalled that countries were preparing to engage in future monetary union. Firms and individuals could then have responded by taking decisions to prepare for this eventuality.

5.2 OLS Regressions

The model to be estimated takes the following form:

$$x_{it} = \beta_0 M_i M_j + \beta_1 \left(\frac{M_i M_j}{Pop_i Pop_j} \right) + \beta_2 DIST_{ij} + \beta_3 Border_{ij} + \beta_4 Lang_{ij} + \beta_5 FTA_{ij} + \beta_6 Colony_{ij} + \phi cu_{ij} + \varepsilon_{ij} \quad (6)$$

where M_i and M_j are log GDP for country i and j, respectively, Pop_i and Pop_j are log population for i and j, respectively, $DIST_{ij}$ is the log distance between i and j, Border_{ij} is a dummy variable equal to one if i and j share a common border, FTA_{ij} represents whether the trading partners have a bilateral free trade agreement, $Colony_{ij}$ indicates whether i and j have a shared colonial history post-1945, and cu_{ij} is a dummy variable equal to one if the countries use the Euro as their official currency.

Rose (2000) used pooled data from the years 1970, 1975, 1980, 1985 and 1990.[35] He then used an OLS estimator with robust standard errors to determine the effects of monetary union upon trade. It is important to note that this did not incorporate clustering effects. I begin the analysis by adopting

[35] Rose, Andrew. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." Economic Policy 15.30 (2000): 7-45.

an approach similar to that of Rose, although I pool the data across the entire sample I have available. Since the estimation procedure relies upon a pooled OLS model, I use a Breusch-Pagan test to ascertain whether the disturbance terms are spherical. This produced an LM value of 2985.88, which is greater than the critical value of 2.73 at the 5 percent level of significance, leading to a rejection of the null of homoskedasticity. I then implement heteroskedasticity-robust standard errors.

The results of the regressions for the 1980-2004, 1980-1998 and 1999-2004 periods are reported in Table 3. I also include the Rose results for comparison. For the entire sample period, with the exception of the currency union dummy, all the variables appear correctly signed and are statistically significant. Some of the t-statistics are huge with values in excess of 20. However, this is not unreasonable and the magnitudes are similar to those reported elsewhere in the literature.

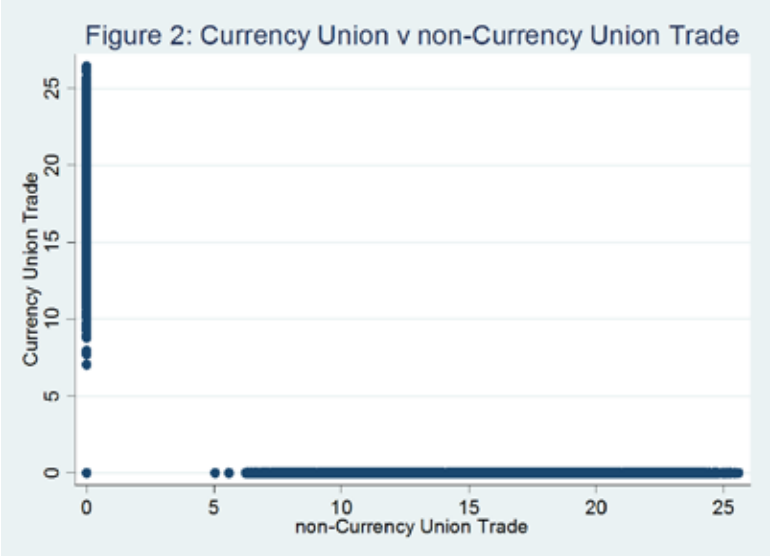
Table 3: OLS Regressions

Dependent Variable: Bilateral Trade

	1980-2004	1980-1998	1999-2004	Rose 1970-1990
GDP_iGDP_j	.93	.91	.96	.80
	(.004)	(.004)	(.01)	(.01)
GDPiGDPj per capita	.17	.26	.30	.66
	(.01)	(.01)	(.02)	(.01)
Distance	-.89	-.92	-.77	-1.09
	(.02)	(.03)	(.03)	(.02)
Border	.52	.39	.45	
	(.05)	(.06)	(.08)	
Language	.91	.92	.81	.40
	(.03)	(.04)	(.06)	(.04)
FTA	.79	.63	.68	.99
	(.03)	(.03)	(.06)	(.08)
Colonial History	1.50	1.57	1.54	2.40
	(.06)	(.07)	(.13)	(.07)
Currency Union	-.38	-2.68	.11	1.21
	(.04)	(.10)	(.04)	(.14)
R^2	.7432	.7402	.7857	.63
Number of observations	38498	27860	10638	22948

Robust standard errors reported in parentheses

The currency union effect is actually found to reduce trade between members of a common currency by approximately 38 percent over the entire period. However, this is more an artefact of the estimation procedure used and outliers. To see this, consider Figure 2 below.



This demonstrates that, when OLS is applied to the model, countries which are members of currency unions are drawn from a different panel than non-members. Consequently when the regression is run, the OLS estimator establishes a negative relationship, as this is the nature of the distribution.

Over the 1980-1998 period the currency union coefficient is far greater than that for the whole sample period and assumes a fairly implausible yet statistically significant value. However, inference is based upon a mere 16 observations which include only France and a dependency, French Guiana. Thus the estimates for this period are of little significance. The estimates for the 1999-2004 period, when the single currency came into effect, are of greater interest. It appears that GDP per capita is a better determinant of trade during this period, whereas the effect of distance between trading partners, while still significant at the 5 percent level, has decreased. A similar trend has occurred regarding language, which might signal a greater degree of interdependence across countries. However, the central finding of this regression is that the introduction of the Euro has served to increase trade among the 11 members by approximately 11 percent and the accompanying t-statistic is 2.20.

An increase in trade of 11 percent pales in comparison to the 397 per cent gains in trade found by Rose. However, the sample I use may be a better barometer in that it has within it countries which are not small, remote or poor. Only one island economy is included. The value I have found could be ‘low’ because the level of trade which had previously taken place amongst Eurozone members was high. In effect, there may be diminishing returns to trade follow-

ing the introduction of a common currency. The greater the volume of trade already conducted between members could result in the common currency having a lesser impact because of the established trading links and the free trade agreements covering all European Union members.

The results I have obtained for the period differ quite starkly from those of Rose. This is hardly surprising given the different data sets that cover different years. Ignoring this, even for the period in which the Euro is adopted, its estimated effect on trade is small in comparison to the Rose findings (0.11 against 1.21). This may be because the countries in Rose's data set have engaged in monetary union for much longer periods of time. This means the effect of using a different currency has had sufficient time to permit the establishment of trading relationships. However, it could also be the differences in the results are caused by the different countries used in mine and Rose's datasets. Perhaps the trade benefits for large countries are small.

Table 4: WLS Regressions

Dependent Variable: Bilateral Trade

	1980-2004	1980-1998	1999-2004
GDP_iGDP_i	.86	.86	.91
	(.006)	(.006)	(.005)
GDPiGDPj per capita	.23	.26	.40
	(.01)	(.01)	(.01)
Distance	-.85	-.88	-.73
	(.02)	(.03)	(.04)
Border	.56	.48	.48
	(.01)	(.02)	(.02)
Language	.73	.78	.59
	(.01)	(.01)	(.02)
FTA	.69	.69	.53
	(.01)	(.01)	(.02)
Colonial History	1.49	1.53	1.54
	(.02)	(.02)	(.03)
Currency Union	-.31	-2.49	.16
	(.02)	(.09)	(.02)
R^2	.7569	.7544	.7857
Number of observations	38498	27860	10638

Robust standard errors reported in parentheses

In Table 4 are the results from a weighted least squares (WLS) estimator. As mentioned in the previous section, this method was used to control for measurement error in the reported trade values. This estimator was computed by weighting the importance of the observation by the average trade value conducted by all countries and that specific trade partner for each year. The results do not show a large departure from those computed using OLS on the

averaged level of trade. This is mainly because there are only 131 observations that are averaged (the trade between fellow Euro members), which are unlikely to make much of an impact in a sample of more than 10000 observations. It is important to note, however, that the currency union effect is found to be larger under WLS with a coefficient of .16 and this is estimated with greater precision than under OLS, shown by the smaller standard error. The other variable coefficients show little deviation from the OLS estimates.

5.3 Tests for Serial Correlation

An important question this paper seeks to address concerns the timing of the effects of the introduction of monetary union. For example, is it the case that the increases in trade occurred immediately following the introduction of the new legal tender, or, were the effects felt before this?

The OLS estimate of an increase in trade by 11 percent for the Eurozone could be an underestimate of the eventual effects of the single currency. Trading relationships may take time to develop as exporters and importers establish contact with foreign firms which can supply the goods or services demanded. Evidently it will require time for the data to become available. However, it is also possible that the estimated effects of the Euro could be an overestimate since its effects began to surface in the period prior to its official use. If firms and individuals expect change, they may decide to take advantage of the opportunities on offer and start establishing trading relationships prior to the introduction of the new monetary regime. In this case, one would expect the error terms across countries to be serially correlated because trade between country *i* and country *j* in 1995 will be dependent upon trade at a future date.

It is also important to establish whether the errors are serially correlated as this could affect the OLS results previously found. Although the estimates would remain unbiased, the standard errors would be underreported, meaning the t-statistics are larger than they otherwise should be. If this is the case, then it is possible that we could reject the OLS estimates of the statistically significant increase in trade found in section 5.1.

To determine whether the errors are serially correlated, and if so, to what extent, an OLS regression on an autoregressive model with six lags is used. The number of l ags chosen corresponds to the number of years between the introduction of the single currency and the Maastricht treaty of 1993. In that year, members of the European Union, apart from Denmark and the United Kingdom, pledged to join the Euro. It may have been the case that firms took this as a signal, anticipated the introduction of a common currency and began to tailor their businesses so that they could respond in due course.

The model to be estimated is

$$\hat{u}_t = \rho_1 \hat{u}_{t-1} + \rho_2 \hat{u}_{t-2} + \rho_3 \hat{u}_{t-3} + \rho_4 \hat{u}_{t-4} + \rho_5 \hat{u}_{t-5} + \hat{u}_{t-6} + \xi_t \quad (7)$$

where $\hat{u}_{t-i}$ are the residuals of an OLS regression and ξ_t is a random error.

I then use an OLS regression with clustering to control for country specific factors on (4) to test the null that $\rho_i = 0$. If ρ_i is found to be significantly different from zero, then there is evidence that the error terms are serially correlated.

Table 5: Test for Serial Correlation

Dependent Variable: OLS residuals

	Entire Sample	**Euro Members**
uhat$_{t-1}$	.175	.149
	(.0067)	(.0230)
uhat$_{t-2}$	.168	.123
	(.0066)	(.0222)
uhat$_{t-3}$	.148	.133
	(.0065)	(.0234)
uhat$_{t-4}$	.155	.101
	(.0066)	(.0224)
uhat$_{t-5}$	.147	.126
	(.0065)	(.0225)
uhat$_{t-6}$	.149	.115
	(.0065)	(.0227)
R^2	.6820	.2494
Number of observations	29216	2087

Robust standard errors reported in parentheses

The evidence in Table 5 clearly illustrates that there is serial correlation between observations over time for the entire sample and the Euro sample because the effects are found to be statistically significant for the lagged variables. In both samples, the magnitude of the effect diminishes over time. However, as shown in the second column, when the members of EMU deal with other members, the effect starts at a lower level and decreases at a faster rate than when they deal with non-members.

This may offer (very) tentative evidence that the Eurozone countries experienced an increase in trade prior to the actual introduction of the common currency. However, the low explanatory power of the regression leads me to doubt this finding. Coupled with this is the apparent inevitability that trade will

show signs of serial correlation. This makes it difficult to disentangle the effect of any response to the Maastricht treaty.

5.4 Panel Data Estimators

There is, evidently, a degree of uncertainty regarding the results extrapolated from the pooled OLS. A major concern is that there may be omitted variables, which could be acting as an influence. With OLS, estimates are only unbiased if the omitted variables are uncorrelated with the dependent variable. Furthermore, OLS plots the regression line by best fit. However, if the intercept for a certain country is higher, the greater will be the matrix of explanatory variables and OLS will overestimate the effect of a particular variable. The way in which my sample has been constructed illustrates a variation both within countries and across countries that OLS fails to exploit. One way of overcoming these problems would be the use of a fixed effects estimator. I would thereby hope to control for such omitted variables as the multilateral resistance terms mentioned by Anderson and van Wincoop (2003)[36], which could bias the results upwards. It would also mean that country specific factors, such as openness to trade and business cycles, are controlled for, as these will be contained within the fixed effect parameter.

The fixed effects estimator includes an intercept term that captures the influence of variables not included in the regression. A simple model would be of the form

$$y_{it} = \alpha_i + \beta X_{it} + \varepsilon_{it} \tag{8}$$

where α_i is the constant term, X_{it} is a matrix containing the explanatory variables and ε_{it} is an independently and identically distributed disturbance term. A fixed effects estimator assigns a dummy variable to control for each country in the sample, effectively eradicating the intercept term. However, in doing so, degrees of freedom are lost and the estimator becomes less efficient. This problem may be overcome by introducing 'centred' variables equal to the variable's value minus its mean. While this solves one problem, it introduces another, as all time invariant variables will be removed from the sample, thereby prohibiting estimation of that variable

For these reasons, I also employ a random effects estimator which seeks to lessen these problems. With the random effects model, different countries are again allowed to have different intercepts, but these are treated as being randomly assigned and as if they are an integral part of the error term.

[36] Anderson, James, and Eric Van Wincoop. "Gravity with Gravitas: A Solution to the Border Puzzle." Boston College Working Papers Working Paper 485 (2000).

Thus the model differs from the fixed effects estimator in that the error term contains two components.

$$y_{it} = \beta X_{it} + u \tag{9}$$

where

$$u_{it} = \eta_i + \varepsilon_{it} \tag{10}$$

where η_i is a random intercept term which measures the magnitude to which the individual and overall intercept differ, and ε_{it} is a random error component.

Since the random effects estimator does not impose a host of dummy variables, it produces more efficient estimates than would a fixed effects estimator. It does not eliminate all the time-invariant variables because it exploits the variation in these variables across countries, individuals, and so on, so as to gain estimates. Although the random effects estimator appears to be a silver bullet, it does have one major limitation in that it imposes the fairly strict assumption that all observations of country *i* are assumed to be independent of all other countries.

Having outlined some of the theoretical considerations behind the fixed and random effects estimators, I now use them to draw inferences. This produces the following estimates.

Table 6: Fixed and Random Effects Results

Dependent Variable: Bilateral Trade

	Fixed	Random
GDP_iGDP_j	.936	.937
	(.01)	(.01)
GDPiGDPj per capita	.358	.359
	(.01)	(.01)
Distance	-.778	-.777
	(.02)	(.02)
Border	.416	.416
	(.11)	(.11)
Language	.782	.779
	(.08)	(.08)
FTA	.709	.706
	(.08)	(.08)
Colonial History	1.492	1.496
	(.12)	(.12)
Currency Union	.067	.068
	(.09)	(.09)

The results are reported to three decimal places due to the similarities between the estimated values under the two estimators. Compared with the results reported in Table 3 for the OLS estimator, the fixed and random effects estimators show a strong similarity to one another across the variables, especially for GDP, GDP per capita, distance and a shared border. However, the panel data estimators deem language to have a greater effect, 0.78 as opposed to 0.68 under OLS. The importance of free trade agreements is also estimated to be greater at approximately 0.71 versus 0.58 under OLS, while colonial history is found to be of lesser importance under these models than when using OLS. Furthermore, under OLS, the standard error for most of the variables was smaller than when either of the panel data models was used.

While these effects are interesting, the main variable of interest, the currency union dummy, is now found to have a lesser effect upon trade than was the case under OLS estimation. Using fixed effects the Euro is estimated to increase trade by roughly 6.7 percent over the period and the random effects estimator produces a practically identical result of a 6.8 percent increase. OLS produced a statistically significant result, which was not the case with either the fixed or random effects models. Indeed these models calculate the t-statistic as a meagre 0.7, which implies that the Euro's effect upon trade by its members is either absent or has yet to materialise.

Normally a Hausman test would determine which of the two panel data estimators should be used. The reason for this is that, although fixed effects estimators lack degrees of freedom, they do allow for correlation across countries. This is fairly realistic when applied to the data set used since the level of trade conducted by France is likely to be influenced by German trade and vice-versa. Since random effects do not allow for any correlation across countries, it may be inconsistent because of the correlation between the random effect and the explanatory variables.

A Hausman specification test may be used to establish whether the random effects are orthogonal to the regressors. Under the null hypothesis, the results from fixed and random effects estimation should not differ systematically. If the test statistic is found to be less than the critical value (determined by using a chi-squared distribution for the given number of degrees of freedom), then the null hypothesis cannot be rejected. The results of the Hausman test are reported in Table 7.

Table 7: Hausman Test

	Coefficients			
	(b) **RANDOM**	(B) **FIXED**	(b-B) **DIFFERENCE**	sqrt[diag(V_b-V_B) **S.E**
GDP_iGDP_i	.9368932	.936309	.0005842	.
GDPiGDPj per capita	.3587283	.3581049	.0006234	.0003443
Distance	-.77485	-.7776264	.0001415	.0008168
Border	.4164721	.4159672	.0005049	.0041989
Language	.7788576	.7818759	-.00030182	.
FTA	.7059148	.7093338	-.0034189	.0031513
Colonial History	1.495523	1.492303	.0032205	.
Currency Union	.0680498	.0669627	.0010871	.0037628

The test statistic is calculated using the following formula and a chi-squared distribution with the degrees of freedom equal to the number of explanatory variables.

$$t = (b - B)'[V\_b - V\_B]^{-1}(b - B) \tag{11}$$

This method yields a test statistic equal to 3.66, while the critical value for eight degrees of freedom at the 5 percent confidence level using the chi-squared distribution is 15.15. Since the test statistic lies below the critical value, I reject the null hypothesis that the differences in the coefficients are systematic; that is, omitted variable bias is small. Consequently, it can be concluded that the individual effects are not correlated with the explanatory variables. This implies that the random effects model may be superior to the fixed effects model.

5.5 Dynamic Panel Data Models

The fixed and random effects estimators used in the previous section represent static panel data estimators. It is conceivable that these estimators may not encompass all the available information as the explanatory variables are assumed to produce the observed outcome in the dependent variable.[37] The introduction of lagged variables means that historical information on the dependent and explanatory variables is included in the regression. This implies that the effect of these variables is now dependent on past information. Therefore, any change in the underlying variables will constitute new information, which makes the estimation process closer to a randomised experiment. It should only pick up the effect of the introduction of the Euro.

However, this method is not without its problems. Simply appending

[37] Greene, William. Econometric Analysis: 5th Edition. New Jersey: Pearson, 2003.

a random effects estimator to incorporate a lagged dependent variable would produce correlation between the lagged dependent variable and the part of the disturbance term, $u_{i.}$. This appears in the regression for every observation in group i.[38]

$$y_{it} = \beta_0 y_{i,t-1} + x_{it}' \beta_1 + u_i + \varepsilon_{it} \quad (12)$$

One means of overcoming this problem was proposed by Arellano and Bond (1991)[39], who use a Generalised Method of Moments (GMM) estimator. The Arellano and Bond estimator takes the first difference of all the right-hand-side variables so as to remove the unobserved heterogeneity, resulting in a model of the form:

$$y_{it} - y_{i,t-1} = \beta_0 (y_{i,t-1} - y_{i,t-2}) + (x_{it}' - x_{i,t-1}')\beta_1 + (\varepsilon_{it} - \varepsilon_{i,t-1}) \quad (13)$$

Taking first differences gets rid of the fixed effect term but it does not solve the problem of correlation between the lagged dependent variable and the disturbance terms. However, the lagged differences or the lagged levels of the dependent variable may be used as instrumental variables to overcome this problem. As usual, the instruments, z_i, are assumed to satisfy the moment conditions so they are uncorrelated with the error term. A unique feature of this model is the number of instruments need not be the same over time and can increase as the time series lengthens. A minimum of three periods is required for the model to be workable.

The basic tenet of the Arellano and Bond estimator is to exploit the lack of correlation between a shock at time t and the past and future values of the dependent and explanatory variables. Despite this, adding more and more orthogonality conditions (through the use of an increasing number of instruments) will cause the estimator to tend towards OLS, which is unsurprising as an OLS estimator imposes zero correlation between the explanatory variables.

Having outlined the theoretical considerations behind the Arellano and Bond estimator, I now apply it to the data to estimate the effect of the introduction of the Euro. The results of this exercise are listed in Table 8. Delta is used to indicate where the variable is differenced.

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[38] Greene, William. Econometric Analysis: 5th Edition. New Jersey: Pearson, 2003.

[39] Arellano, Manuel, and Stephen Bond. "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations." Review of Economic Studies 58 (1991): 277-297.

Table 8: Arellano and Bond Estimator 1999-2004

Dependent Variable: Bilateral Trade	
delta GDP_iGDP_i	-1.48
	(.40)
delta GDPiGDPj per capita	1.90
	(.39)
Distance	dropped
Border	dropped
Language	dropped
FTA	.12
	(.10)
Colonial History	dropped
Currency Union	-.22
	-0.14
Number of observations	9060
Number of groups	1788

The Arellano and Bond estimator finds that past levels of trade exert a positive and significant effect upon the present level. This may be unsurprising since trading relationships are likely to develop over time and persist. Countries may also be dependent upon the import of certain products, such as oil, which are unavailable elsewhere. GDP is found to have a negative effect upon trade and the size of the standard error causes this to be statistically significant. GDP per capita, however, has a significant impact upon trade with a positive coefficient of 1.90, which is significant at the 5 percent level of confidence. Free trade agreements also affect trade positively, but the variable is statistically insignificant. Unlike OLS and the fixed and random effects estimators, the Arellano and Bond estimator finds that the currency union dummy lowers trade by Eurozone countries by 22 percent. However, the associated z-statistic is -1.56, which means that we cannot accept this finding at the 5 percent level of confidence.

An inspection of the results highlights the lack of estimates for coefficients on the distance, shared border and shared language variables. These

variables are dropped due to the first differencing method used by the estimator. The distance between countries and their neighbours remains constant over long periods of time. The same applies to the colonial history and language dummies. Either a country does or does not have a shared colonial history with another, likewise with language. There is no tendency for countries to eradicate one of their official languages at any point over the sample period. Thus, when the first difference of these variables is taken, the result is zero and they are dropped from the model.

5.6 Openness

The results in section 5.1 suggest that there could be a relationship between the effect of monetary union and openness to trade. It may be the case that countries which are more open to trade reap larger gains from the reduction in barriers to trade because they engage in a high level of trade.

In an attempt to overcome this problem, I investigate the currency union response among countries with an openness value below the lower quartile value, above the upper quartile threshold and above and below the mean and median openness for the 1999-2004 period.

Table 9: Openness and the Currency Union Effect

Dependent Variable: Bilateral Trade

	Lower Quartile	Upper Quartile	< Median	> Median	< Mean	> Mean
GDP_iGDP_i	.85	.93	.97	.96	.98	.98
	(.04)	(.01)	(.01)	(.01)	(.01)	(.01)
GDPiGDPj per capita	.30	.27	.37	.35	.37	.32
	(.09)	(.03)]	(.03)	(.02)	(.02)	(.03)
Distance	-1.04	-.70	-.83	-.73	-.79	-.74
	(.09)	(.04)	(.08)	(.03)	(.06)	(.03)
Border	1.10	.44	.53	.42	.36	.47
	(.27)	(.14)	(.17)	(.08)	(.12)	(.10)
Language	1.79	-.05	1.30	.34	1.13	.24
	(.24)	(.11)	(.09)	(.08)	(.08)	(.10)
FTA	.67	.78	.57	.64	.52	.75
	(.20)	(.10)	(.09)	(.08)	(.08)	(.08)
Colonial History	-.88	1.58	1.46	1.52	1.42	1.78
	(.25)	(.38)	(.16)	(.18)	(.12)	(.41)
Currency Union	.10	.06	.16	.07	.16	-.02
	(.19)	(.11)	(.07)	(.07)	(.06)	(.09)
R^2	.6342	.7050	.7797	.7876	.8156	.7492
Number of observations	656		3836	5992	5470	4358

Robust standard errors reported in parentheses

I have also tested to see whether the results differ when the sample is split into three as well five. I do not observe a large departure from the results reported in Table 9.

One interesting result of this exercise is that the currency union effect is greater for countries with an openness to trade less than the median and mean values than is the case for those with an openness to trade above these

thresholds. The effect for these groups is also statistically significant, which is not the case for the above mean and median openness samples. The currency union effect shows up as positive for countries with openness to trade that lay in the lower and upper quartiles. The absolute effect is larger for those among the bottom 25 percent than among the top 25 percent of the distribution. However, both of these variables are estimated to be statistically insignificant.

Despite the insignificance of some of the findings, there appears to be a trend towards countries with lower openness experiencing larger returns because of the introduction of the single currency. Why might this be the case? One possible explanation could be a case of diminishing returns. Those countries with high openness to trade values already conduct a large amount of international trade. The resultant elimination of exchange rate costs represents a smaller fraction of the total amount of trade conducted than for less open economies. Thus the barrier to trade that more open economies face is smaller than for less open economies.

5.7 Is there Evidence of Trade Diversion?

The introduction of monetary union reduces the transaction costs for firms dealing with other firms within the union. The removal of exchange transaction costs means that firms can deal more cost effectively with other firms using the same currency. This, and the ease with which price comparison can be conducted, could lead to firms increasing trade with other currency union members and decreasing trade with firms using a different currency.

One of the claims of Rose and van Wincoop (2001)[40] was that this trade diversion did not appear to occur in the currency unions analysed. Perhaps this was because their inferences were drawn from small, remote member countries which specialised in the production of a small range of goods. Such countries would be very dependant upon the import of essential goods and materials produced only by countries external to the currency union. This issue is less likely to feature within the Eurozone given the high volume of intra-industry trade amongst members.

The mechanisms behind trade diversion are difficult to understand. It is difficult to see why a German firm would reduce trade with a Brazilian firm if it used the Euro rather than the Deutschmark. Indeed, in both cases, the German firm would incur transaction costs to buy the required Real to deal with the Brazilian firm. Perhaps it is the case that, prior to the enactment of monetary union, only wares currently produced in another Eurozone country

[40] Rose, A. & van Wincoop, E. National Money as a Barrier to International Trade: The Real Case for Currency Union. American Economic Review: 91(2), 386-390, 2001.

were uncompetitive at the margin with Brazilian goods. However they are competitive ex-post. This could lead to a switch in demand by the German firm and thus trade diversion.

To ascertain if there is evidence of this, I generate a "rest-of-the-world" dummy variable for countries that are not a members of EMU. I then split the sample at the year 1999 and run the regression below for the first and second periods

$$x_{it} = \beta_0 M_i M_j + \beta_1 \left(\frac{M_i M_j}{Pop_i Pop_j} \right) + \beta_2 DIST_{ij} + \beta_3 Border_{ij} + \beta_4 Lang_{ij} + \beta_5 FTA_{ij} + \beta_6 Colony_{ij} + \beta_7 ROWdummy + \phi cu_{ij} + \varepsilon_{ij} \quad (14)$$

This produces the results in Table 10.

Table 10: Trade Diversion

Dependent Variable: Bilateral Trade

	pre-1999	post-1999
GDP_iGDP_i	.91	.95
	(.005)	(.01)
GDPiGDPj per capita	.26	.39
	(.01)	(.02)
Distance	-.92	-.77
	(.03)	(.03)
Border	.40	.42
	(.06)	(.08)
Language	.89	.68
	(.04)	(.06)
FTA	.69	.50
	(.05)	(.06)
Colonial History	1.59	1.59
	(.07)	(.13)
ROW Dummy	.09	-.26
	(.05)	(.05)
R^2	.7399	.7801
Number of observations	27860	9828

Robust standard errors reported in parentheses

From the results in the table above, there appears to be a tendency for the 11 EMU members to reduce trade with rest-of-the-world countries post-monetary union. In the 1980-1999 period, the ROW dummy variable is positive but statistically insignificant. In the second period, being a rest-of-the-world country is associated with approximately a 30 percent reduction in the volume of trade conducted with Eurozone members. This coefficient is also statistically significant. This may indicate that there has been trade diversion

away from non-EMU members.

However, the effect estimated for trade with a rest-of-the-world country could be biased downwards due to the omission from the data set of a multilateral free trade variable. Since the EU countries make free trade agreements with non-EU members through the World Trade Organisation and with the non-member governments, the omission of this variable could mean that the reported coefficient is found to be statistically significant when in fact this may not be the case.

VI. Conclusions

In this paper, I sought to establish whether the introduction of the Euro has had an impact upon trade. The results of this exercise are at best mixed and sensitive to the estimation procedure used. A pooled OLS, like the Rose (2000)[41] model, shows that the Euro raised trade by a statistically significant value of 11 percent. However, this fails to account for country specific effects and omitted variables.

Applying fixed effects to the data set yielded a smaller currency union value of approximately 7 percent. However, the corresponding standard error renders this statistically insignificant. Using an Arellano and Bond estimator yielded yet another estimate: a decrease in trade by 22 percent occurs because of the introduction of the single currency. As with the fixed effects estimator this too is found to be statistically insignificant. Additionally, I used a difference-in-difference estimator. This found that the Euro had increased trade by a statistically significant 78 percent. However, this estimator appears to suffer from very low explanatory power with an R^2 value of 2 percent. The results were, therefore, dubious.

Thus it may be concluded that the effects of the Euro upon trade are either fairly small, in the region of 6-11 percent, or that they will take time to manifest. Even if the trade effects were within this range, it would still constitute a large, absolute increase in the average amount of trade conducted by each Eurozone member. It may take several years before sufficient data is available on which to form a judgement.

One can also draw several normative implications relating to policy makers and businesses. Firstly, policy makers in countries considering joining the Euro should be aware that the total trade effect might not occur immediately. However, the results suggest that on average, countries that join the Euro, despite fundamental differences in the structure of their economies, experience increases in trade. This is especially important in light of the accession

[41] Rose, Andrew. "One Money, One Market: Estimating The Effect of Common Currencies on Trade." Economic Policy 15.30 (2000): 7-45.

of many eastern-European countries that have joined the EU in recent years. While these countries may gain through greater trade, the loss of monetary autonomy could impose a short-term burden upon their economies. Striking a balance between interest rates favourable for all members could also be difficult. The rapid development of many eastern-European economies, coupled with low interest rates to suit the large economies of central Europe (France, Germany and Italy), could result in high rates of inflation in the former countries. Furthermore, current Euro members must also consider the potential consequences of admitting many more countries. For example, tighter rules on the SGP may be necessary since the incentive to break the SGP increases with a greater number of members.

Lastly, businesses must also be aware that EMU membership could have implications for them. If indeed business cycles do become more synchronised across countries, then firms operating in highly specialised industries could be more susceptible to industry exit. This may necessitate the introduction of organisational strategies such as offshoring and outsourcing to cope with such pressures.

Appendix

Table 11: Currency Unions in the Data set

Euro Memebers

Country	First Observation*
Austria	1999
Belgium	1999
Finland	1999
France	1999
Germany	1999
Greece	2001
Ireland	1999
Italy	1999
Luxembourg	1999
Netherlands	1999
Portugal	1999
Spain	1999

Other Currency Union Members

France	1980
French Guiana	1980
Belgium	1980
Luxembourg	1980

* First Observation refers to the first observation in the sample period

Table 12: Difference-in-Difference Control Sample

Denmark
Sweden
United Kingdom

Table 13: Countries in the data set

Afghanistan	Djibouti	Lebanon
Albania	Dominica	Lesotho
Algeria	Dominican Republic	Liberia
Angola	Ecuador	Libya
Antigua	Egypt	Lithuania
Argentina	El Salvador	Luxembourg
Armenia	Equatorial Guinea	Macao
Australia	Eritrea	Macedonia
Austria	Estonia	Madagascar
Azerbaijan	Ethiopia	Malawi
Bahamas	Fiji	Malaysia
Bahrain	Finland	Maldives
Bangladesh	France	Mali
Barbados	Gabon	Malta
Belarus	Gambia, The	Mauritania
Belgium	Georgia	Mauritius
Belgium-Luxembourg	Germany	Mexico
Belize	Ghana	Micronesia, Fed. St
Benin	Greece	Moldova
Bermuda	Grenada	Mongolia
Bhutan	Guatemala	Morocco
Bolivia	Guinea	Mozambique
Bosnia and Herzegovina	Guinea-Bissau	Namibia
Botswana	Guyana	Nepal
Brazil	Haiti	Netherlands
Brunei	Honduras	Netherlands Antille
Bulgaria	Hong Kong	New Zealand
Burkina Faso	Hungary	Nicaragua
Burundi	Iceland	Niger
Cambodia	India	Nigeria
Cameroon	Indonesia	Norway
Canada	Iran	Oman
Cape Verde	Iraq	Pakistan
Central African Republic	Ireland	Palau
Chad	Israel	Panama
Chile	Italy	Papua New Guinea
China	Jamaica	Paraguay
Colombia	Japan	Peru
Comoros	Jordan	Philippines
Congo, Dem. Rep.	Kazakhstan	Poland
Congo, Republic of	Kenya	Portugal
Costa Rica	Kiribati	Puerto Rico
Cote d`Ivoire	Korea, Dem. Rep.	Qatar
Croatia	Korea, Republic of	Romania
Cuba	Kuwait	Russia
Cyprus	Kyrgyzstan	Rwanda
Czech Republic	Laos	
Denmark	Latvia	

Table 13 Continued

Samoa
Sao Tome and Principe
Saudi Arabia
Senegal
Serbia and Montenegro
Seychelles
Sierra Leone
Singapore
Slovak Republic
Slovenia
Solomon Islands
Somalia
South Africa
Spain
Sri Lanka
St. Kitts & Nevis
St. Lucia
St.Vincent & Grenadines
Sudan
Suriname
Swaziland
Sweden
Switzerland
Syria
Taiwan
Tajikistan
Tanzania
Thailand
Togo
Tonga
Trinidad &Tobago
Tunisia
Turkey
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Uzbekistan
Vanuatu
Venezuela
Vietnam
Yemen
Zambia
Zimbabwe
French Guiana
Greenland

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