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To peg or to join:

Estimating the effects on bilateral trade of an EMU membership and a direct fixed exchange rate regime

Abstract

This thesis report examines the impact on trade, within the European Union, of an EMU membership and a direct fixed exchange rate regime during the period 2003-2012. This has been done using the gravity model of trade and three different estimation techniques, the Pooled OLS model, the fixed effects model and the random effects model. Previous research in this area has focused on estimating the trade effects in a global perspective. As far as we are aware, this report is the first to study this topic in a strictly European context. Since the composition of countries using a common currency apart from the Eurozone, to a large extent, consists of small and poor countries our estimated results, from a data set with a high concentration of OECD countries, are an interesting benchmark to earlier studies. Our core result indicates that two members of the EMU trade 9.3 % more between each other than if one of the countries is a member of the EMU and the other has a direct fixed exchange rate to the euro.

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Chapter 1 - Introduction

Europe is currently experiencing the aftermath of the Euro crisis with the imminent risk that a new one is lurking behind the corner, with the state of the public finances in some of the southern European countries in mind. This has led to a situation where voices are being raised about how the pros and cons of the euro project really add up. One of the main arguments for the Economic and Monetary Union (EMU) is that it promotes trade and recent studies on this subject states that the EMU indeed has a positive impact on trade. This thesis will study whether a country can keep its national currency, and all the benefits this entails, and still gain trade benefits in level with an EMU membership by setting up a direct fixed exchange rate regime[1] to the euro. In other words, is it possible to eat the cake and have it to? We will analyse this by estimating the impact on trade of an EMU membership and a direct fixed exchange rate regime using a gravity model. Similar studies have been done but never, as far as we are aware, in a strictly European context. The results obtained from this research are thereby unique and a contribution to the always ongoing debate concerning exchange rate regimes. Adam and Cobham (2007) emphasized the relevance in studying the impact of exchange rate regimes on trade in Europe because of the fact that the estimations from such a data set, consisting of high concentration of OECD countries, would be interesting to compare with those done with a global focus[2].

1.1 Research question

Our hypothesis is stated so that it is in line with findings from previous research:

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[1] Direct fixed exchange rate and direct peg are used as synonyms, the same implies for indirect fixed exchange rate and indirect peg. A fixed exchange rate is used as a general term to highlight that one or several countries fix their domestic currency to the currency of the base country.

[2] Adam ans Cobham (2007) states in their conclusion:" However, the research reported here leaves open a number of avenues that need to be explored, and on which we are currently working. First, an extended data set which covers the first five or so years of EMU will allow better estimates of the effects of currency unions because such a data set (unlike the present one) will include unions between advanced countries."

H_0: During the period 2003-2012 an EMU membership has exceeded a direct fixed exchange rate regime to the euro in terms of gains in intra-EU bilateral trade.

H_1: H_0 not true.

1.2 Background - The EMU and the ERM II

In 1999 the monetary system in Europe was fundamentally changed due to the introduction of the euro. This was another step to further strengthen the market integration in Europe that, among other things, facilitate for trade between the European countries. The currency union initially consisted of eleven member countries; a figure that today has been expanded to eighteen (The European Commission, 2014). The decision to implement the euro was taken in 1992 from the agreement of the Maastricht Treaty, which set up the rules of the introduction. Among other things it states the conditions a country needs to meet to be able to join the currency union. These conditions are known as the convergence criteria and address issues as required levels of inflation, public debt, interests rates and exchange rate fluctuations (Krugman and Obsfeldt, 2006).

One criteria concern participation in the European Monetary System's exchange rate mechanism (ERM II) and is of specific interest in our research since it has had significant repercussions on the exchange rate regime landscape in Europe. The criteria states that the member state must have participated in the ERM II for the preceding two years without severe exchange rate fluctuations and must also not have devalued its currency in that period. The ERM II was set up in 1999, when it replaced the ERM, to safeguard that exchange rate fluctuations does not interfere with the economic stability in Europe (European Commission, 2014). The operating procedures are determined in agreement between the European Central Bank (ECB) and the central bank of the nation in question. Fluctuation margins of +/- 15 % are set up around an agreed central rate. The ECB has the power to initiate a procedure with the purpose to change the rate (De Grauwe, 2012).

Table A3 in the appendix shows the distinct relationship between the presence of ERM II and the amount of nations that have used a fixed exchange rate regime in Europe during the period 2003-2012. It should be pointed out that the fluctuation possibilities incorporated in the ERM II agreements makes it somewhat of a stretch to call it per definition a fixed exchange rate regime. We have addressed this fact by using exchange rate volatility terms to get a suitable selection, but more on that later. However, the ERM II does not give the whole picture regarding the fixed exchange rate regimes in Europe since there are countries, Bulgaria and Hungary, that have exercised a fixed exchange rate regime in the period 2003-2012 despite not at any time been participating in the ERM II. Both countries had problems with high levels of inflation during the end of the 1990's and this was a significant factor for them to adopt a fixed exchange rate regime (Moghadam, 1998) (Gulde, 1999). Currently the ERM II consists of only two countries, Denmark and Lithuania. Denmark has not a pronounced intention to join the EMU but is involved in the ERM II at a +/- 2.25 % fluctuations margin. Lithuania on the other hand has been required to postpone their entry to the EMU because of too high levels of inflation (European Commission, 2006).

Chapter 2 - Theory and previous research

2.1 Previous research

The starting point of the last decade's research concerning common currency and trade can be attributed to Andrew Rose (2000). Rose's extraordinary finding that countries using the same currency trade three times as much as they would if they used different currencies got a major impact in the academic world. Rose studied bilateral trade between 186 countries in the period 1970 to 1990 using a gravity model and cross-sectional data. Since currency unions are rare, a majority of the observations referred to trade between countries with different currencies and only about one per cent of the observations concerned country pairs involving countries using the same currency. Despite this fact his findings were statistically significant.

The subsequent research used Rose's results as a benchmark and it did not take long until criticism arose. The name of the report "*Honey, I shrunk the currency union effect on trade*" quite obviously stated the author, Volker Nitsch's, view on the topic. Nitsch presented results that showed how minor changes in the data set, used by Rose, got major implications in the results and he argued that the effect was exaggerated. One substantial characteristic in the data set is that countries using a common currency typically are small and poor, for example countries using the East Caribbean dollar. Another characteristic in Rose's data is small and poor countries that have adopted a currency from a larger economy, for example island states in the Pacific adopting the Australian dollar, a phenomenon called dollarization (Nitsch 2001).

Torsten Persson criticised the gravity model used by Rose on the basis that the observations of trade amongst countries with the same currency were so few. Persson stated that *"Rose's finding of a huge treatment effect of a common currency on bilateral trade are likely to reflect systematic selection into common currencies of country pairs with peculiar results*" (Persson 2001).

If we put it in a European context; what is the EMU's impact on bilateral trade? Once again Andrew Rose plays a significant role with his research done together with Eric van Wincoop (2001). Their research is an extension of Rose's previous one and it is based on trade statistics in the period 1970 to 1995, but the authors are now making regional breakdowns. They estimated that the eleven initial members of the EMU would have increased their overall trade with 59 % if they had used a common currency during the years 1970 to 1995. The statistics include multilateral residence effects to be more accurate.

Other studies on the subject have been conducted by Faraquee (2004), Micco, Stien and Ordonez (2003) and De Nardis and Vicarelli (2003). These all indicate that the EMU have had a positive impact on trade, though in lesser terms then those presented by Rose and Wincoop (2001). All studies use a similar technique, the gravity model, but their data is comprised of slightly different variables. In summary their estimated results indicate that the EMU has had a positive impact on bilateral trade in the range of 2-8 % for its members.

Since the breakdown of the Bretton Woods system in the early 70's, numerous studies have been published to examine the impact of exchange rate volatility on trade. The underlying concept is that less exchange rate volatility gives more stability and should promote trade, therefore should a fixed exchange rate regime have a positive impact on trade. Despite the logic in this there has been no coherency in the empirical studies stating that this is true. Most studies have found no evidence that exchange rate volatility impact trade, for example van Wincoop and Banchetta (2000) and Tenreyro (2007). McKenzie (2002) made a compilation of previous research on this topic and reached the conclusion that; "*the empirical literature contains the same mixed results as the evidence provided by world trade data most commonly fails to reveal a significant relationship. However, where a statistically significant relationship has been derived, they indicate a positive and negative relationship seemingly at random."*

One study with a different approach is Klein and Shambaugh's (2004). Their research indicates that a direct fixed exchange rate regime has a significant positive impact on bilateral trade. Their panel data consist of 181 countries and the observation period is 1973-1999. The result, using country pair fixed effects, implies a 21 % increase in trade of using a direct fixed exchange rate regime compared to not using one, everything else equal. The difference with this study, compared to previous ones, is that the authors measure the significance on dummy variables representing if there is a direct fixed or indirect fixed exchange rate between countries. Previous studies have estimated the effects of a fixed exchange rate on trade by multiplying the estimated coefficients of the exchange rate volatility terms by a given change in exchange rate volatility and exchange rate volatility squared respectively, with results that implies minor effects of fixed exchange rates on trade. Klein and Shambaugh also measure the effect on trade of being a member of a currency union. Their results, using country pair fixed effects, implies that a pair of countries that are members of the same currency union trade 38% more than an otherwise similar pair, this result is not statistically significant though.

Adam and Cobham (2007), the research we referred to in the introduction, used the same dummy variable estimation technique as Klein and Shambaugh (2004) but expanded the area of interest to not only include fixed exchange rate regimes but various ones. Using a pooled OLS gravity model they presented results indicating not only a great treatment effect of being member of a currency union but also that a fixed exchange rate regime fosters trade and, not the least, that it is a sliding scale, indicating that the stronger the ties are to the base currency the greater is the positive impact on trade. Trade between members of a currency union was 139.8 % higher then it would be if they were non-members. Furthermore they found that if one country was a member of a currency union and the other country pegged to this currency, the trade increased with 56.8% compared to if this relationship did not exist. Their results concerning if both countries have a floating regime implied a negative impact of 17.6 % on trade. The relationships indicated by Klein and Shambaugh (2004) and Adam and Cobham (2007) are the ones we want to study in a European perspective since, as stated earlier, the composition of countries being members of currency unions globally does not reflect the European context.

2.2 Theoretical framework

Even if the number of empirical studies comparing trade effects of currency unions and fixed exchange rate regimes are limited, there are consensus among these that currency unions foster trade to a greater extent. In this section we try to identify what in the structure of the two regimes that cause this order. The focus is directed at the issues of transaction costs and exchange rate uncertainty and how these affect bilateral trade.

Robert Copeland (2008) defines a monetary union as: *"one (zone)[3] where the accepted means of payment consists either of a single, homogeneous currency or of two or more currencies linked by an exchange rate that is fixed (at one for one) irrevocably".* This definition underlines the fact that a currency union in many ways resembles a system of fixed exchange rate regimes, but in the same time the two systems differ in essential areas.

Robert Mundell's theory of Optimum Currency Areas highlights two major benefits of a common currency; the elimination of transaction costs and a better performance of money as a medium of exchange and as a unit of account (Ricci, 2008). The Commission of the European Community (1990) describes the direct benefits from a monetary union to be; "*the elimination of exchange rate related transaction costs and the suppression of exchange rate uncertainty*".

The matter of transaction cost is straightforward. When adopting a common currency the need for currency exchange transactions within the currency union, and the cost associated with these, vanish. With regards to the extreme amount of euros traded daily in the money market, this adds up to a significant amount. Estimations concerning the total transaction cost figure, associated with euro transactions, have been found to be in the range of 0.25 % to 0.5 % of EU's GDP (De Grauwe, 2012). In this perspective the national currency is a barrier of trade since it carries transaction costs.

The issue of exchange rate uncertainty between countries disappears if they both adopt a common currency. The same applies if one country pegs its currency to the other, but in this case it is a matter of the construction of the peg. The benefit of the reduction of exchange rate uncertainty is related to the theory of the risk-averse investor. Faced with investment or trade opportunities, investors are likely to be less enthusiastic when the decision involves the risk of currency fluctuations (Copeland, 2008). However, the existence of forward and futures markets reduce the influence of exchange rate fluctuations on trade and, as stated earlier, research have not been successful in finding a causal relationship between exchange rate fluctuations and

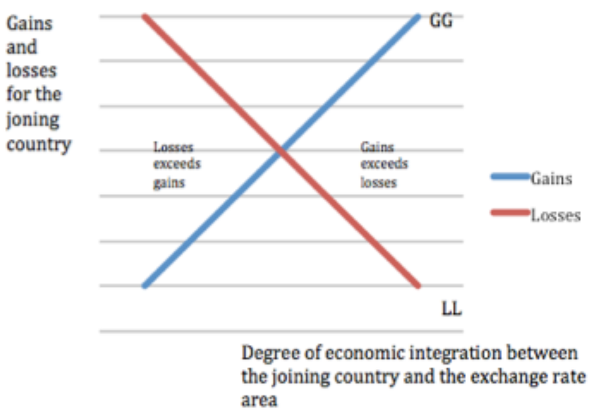
[3] Authors remark

trade reduction. Even so, sharing a common currency is a much more serious and a more durable commitment than a fixed exchange rate (Rose, 2000).

So far we have presented information that emphasizes benefits of a common currency over a fixed exchange rate regime. A quick look at the European economic landscape makes it quite clear that also this coin has two sides. The primary disadvantage with joining a monetary union is that the country gives up its monetary independence, which is a fundamental tool to react to changes in the economic environment as well as strengthen the nation's competitiveness in terms of trade (Fregert and Jonung, 2010).

The same argument can be used against a fixed exchange rate regime. Under a fixed exchange rate regime it is the obligation of the central bank to make sure that the exchange rate is kept. As a consequence of this the central bank cannot deviate from this duty by changing the money supply or interest rate if it is not in the purpose of retaining the exchange rate (Burda and Wyplosz, 2009). The monetary independence is therefore undermined. But what is a major difference between being a member of a currency union and having a fixed exchange rate regime is the relative flexibility of changing system if the current one does not benefit the country's economic performance. If we put this in context; it would be a much larger operation for example Greece to leave the EMU, which has been discussed in recent years, then it would be for Denmark to leave the ERM II. What we want to point out is that joining a currency union is to a large extent a point of no return, a description that does not reflect the situation for a country with a fixed exchange rate regime.

Figure 1. LL-GG Schedule



(Krugman and Obsfeld, 2006)

You can explain the reasoning behind the decision to join a monetery union or setting up a fixed exchange rate regime with the LL-GG schedule; it all comes down to the level of economic integration. Setting up a fixed exchange rate will give the country gains in monetary efficiency, because of the removal of exchange rate fluctuations with the currency it pegs to. Joining a currency union is one step further in the pursue of monetary efficiency. On the other hand the country gives up its possibility of using the exchange rate and monetary policy when either setting up a fixed exchange regime and even more so when joining monetary union. Figure 1 shows how the level of economic integration and the gains and losses covary. The stronger the economic integration is the greater the incentive is in pegging the currency, or even joining the monetary union.

Chapter 3 - Data and Methodology

3.1 The Gravity Model

Ernst Georg Ravenstein first introduced the gravity model in the 19th century to explain migration patterns. The person to apply the gravity model on the issue of trade was Jan Tinberg, who gave birth to the traditional gravity model of trade in 1962 (Soloaga and Winters, 1999). The model derives from Newton's universal law of gravitation and describes the trade flows between two countries. The model explains the trade flows, in a certain period of time, as proportional to the economic size of the two countries (often measured in GDP or GNP) and inversely proportional to the distance between them. This equation is often argued to be the foundation for estimating trade diversion and trade creation (Krugman and Obsfeldt, 2006).

$$T_{ij} = A \times \frac{Y_i \times Y_j}{D_{ij}}$$

Variable	Explanation
T_{ij}	The total trade between country i and j.
A	Constant
Y_i	Indicator of the economic size of country i, often defined by its GDP or GNP.
Y_j	Indicator of the economic size of country j, often defined by its GDP or GNP.
D_{ij}	The distance between country i and country j.

The model has proven stable over time in a variety of empirical studies including different countries and methodologies. Empirical evidence also displays that the impact of economic size and distance is stabile across time periods. The gravity model can be written and extended in numerous ways depending on the research in question (Chaney, 2011).

When creating our modified version of the gravity model, presented later in this chapter, we have taken influence from the model used by Klein and Shambaugh (2004). As mentioned previously Klein and Shambaugh used the model to estimate the impact of fixed exchange rate regimes on trade. The gravity model used in their research had the following structure:

$$\ln(T_{i,j,t}) = \alpha_1 X_{i,j,t} + \alpha_2 Z_{i,j} + \beta_1 F_{1,i,j,t} + \beta_2 F_{2,i,j,t} + \beta_3 CU_{i,j,t} + \beta_4 v_{i,j,t} + \beta_5 v_{i,j,t}^2 + \varepsilon_{i,j,t}$$

Variable	Explanation
$\ln(T_{i,j,t})$	The natural logarithm of trade between country i and j at time t.
$X_{i,j,t}$	A set of variables that vary over time (e.g. GDP).
$Z_{i,j}$	A set of variables that do not vary over time (e.g. distance).
$F_{1,i,j,t}$	Dummy variable equal to 1 if there was a fixed exchange rate, but no currency union, between country i and country j at time t.
$F_{2,i,j,t}$	Dummy variable equal to 1 if there was an indirect peg between country i and country j at time t.
$CU_{i,j,t}$	Dummy variable equal to 1 if there was a currency union amongst country i and country j at time t.
$V_{i,j,t}$	A measure of volatility of the exchange rate between country i and country j at time t.
$\varepsilon_{i,j,t}$	Error term at time t.

3.2 Pooled OLS, Fixed effects model and Random effects model

We will make use of three different types of models to perform our regression analysis; pooled OLS, fixed effects model and random effects model.

3.2.1 Pooled OLS

A pooled OLS-model is based on the principle of simply pooling together data from different individuals (in our case country-pairs) with no respect for individual inequality. In general, for an equation with two explanatory variables x_1 and x_2, a pooled OLS-model can be written as: (Carter Hill, Griffiths and Lim, 2012)

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + e_{it}$$

where *i* corresponds to the *i*th individual and *t* to the *t*th time period.

The first thing to keep in mind is that the coefficient betas do not have any subscripts that denote individual characteristics or changes over time. The coefficient betas (including the intercept) in the pooled OLS are constant for all individuals over all time periods, hence it cannot allow for heterogeneity across individuals. For the

OLS estimators to be unbiased and consistent this exogeneity assumption must be fulfilled.

When adding the assumptions for the residual, there are little difference between the pooled model and the multiple regression model:

1. E(e_{it}) = 0 (the residuals have zero mean)
2. var(e_{it}) = E (e_{it}^2) = σ_e^2 (constant variance, i.e. homoskedasticity)
3. cov(e_{it}, e_{js}) = 0 for i≠j or t≠s (all error terms are uncorrelated over time for the same individual)
4. cov(e_{it}, x_{1it}) = 0 & cov(e_{it}, x_{2it}) = 0 (error terms are uncorrelated with the explanatory variables)

If we also suppose that the explanatory variables x_1 and x_2 are nonrandom, and all other criteria are satisfied, the pooled OLS-model will be the minimum variance linear unbiased estimator for our sample. (Carter Hill, Griffiths and Lim, 2012)

3.2.2 The Fixed Effects Model

The main benefit with a fixed effects model is that it allows for individual characteristics, or individual heterogeneity, and therefore relaxes the assumption that all coefficients have to be the same for all individuals. If we still consider two explanatory variables this can be written as: (Carter Hill, Griffiths and Lim, 2012)

$$y_{it} = \beta_{0i} + \beta_{1i}x_{1it} + \beta_{2i}x_{2it} + e_{it}$$

The difference from the pooled OLS-model is the *i* subscripts related to the betas, implying that the beta coefficients can differentiate from individual to individual.

However this panel data model is not suitable for short and wide panels and since our data set is short and wide (N=351 > T=40), we have to make use of a simplified version of this model: (Carter Hill, Griffiths and Lim 2012)

$$y_{it} = \beta_{0i} + \beta_1 x_{1it} + \beta_2 x_{2it} + e_{it}$$

The *i* subscripts for the parameter betas (β_1 and β_2) are gone which implies that these parameters are treated as constants for all individuals. The differences in behavioral characteristics between individuals, or heterogeneity, are now assumed to be captured by the intercept (β_{0i}). This is the key feature of a fixed effects model that the individual intercepts (often called fixed effects) are included to control for characteristics that are distinctive for one individual and that does not change over time.

The estimation technique we will make use of is called the fixed effects estimator and since our number of individuals (country-pairs) is relatively large this will be the most appropriate technique to use. We will illustrate this estimation technique below with the simplified fixed effects model as our starting point: (Carter Hill, Griffiths and Lim, 2012)

$$y_{it} = \beta_{0i} + \beta_1 x_{1it} + \beta_2 x_{2it} + e_{it}, \quad t = 1,...,T \quad (1)$$

Sum both sides of the equation and divide by T:

$$\frac{1}{T}\sum_{t=1}^{T}(y_{it} = \beta_{0i} + \beta_1 x_{1it} + \beta_2 x_{2it} + e_{it}) \quad (2)$$

Since we know that the parameter betas do not change over time, we can simplify this as:

$$\bar{y}_i = \frac{1}{T}\sum_{t=1}^{T} y_{it} = \beta_{0i} + \beta_1 \frac{1}{T}\sum_{t=1}^{T} x_{1it} + \beta_2 \frac{1}{T}\sum_{t=1}^{T} x_{2it} + e_{it}$$

$$\bar{y}_i = \beta_{0i} + \beta_1 \bar{x}_{1i} + \beta_2 \bar{x}_{2i} + \bar{e}_i \quad (3)$$

We have now averaged the values of y_{it} over time and by subtracting (3) from (1) we get:

$$y_{it} - \bar{y}_i = \beta_1(x_{1it} - \bar{x}_{1i}) + \beta_2(x_{2it} - \bar{x}_{2i}) + (e_{it} - \bar{e}_i) \quad (4)$$

Since $\tilde{y}_{it} = y_{it} - \bar{y}_i$ (and the same goes for x and e) this can be rewritten as:

$$\tilde{y}_{it} = \beta_1\tilde{x}_{1it} + \beta_2\tilde{x}_{2it} + \tilde{e}_{it} \quad (5)$$

We end up with (5) and the fixed effects model is here written in terms of deviations from individual means. Hence when calculating coefficients with the fixed effects estimator, the coefficients are only decided by the variation in the dependent and explanatory variables within that single individual over time. This also suggests that to obtain coefficient results using the fixed effects models, there will have to be some variation in the variables for an individual over time. For that reason the fixed effects model cannot estimate beta coefficients on time-invariant variables, i.e. variables that are persistent over time.

Noticeable is that the intercept term (β_{0i}) has disappeared in equation (5) above. These intercepts can be rediscovered by acknowledging that the least squares fitted regression tracks the point of the means:

$$\bar{y}_i = \beta_{0i} + \beta_1\bar{x}_{1i} + \beta_2\bar{x}_{2i}$$

Where $\hat{\beta}_1$ and $\hat{\beta}_2$ are estimates from equation (5) and therefore we can calculate the individual intercepts, or fixed effects by:

$$\beta_{0i} = \bar{y}_i - \beta_1\bar{x}_{1i} - \beta_2\bar{x}_{2i},$$

3.2.3 The Random Effects Model

The random effects model and the simplified fixed effects model both assume that the individual heterogeneity is captured by the variation in the intercept. What distinguish the random effects model is that the individual differences are viewed as random rather than fixed, as in the fixed effects model. The random effects model presumes that the individuals are randomly sampled and therefore the intercept parameter (β_{0i}) is divided into two parts: (Carter Hill, Griffiths and Lim, 2012)

$$\beta_{0i} = \bar{\beta}_0 + u_i \quad (6)$$

Where $\bar{\beta}_0$ is the fixed part and is referred to as the population average whereas u_i is looked upon as the random individual heterogeneity from the population average, often called the random effects. If we incorporate (6) into (1) we will have:

$$y_{it} = (\bar{\beta}_0 + u_i) + \beta_1 x_{1it} + \beta_2 x_{2it} + e_{it} \quad (7)$$

Rearranging terms will make us end up with:

$$y_{it} = \bar{\beta}_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + (e_{it} + u_i)$$

$$y_{it} = \bar{\beta}_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + v_{it} \quad (8)$$

The $\bar{\beta}_0$ is now the intercept parameter and the error term v_{it} carries both the usual error term that we looked at earlier (e_{it}) and the random individual effect (u_i). The combined error term in a random effects model can be given by:

$$v_{it} = u_i + e_{it}$$

The major difference regarding the residual assumptions in the random effects model and the pooled OLS-model is that the errors terms for the same individual are assumed to be correlated over time: (Carter Hill, Griffiths and Lim, 2012)

1. $E(v_{it}) = 0$ (the residuals have zero mean)
2. $var(v_{it}) = \sigma_e^2 + \sigma_u^2$ (constant variance, i.e. homoskedasticity)
3. $cov(v_{it}, v_{is}) = \sigma_u^2$ for $t \neq s$ (error terms for individual i are correlated)
4. $cov(v_{it}, v_{js}) = 0$ for $i \neq j$ (error terms for different individuals are uncorrelated)
5. $cov\ (e_{it}, x_{1it}) = 0$ & $cov\ (e_{it}, x_{2it}) = 0$ (error term e_{it} are uncorrelated with the explanatory variables)
6. $cov\ (u_{it}, x_{1it}) = 0$ & $cov\ (u_{it}, x_{2it}) = 0$ (random effects are uncorrelated with the explanatory variables)

3.2.4 The Breusch-Pagan Lagrange Multiplier (LM)

When coefficient results have been obtained from the Pooled OLS-model, the fixed effects model and the random effects model we will perform a Breusch-Pagan (LM) test to determine whether the Pooled OLS-model is an appropriate estimation technique that fits the purpose of this thesis report.

The Breusch-Pagan test will help to examine if there is individual heterogeneity to account for across our data sample. The random individual effect (u_i) and the assumptions for the residuals in the random effects model, both discussed above, are the key components for this test alongside with the correlation equation given by: (Carter Hill, Griffiths and Lim, 2012)

$$\rho = \text{corr}\,(v_{it}, v_{is}) = \frac{\text{cov}\,(v_{it}, v_{is})}{\sqrt{\text{var}(v_{it})\text{var}(v_{is})}} = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2} \qquad t \neq s$$

Suppose if $\sigma_u^2 = 0$ this will lead to $\rho = 0$ and we can therefore conclude that differences amongst the individuals in our data set occur. The Breusch-Pagan test is consequently a simple hypothesis test stated by:

$$H_0: \sigma_u^2 = 0$$

$$H_1: \sigma_u^2 \neq 0$$

If the null hypothesis can be rejected when performing the Breusch-Pagan test we can be assured that random individual effects are present in the data sample and the pooled OLS-model will be biased and inconsistent estimating the coefficient results. If this is the case, then the pooled OLS-model is disqualified as an estimation technique and we have to put our faith to either the fixed effects model or the random effects model.

3.2.5 Hausman test

To decide whether to apply the fixed effects model or the random effects model, in case the null hypothesis is rejected in the Breusch-Pagan test, a Hausman test is appropriate for making this decision.

The basic theory behind the Hausman test is that if there is no correlation between the random individual effect (u_i) and any of the explanatory variables, then both the fixed effects model and the random effects will be consistent and generate estimators that in large samples will merge into the true beta parameters. However, if there is correlation between (u_i) and any of the explanatory variables, the random effects model will be inconsistent and in large samples not converge into the true beta parameters, whilst the fixed effects model still would generate consistent parameters. In the presence of the correlation mentioned previously, we can expect differences in the estimates obtained from the two models. (Carter Hill, Griffiths and Lim, 2012)

The hypothesis testing connected to the Hausman test is as follows:

$$H_o: Corr(u_i, x_{kit}) = 0$$

$$H_1: Corr(u_i, x_{kit}) \neq 0$$

Hence if the null hypothesis is rejected when performing the Hausman test, the random effect models estimation parameters will be misleading and the fixed effects model should be put to practice.

A vital shortcoming of the Hausman test is that it cannot be exercised in combination with cluster-robust standard errors. The method of cluster-robust standard errors liberates the assumptions regarding the standard errors and this causes violations in the assumptions for the Hausman test.

3.3 Our Regression Model

As mentioned previously our regression model is influenced by the regression model used by Klein and Shambaugh (2004). The two models differentiate regarding the classification scheme of exchange rate regimes that are not classified as a currency union, direct peg or indirect peg. We will not include exchange rate volatility as one of the explanatory variables. This is because of the problem, discussed in section 2.1, to find a causal relationship between exchange rate volatility and bilateral trade - even when you do so the economic significance can be either positive or negative. Also, we are not studying the effects of exchange rate volatility on bilateral trade in the EU but the exchange rate regimes as such, hence the exclusion of this term from our model.

$$\begin{aligned} \ln(T_{i,j,t}) = {} & \beta_1 \ln(GDP_{it} * GDP_{jt}) + \beta_2 \ln(Distance_{ij}) + \beta_3 Border_{i,j} + \beta_4 CU_{i,j,t} \\ & + \beta_5 Direct\ peg_{i,j,t} + \beta_6 Indirect\ peg_{i,j,t} + \beta_7 Floating_{i,j,t} \\ & + \beta_8 Other_{i,j,t} + \beta_9 quarter_t + \varepsilon_{i,j,t} \end{aligned}$$

where: $i = 1,2, \dots, N$
$j = 1,2, \dots, N$
$i \neq j$
$t = 1, 2, \dots, T$

Variable	*Explanation*
$\ln(T_{i,j,t})$	Dependent variable. The natural logarithm of trade between country i and country j at time t. Time-variant variable.
$\ln(GDP_{it} * GDP_{jt})$	The natural logarithm of the product of GDP in country i and country j at time t. Time-variant variable.
$\ln(Distance_{ij})$	The natural logarithm of distance between country i and country j in kilometres. Time-invariant variable.
$Border_{i,j}$	Dummy variable equal to 1 if the counties share a land border. Time-invariant variable.
$CU_{i,j,t}$	Dummy variable equal to 1 if country i and country j are members of the EMU at time t. Time-variant variable.
$Direct\ peg_{i,j,t}$	Dummy variable equal to 1 if country i or country j is a member of the EMU and the other country has a fixed exchange rate to the euro at time t. Time-variant variable.
$Indirect\ peg_{i,j,t}$	Dummy variable equal to 1 if country i and country j have a fixed exchange rate to the euro at time t. Time-variant variable
$Floating_{i,j,t}$	Dummy variable equal to 1 if there is a floating exchange rate between country i and country j at time t. Time-variant variable.
$Other_{i,j,t}$	Dummy variable equal to 1 if country i or country j has a fixed exchange rate to a currency basket and the other country does not have a floating exchange rate at time t. Or if country i or country j has a fixed exchange rate to the Euro with a volatility exceeding 2% in a given year and the other country does not have a floating exchange rate at time t. Time-variant variable.
$quarter_t$	Dummy variable equal to 1 for all observations in a given quarter.
$\varepsilon_{i,j,t}$	Error term. Time-variant variable.

What is important to keep in mind is that only one of the dummy variables that represents the current exchange rate regime between countries (Direct peg, Indirect peg, Floating and Other) or if the countries are members of EMU (CU) can be equal to one at the time. The values of these dummy variables explaining the exchange rate regime are based on the information given in Table A2 in the appendix. The table include information concerning which type of exchange rate regime that has been used in the 27 countries during the years 2003-2012. In seven cases (Cyprus, Estonia, Hungary, Latvia, Malta, Slovenia and Slovakia) the exchange rate regime have changed at least once during this period with the result that the dummy variables change value in the country pairs that involve at least one of these countries.

We make a distinction between countries with a fixed exchange rate to the euro and countries with a peg to a currency basket by separating them with dummy variables. This becomes actualized because of the fact that a few countries in our data set during some period have had a fixed exchange rate to different sorts of currency baskets. Since our aim is to compare the trade flows of EMU members and countries with a direct fixed exchange rate to the euro we want to exclude these observations from impacting the Direct peg dummy and therefore we have created a dummy variable, Other, whose purpose is to collect these observations.

We also make a distinction between countries with a direct and indirect fixed exchange rate. We illustrate the difference with an example; Denmark and Bulgaria have had a fixed exchange rate to the euro during the entire sample period, 2003-2012, resulting in that the Direct peg dummy is equal to 1 in the country pairs involving Denmark or Bulgaria and any member of the EMU. As a consequence of the two countries' exchange rate regime there is an indirect fixed exchange rate between the two countries in question and we devote a dummy variable, Indirect peg, for observations of this kind.

To account for time trends and seasonality we have included forty dummy variables, one for each quarter of observation. These are included only for controlling purposes.

Table A3 in the appendix shows the maximum and minimum exchange rates for the currencies that during at least some part of the period 2003-2012 have been pegged to the euro. The volatility term clearly indicates that there have been differences in the way the fixed exchange rate regimes have been constructed and implemented. All countries besides Bulgaria and Hungary have been, or are, members of the ERM II and the volatility terms indicates that they have used the fluctuation possibility in the ERM II agreements in different fashion. We have made a classification scheme for those countries with a peg to the euro, proceeded from the classification used by Klein and Shambaugh (2004). Therefore a particular country with a peg to the euro is judged to have a direct peg if the exchange rate volatility, between the domestic currency and the euro, stays within a +/- 2 per cent band in a given year. We do not need to make any further distinctions here since the only two countries that have experienced exchange rate fluctuations exceeding these yearly limitations are Hungary (in five consecutive years between 2003 and 2007) and Slovakia (between year 2006 and 2008). The observations not eligible as direct pegs will be placed in the Other dummy. Given that the purpose of our analysis is to highlight the difference in trade flows among members of the EMU and countries with a direct peg to the euro, we will not suffer from adding these observations in the Other dummy – as the results provided from the variable Other is not of interest to us.

3.4 Data

The data used in our research concern the 27 member countries of the European Union and refers to our chosen period of observation, 2003-2012. Our data set includes 14 040 observations and is categorized as unbalanced panel data because of some missing values. We have not made the data balanced by estimating the missing values because of the nature of these, for example GDP statistics for Greece are missing during 2011 and 2012. Since the Greek state could not manage to calculate the GDP during these years it is unlikely that our estimations would be close to reality.

GDP statistics: The GDP statistics are collected from the European Commissions database, Eurostat. The data published at Eurostat is given in quarterly and early observations. To get as many observations as possible we use quarterly data in our research. There are seven missing values in this data set for Greece from the second quarter of 2011 until the end of 2012 with the result that our data include 1 075 GDP observations. The GDP is measured in current millions of euros.

Trade statistics: The trade statistics are also gathered from Eurostat. The trade data is published in monthly figures. We have recalculated these into quarterly ones to fit the time period of the GDP statistics. The trade figures show the amount of quarterly trade, measured in current millions of euros, between the 27 countries during the ten years. The first five quarters include missing values for the country pairs involving Poland and Slovakia, with the result that our data set includes 13 542 trade observations.

Distance: The distance between countries is measured as the distance between the countries' capitals. The data is gathered from worldatlas.com.

The rest of the data used in our research relates to information integrated in the dummy variables and have been explained in-depth in section 3.3. Table 1 below shows the proportion of observations included in the different exchange rate regime dummy variables.

Table 1. Descriptive statistics, Exchange rate regime dummy variables

Variable	Number of total observations	Number of observations equal to 1	Number of observations equal to 0	Number of observations equal to 1 / Number of total observations
$CU_{i,j,t}$	14040	3836	10204	27.32 %
Direct $peg_{i,j,t}$	14040	3096	10944	22.05 %
Indirect $peg_{i,j,t}$	14040	552	13488	3.92 %
$Floating_{i,j,t}$	14040	5580	8460	39.75 %
$Other_{i,j,t}$	14040	976	13064	6.95 %
	-	-	-	100 %

We feel the need to comment on our country selection. Table A1 in the appendix present the 27 countries year of entry in the EU as well as in the EMU, in the cases it concerns. Eleven countries have joined the union after 2003, a majority in the great enlargement in 2004, but are still included in our selection. The reason behind this is that they all were enrolled in the procedures of joining the union and in the same time have been full members in the majority of our research period.

Chapter 4 - Results and analysis

4.1 How to interpret the coefficient results in Table 2

The coefficient estimators obtained from the Pooled OLS-model, the fixed effects model and the random effects model are presented in Table 2 below. When interpreting the coefficient estimates it is important to keep in mind that we assume that all other variables are held constant, so called ceteris paribus.

The dependent variable ln trade_{ijt} is the natural logarithm of trade between country i and country j at time period t. The first two explanatory variables are ln $(\text{GDP}_{it} * \text{GDP}_{jt})$ and ln distance_{ij}, both given as natural logarithms and therefore the coefficient estimates from these two variables should be interpreted as a log-log regression. If we consider the coefficient result for ln $(\text{GDP}_{it} * \text{GDP}_{jt})$ this is given by:

$$\%\Delta\text{trade}_{ijt} = \beta_{(\text{GDP}_{it}*\text{GDP}_{jt})} * \%\Delta(\text{GDP}_{it} * \text{GDP}_{jt})$$

Table 2. Estimation Results

Dependent variable: ln trade_{ijt} Number of observations: 13542

Variables	Pooled OLS	Fixed Effects Model	Random Effects Model
Constant	-4.322 (-34.08)***	-43.779 (-1.15)	-5.083 (-9.92)***
ln $(\text{GDP}_{it} * \text{GDP}_{jt})$	0.875 (255.39)***	1.084 (49.99)***	0.931 (77.69)***
ln Distance_{ijt}	-1.229 (-99.16)***	(omitted)	-1.265 (-20.57)***
Border_{ijt}	0.389 (14.94)***	(omitted)	0.290 (2.19)**
Direct peg_{ijt}	-0.108 (-5.97)***	-0.089 (-5.92)***	-0.078 (-5.20)***
Indirect peg_{ijt}	0.486 (10.06)***	-0.087 (-3.25)***	-0.071 (-2.66)***
Floating_{ijt}	-0.026 (-1.87)*	-0.169 (-8.51)***	-0.182 (-9.51)***
Other_{ijt}	0.067 (2.33)**	-0.132 (-7.16)***	-0.134 (-7.36)***
R-squared	0.917	0.418	0.416
F-test		155.29***	
LM-test			0.000015***
Hausman test		88.94***	

Notes: The estimation results for Direct peg, Indirect peg, Floating and Other are estimated with the variable Currency union as base group.
The regressions are made with time variables but these are excluded in this table for presentation purposes. Table A4 in the appendix include time variables.
***/**/* significant at 1 %/5 %/10 % level. t-statistics are in parentheses.

Let us suppose that the product of GDP between countries i and j increase with 1 % at time t, everything else held constant. The beta coefficient related to $\mathrm{GDP_{it}} * \mathrm{GDP_{jt}}$ is 0.875, using the Pooled OLS-model, we thereby get:

$$\%\Delta \mathrm{trade_{ijt}} = 0.875 * 1\ \% = 0.875\ \%$$

Accordingly, if $(\mathrm{GDP_{it}} * \mathrm{GDP_{jt}})$ increase with 1 % we would expect a 0.875 % increase in trade between the two countries i and j, ceteris paribus, given the Pooled OLS estimators. The same interpretation should be used for all estimates regarding ln $(\mathrm{GDP_{it}} * \mathrm{GDP_{jt}})$ and ln $\mathrm{distance_{ij}}$.

The next explanatory variable, $\mathrm{border_{ij}}$, is a dummy variable given the value 1 if the countries i and j share a border and 0 if they do not. The estimated beta coefficients of $\mathrm{border_{ij}}$ should be interpreted as the effect on bilateral trade if countries i and j share a border. Since the dependent variable is expressed as a natural logarithm, the exact percentage change in $\mathrm{trade_{ijt}}$ given a movement in the dummy variable from 0 to 1 is:

$$\%\Delta \mathrm{trade_{ijt}} = 100 * (\mathrm{e}^{\beta_{\mathrm{border_{ij}}}} - 1)$$

Reading of the Table 2 above, the $\mathrm{border_{ij}}$ beta coefficient obtained from the Pooled OLS-model is 0.389, inserting this figure in the equation above gives us:

$$\%\Delta \mathrm{trade_{ijt}} = 100 * (\mathrm{e}^{0.389} - 1) \approx 47.55\ \%$$

The bilateral trade for two countries within the European Union in general is 47.55 % higher if the country pair shares a border compared to if they do not, during the period 2003 to 2012 given the Pooled OLS estimates. All three coefficient results from the variable $\mathrm{border_{ij}}$ should be understood in the same way as described above.

What is significant to remember regarding the dummy variables Direct peg, Indirect peg, Floating and Other is that their coefficient estimates stand in comparison to the base group, CU. The coefficient results for Direct peg should consequently thereby be taken as the effects on bilateral trade between countries i and j at time period t, for applying a direct fixed exchange rate regime instead of both being members of the EMU. The exact percentage change is given by:

$$\%\Delta \text{trade}_{ijt} = 100 * (e^{\beta_{\text{Direct peg}_{ijt}}} - 1)$$

If we consider the coefficient results regarding the Direct peg, once again obtained from the Pooled OLS, from Table 2 and insert this to the equation above:

$$\%\Delta \text{trade}_{ijt} = 100 * (e^{-0.108} - 1) \approx -10.24\ \%$$

The interpretation of this result is that a country pair involving one country that is a member of the EMU and the other pegs to the euro will trade 10.24 % less than if both countries were members of the EMU, according to the Pooled OLS-model.

The same inference should be applied for all the dummy variables Direct peg, Indirect peg, Floating and Other regardless of what model the coefficient estimates are obtained from.

4.2 Similarities and differences across the models

Studying the coefficient results we can conclude that there are both similarities and differences across the three regression models. Acknowledging that the intercept (or constant) is much larger in absolute values in the fixed effects model, although it is statistically insignificant, is a good beginning. As stated in the theory section, in the fixed effects model potential individual heterogeneity is captured by the intercept which this is the proof of. It is hard to argue that the intercepts are economic significant since it is difficult to imagine negative bilateral trade but the intercepts are nonetheless crucial for the models themselves.

Regarding the variables ln $(\text{GDP}_{it} * \text{GDP}_{jt})$, ln distance_{ij} and border_{ij} there are little differences in the coefficient estimators across the models. A part from the estimated coefficients border_{ij}, obtained from the random effects model, all estimates are statistically significant at the 1 % level. All three models suggest that an increase in the product of two countries' GDP will boost their bilateral trade with only minor differences in the magnitude of this increase.

Noticeable is that the fixed effects model cannot provide estimates for the time-invariant variables ln distance_{ij} and border_{ij} due to the lack of variation within these variables. Although the Pooled OLS-model and the random effects model give fairly consistent estimations of these two variables. If the distance between country i and country j increase by 1 % the Pooled OLS predicts a decrease in bilateral trade by 1.229 %, whilst the random effects model suggests a decrease by 1.265 %.

The effects of two countries sharing a border on bilateral trade are as follows:

$$\text{Pooled OLS}: \ \%\Delta \text{trade}_{\text{ijt}} = 100 * (e^{0.389} - 1) \approx 47.55\ \%$$

$$\text{Random effects model}: \%\Delta \text{trade}_{\text{ijt}} = 100 * (e^{0.290} - 1) \approx 33.64\ \%$$

The bilateral trade for two countries within the European Union is in general 47.55 % higher if the country pair shares a border compared to if they do not, during the period 2003 to 2012 given the Pooled OLS estimates. The corresponding figure using the random effects model is 33.64 %.

The major distinctions in the results are found when we evaluate the coefficient estimations for the dummy variables Direct peg, Indirect peg, Floating and Other. The fixed effects model and the random effects model give consistent rankings and the magnitude of the coefficient results do not differ sufficiently. However, the results from the Pooled OLS-model provide us with a completely different set of rankings. According to the results from the Pooled OLS if a country pair's exchange rate regime is characterized as Indirect peg or Other, the two countries would be better off than if both countries were a part of the EMU – in terms of bilateral trade. An indirect peg would increase trade between country i and country j by 62.58 % compared to if both countries i and j were members of the EMU, according to the Pooled OLS estimation. Whilst the fixed effects model suggests a decrease in bilateral trade by 8.33 % and the random effects model a decrease by 6.85 %.

Another difference is that the R-square is much higher with the Pooled OLS-model compared to the two others. The difference occurs due to the fact that in the fixed effects model and the random effects model the intercept captures the individual heterogeneity or random effects. Due to shortcomings in the estimation technique, the explanatory powers in the intercept are lost in the fixed effects model and the random effects model. Therefore, in reality, there are no differences in explanatory power across the three models.

4.3 Breusch-Pagan test

To conclude whether the coefficient results obtained from the Pooled OLS-model, the fixed effects model or the random effects model reflects the true parameter betas to the greatest extent – we have performed a Breusch-Pagan test (LM-test). This test will help us to assess if the results from the Pooled OLS-model are reliable and consistent given the nature of our dataset. If not, we have to apply the fixed effects model or the random effects model to justify the results from our regression model.

The LM test basically examines if there are random individual effects across entities. The null hypothesis can thereby be simplified and interpreted as that there are no individual heterogeneity present across country pairs.

The outcome of the Breusch-Pagan test is both unambiguous and persuasive, displayed in Table A5 in the appendix, as it rejects the null hypothesis at any of the conventional significance levels. Hence we can rule out the theory that there are no individual differences amongst the country pairs in our sample, or in other words that the bilateral trade is determined by identical factors within all country pairs.

The presence of individual differences between the country pairs in our sample is, in hindsight, rational since we are dealing with such a complex greatness as bilateral trade between countries. The driving forces of trade between one country pair are not equal to the driving forces of trade for another country pair. The differences can be attributed to country-specific conditions that arise due to inequality in for example social, economical, political, geographical and historical matters.

The Pooled OLS-model cannot allow for heterogeneity for its estimators to be unbiased and consistent. Through the Breusch-Pagan test we have proved that individual heterogeneity is present in our data set and therefore we can disqualify the Pooled OLS-model as the best suitable estimation technique for our regression analysis. Hence, to obtain trustworthy and unbiased coefficient estimators, we have to make use of either the fixed effects model or the random effects model.

4.4 Hausman test

To decide between the fixed effects model and the random effects model we have executed a Hausman test. The core of this test, further discussed in the theory section, is to examine if the unique random effects (u_i) are correlated with the independent variables in our regression. The null hypothesis is that the random effects are not correlated with the regressors and that the random effects model is therefore preferred. Whilst the alternative hypothesis is that u_i is correlated with the regressors and the fixed effects model is the superior estimation technique.

The result of the Hausman test is displayed in Table A6 in the appendix and it is convincing since the null hypothesis is rejected at the 1 % significance level. The outcome of the Hausman test states that the unique effects are correlated with the independent variables within our model, thus the random effects model is biased and its beta estimators will not merge into the true beta parameters in large samples. Nevertheless the coefficient estimators obtained with the fixed effects are still unbiased and consistent.

The presence of correlation between the random effects and the regressors in our model is as well anticipated. Everything with an explanatory power of bilateral trade between two countries, not included in our model, ends up in the residual. If the omitted variable is correlated with the regressors, then the unique random effect (u_i) of that omitted variable will also be correlated with the explanatory variables in our model. For example, a common language might influence bilateral trade within a country-pair. If so, it can be argued that having a common language is correlated with the distance between the two countries and whether they share a border or not, two variables included in our regression model.

4.5 Shortcomings with the standard errors

We have also tested for heteroscedasticity and autocorrelation, visualized in Table A7 and A8 in the appendix. The outcome of the tests states that both heteroscedasticity and autocorrelation are present within our data set. This will de facto lead to underestimated standard errors and consequently the t-statistics will be upward biased. To correct for this it is appropriate to perform a Huber-White's test, but since this requires clustering of the panel data it cannot be used in combination with a Hausman test. Because of this conflict we are not able to use cluster-robust standard errors.

Another thing to be aware of is that the data set we make use of has the same characteristics as those of a dyadic regression. This means that our observations are not fully independent from one another since the residual for country pair x is correlated to the residual of another country pair that includes one of the countries from country pair x. For example:

$$\text{Corr}\ (\varepsilon_{AUS,BEL,t}, \varepsilon_{BEL,BUL,t}) \neq 0$$

The presence of correlated error terms across our sample complicates the calculations of the standard errors in our model. (Fafchamps and Söderbom, 2013) In general the standard errors will once again be underestimated and influence the t-statistics.

We are therefore aware of the shortcomings with the standard errors in the model but, as mentioned above, we cannot correct for this since we had to perform the Hausman test to conclude which of the three models that were most suitable for our data set.

4.6 Core results from the fixed effects model

Ruling out both the Pooled OLS-model and the random effects model, we will hereon focus on the coefficient estimates given by the fixed effects model. First and foremost when drawing conclusions about the relationship between one of the explanatory variables and bilateral trade, we still have to hold everything else constant. Secondly, all coefficient results discussed in this section are statistically significant and therefore only the economic significance needs to be questioned from now on.

The outcome of the fixed effects model suggests that an increase in the product of two countries GDP at time period t, will cause an upswing in bilateral trade amongst the two countries of consideration roughly equivalent to the percentage increase in the product of GDP. If the product of Sweden's and Germany's GDP increases by 1 % at any given time during the sample period, we expect the trade between Sweden and Germany to enhance with approximately 1.084 %.

As mentioned previously the fixed effects model could not provide coefficient results for the time-invariant variables ln distance_{ij} and border_{ij}. Since these coefficient results will not contribute to fulfill the purpose of our thesis analysis, we are not distressed by this fact. Nonetheless both the Pooled OLS and the random effects model give us insight into to effects of bilateral trade given the distance between the two countries and whether they share a border or not. Both models unambiguously state that an increase in distance within a country pair will result in a decrease in trade between the concerned countries. As well as countries that share a border tend to trade more with one another than countries that do not share a border.

The variables of greatest interest are of course the dummy variables describing the characteristics of the exchange rate regimes between country i and country j at time period t. From Table 2 above we can transform the coefficient results to the exact percentage change, notice that the percentage change for each variable stand in comparison to if both countries i and j were members of the EMU at time period t:

$$\text{Direct peg | CU: } \%\Delta\text{trade}_{ijt} = 100 * (e^{-0.089} - 1) \approx -8.52\ \%$$

$$\text{Indirect peg | CU: } \%\Delta\text{trade}_{ijt} = 100 * (e^{-0.087} - 1) \approx -8.33\ \%$$

$$\text{Floating | CU: } \%\Delta\text{trade}_{ijt} = 100 * (e^{-0.169} - 1) \approx -15.55\ \%$$

$$\text{Other | CU: } \%\Delta\text{trade}_{ijt} = 100 * (e^{-0.132} - 1) \approx -12.37\ \%$$

We can conclude that the variable CU is superior, in terms of bilateral trade, to the four other exchange rate regimes. For convenience of analysis we can converse the relationship and express the percentage changes in how much better of countries i and j are being members of the EMU compared to exercising any other exchange rate regime, in terms of trade:

$$\text{CU | Direct peg: } \%\Delta\text{trade}_{ijt} \approx 9.32\ \%$$

$$\text{CU | Indirect peg: } \%\Delta\text{trade}_{ijt} \approx 9.10\ \%$$

$$\text{CU | Floating: } \%\Delta\text{trade}_{ijt} \approx 18.41\ \%$$

$$\text{CU | Other: } \%\Delta\text{trade}_{ijt} \approx 14.11\ \%$$

The estimated results for the variables Direct peg and Indirect peg are more or less equal. This indicates that the trade effects involving a country pair where country i is a member of the EMU and country j pegs to the euro are similar to those involving a country pair where both countries peg to euro. This is probably due to the fact that country pairs categorized as direct pegs or indirect pegs have experienced very low levels of exchange rate fluctuations between the domestic currency and the euro, as indicated in Table A3 in the appendix.

As our results are presented with the variable CU as base group; we can not speak in terms of impact on trade of having or not having a certain exchange rate regime hence the figures stand in comparison with the base group. The reason to this presentation technique is that we are interested in the difference between the variable CU and Direct peg. As a consequence of this we cannot make a direct comparison with previous research. However, we can conclude that the huge treatment effect of a currency union on trade found by Rose (2000) does not reflect our findings. Remember the critique that Rose received concerning the composition of countries using a common currency globally, them being small and poor. You would describe our sample of countries using a common currency in more or less opposite terms. With regards to these circumstances and the research that followed Rose's these results did not come as a big surprise.

Despite it is beyond our research question the finding that a direct fixed exchange rate regime significantly outperforms a floating regime is interesting, not the least from a policy perspective. As discussed previously there is no coherency in the research on this topic. What is a fact though is that when using a similar technique, measuring the impact using dummy variables instead of exchange rate volatility terms, as Adam and Cobham (2007) we observe the same relationship, but not as strong. Adam and Cobham (2007) found a positive impact on trade of 56.8 % for country pairs classified in the same structure as our variable Direct peg and a negative impact of 17.5 % if both countries used a floating exchange rate regime. Adam and Cobham (2007) utilized a pooled OLS model when conducting their research and, as we have stated, the results obtained from this model should be interpreted with caution when working with data set with this content. It seems likely to assume that their data set has the same structure when it comes to the issue of heterogeneity, but this is a question that they do not raise in their report. However, we can state that our results, taking fixed effects into account, indicates that a direct fixed exchange rate regime is better then a floating ditto in terms of trade.

The result measuring the difference between CU and Direct peg is our core finding, indicating that two countries that are members of the EMU trade 9.32 % more than if one country is member of the EMU and the other have a direct peg to the euro. If we once again compare our findings with the results from Adam and Cobham (2007) we observe the same overall relationship but our results differentiate in magnitude. Even if our figures are not directly comparable, Adam and Cobham (2007) observe a greater difference between the two regimes; 139.8 % for CU and 56.8 % for Direct peg. This study have a significantly longer period of observation and you can once again raise the question about selection influence; that the composition of countries using a common currency historically and globally are not among the richest you find around the globe. The critique Rose (2000) received from Nitsch (2002) and Persson (2001) can reasonably be applied to this study as well.

To summarize, our findings obtained from the exchange rate dummy variables indicate that the stronger the monetary commitment is between countries the greater the positive impact will be on trade amidst the countries in question.

Chapter 5 - Conclusion

The purpose of this thesis report has been to estimate the difference in impact on intra-EU bilateral trade between an EMU membership and a direct fixed exchange rate regime. This have been done using a modified gravity model of trade and three different estimation techniques, the Pooled OLS-model, the fixed effects model and the random effects model. The trade effects of the different exchange rate regimes are captured using dummy variables. We can conclude, from the estimated results given by the fixed effects model, that countries trade 9.32 % more if they both use the euro as national currency than if one country is a member of the EMU and the other have a direct peg to the euro, i.e. that their national currencies are fixed. As a consequence of this we cannot reject our null hypothesis stating that an EMU membership has exceeded a direct fixed exchange rate regime to the euro in terms of gains in intra-EU bilateral trade.

In the theory section we argued that a currency union facilitates monetary efficiency. Our estimated results put figures on the value of this monetary efficiency, incorporating matters such as the removal of transaction cost and exchange rate uncertainty etc. However, this efficiency only applies in terms of intra EU-trade. What would be interesting for further studies to examine is what the relationship would look like if the data set was expanded to include trade with nations globally and this monetary efficiency no longer applies. Would a membership in the EMU still be superior to other exchange rate regimes?

Even if the Eurozone undoubtedly have a positive impact on intra EU-trade this does not by any means imply that joining the EMU is a rational decision on all levels and for all countries. The motive for a country to join the EMU is a far more complex matter and covers various topics that need to be taken in to consideration apart from trade. How will the adoption of the euro affect levels of inflation? How will the inability to conduct an independent monetary policy affect the nation's overall economic environment? The list of these questions is extensive and must all be placed in the balance pan; which these questions are and the how the balance pan will tip are there as many answers to as there are economists.

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Appendix

Table A1. EU and EMU members and year of entry

Country	EU (year of entry)	EMU (year of entry)
Austria	1995	1999
Belgium	1958	1999
Cyprus	2004	2008
Estonia	2004	2011
Finland	1995	1999
France	1958	1999
Germany	1958	1999
Greece	1981	2001
Italy	1958	1999
Luxembourg	1958	1999
Portugal	1986	1999
Malta	2004	2008
Slovakia	2004	2009
Slovenia	2004	2007
Spain	1986	1999
Bulgaria	2007	-
Czech Republic	2004	-
Denmark	1973	-
Hungary	2004	-
Latvia[4]	2004	-
Lithuania	2004	-
Poland	2004	-
Romania	2007	-
Sweden	1995	-
The United Kingdom	1973	-

Source: The European Commission (2014)

[4] Latvia joined the EMU in January 2014

Table A2. Currency and exchange rate regime 2003-2012

Country	Currency	Exchange Rate Regime
Austria	Euro	Member of EMU
Belgium	Euro	Member of EMU
Bulgaria	Lev	Fixed exchange rate to the euro
Czech Republic	Koruna	Floating exchange rate
Cyprus	Pound, Euro	2002-2003 Fixed exchange rate to SDR, 2003-2007 Fixed exchange rate to the euro, 2008- Member of the EMU
Denmark	Krona	Fixed exchange rate to the euro
Estonia	Kroon, Euro	2003-2010 fixed exchange rate to the euro, 2011- Member of the EMU
Finland	Euro	Member of the EMU
France	Euro	Member of the EMU
Germany	Euro	Member of the EMU
Greece	Euro	Member of the EMU
Hungary	Forint	2003-2007 Fixed exchange rate to the euro 2008- Floating exchange rate
Italy	Euro	Member of the EMU
Latvia	Lats	2003-2004 Fixed exchange rate to SDR 2005- Fixed exchange rate to the euro
Lithuania	Litas	Fixed exchange rate to the euro
Luxembourg	Euro	Member of the EMU
Malta	Euro	29/5 2005-2007 Fixed exchange rate to the euro 2008- Member of the EMU
Netherlands	Euro	Member of the EMU
Poland	Złoty	Floating exchange rate
Portugal	Euro	Member of the EMU
Romania	Leu	Floating exchange rate
Slovakia	Koruna, Euro	2003-27/11 2005 Floating exchange rate, 28/11 2005-2008 Fixed exchange rate to the euro, 2009- Member of the EMU
Slovenia	Tolar, Euro	2003-26/4 2004 Floating exchange rate, 27/4 2004-2006 Fixed exchange rate to the euro, 2007- Member of the EMU
Spain	Euro	Member of the EMU
Sweden	Krona	Floating exchange rate
The United Kingdom	Pound	Floating exchange rate

Source: European Commission (2014) and the European Central Bank (2014)

Table A3. Fixed exchange rate regimes to the euro 2003-2012

Period	Country	Currency	€1= Max (YYMMDD)/ Min (YYMMDD)[5]	Volatility over the given period	ERM II status
2003-2012	Bulgaria	Lev	**3,455** (050528)/ **3,452** (050403)	<1 %	No
2003-2012	Denmark	Krona	**7,467** (060207)/ **7,424** (030425)	<1 %	Yes, 1999 -
2003-2010	Estonia	Kroon	**15,647** (040701/ **15,622** (030201)	<1 %	Yes, 28 June 2004 - 2010
2003-2007	Hungary	Forint	**283,35** (060714)/ **234,72** (030113)	≈ 17 %	No
2005-2013	Latvia	Lats	**0,710** (101228)/ **0,696** (050614)	<2 %	Yes, 2 May 2005-2013
2/5 2005-2007	Malta	Lire	**0,4295** (050601)/ **0,4273** (060501)	<1%	Yes, 2/5-2005-2007
28/11 2005-2008	Slovakia	Koruna	**38,307** (060701)/ **30,087** (081201)	≈ 21 %	Yes, 28/11 2005-2008
27/4 2004-2007	Slovenia	Tolar	**239,512**(070101)/ **235,216** (050101)	<2 %	Yes, 28/4 2004 - 2007
2003-2012	Lithuania	Litas	**3.4545** (040401)/ **3.4520** (040325)	< 1%	Yes, 26/6 2004 -
2003-2007	Cyprus	Pound	**0,5865** (030501)/ **0,5692** (041001)	< 3%	Yes, 2/5 2005-2007

Source: The European Central Bank (2014) and oanda.com

5 The exchange rate for the currencies no longer in use are based on monthly figures

Table A4. Complete regression results.

Variables	Pooled OLS	Fixed effects model	Random effects model
Constant	-4.322 (-34.08)***	-43.779 (-1.15)	-5.083 (-9.92)***
ln ($GDP_{it} * GDP_{jt}$)	0.875 (255.39)***	1.084 (49.99)***	0.931 (77.69)***
ln $Distance_{ij}$	-1.229 (-99.16)***	(omitted)	-1.265 (-20.57)***
$Border_{ij}$	0.389 (14.94)***	(omitted)	0.290 (2.19)**
Direct peg_{ijt}	-0.108 (-5.97)***	-0.089 (-5.92)***	-0.078 (-5.20)***
Indirect peg_{ijt}	0.486 (10.06)***	-0.087 (-3.25)***	-0.071 (-2.66)***
$Floating_{ijt}$	-0.026 (-1.87)*	-0.169 (-8.51)***	-0.182 (-9.51)***
$Other_{ijt}$	0.067 (2.33)**	-0.132 (-7.16)***	-0.134 (-7.36)***
q2	0.057 (1.01)	0.052 (2.06)**	0.054 (2.14)**
q3	-0.029 (–0.52)	-0.039 (-1.57)	-0.033 (-1.30)
q4	0.030 (0.54)	0.017 (0.67)	0.029 (1.16)
q5	0.011 (0.19)	-0.007 (-0.29)	0.009 (0.34)
q6	0.022 (0.41)	-0.014 (-0.59)	0.003 (0.11)
q7	-0.030 (-0.55)	-0.067 (-2.72)***	-0.045 (-1.83)*
q8	0.065 (1.20)	0.013 (0.51)	0.041 (1.67)*
q9	-0.017 (-0.32)	-0.079 (-3.21)***	-0.046 (-1.87)*
q10	0.042 (0.77)	-0.029 (-1.18)	0.011 (0.45)
q11	-0.005 (-0.10)	-0.086 (-3.42)***	-0.040 (-1.63)
q12	0.075 (1.38)	-0.014 (-0.56)	0.038 (1.53)
q13	0.075 (1.36)	-0.017 (-0.67)	0.041 (1.65)*
q14	0.094 (1.74)*	-0.007 (-0.26)	0.059 (2.34)**
q15	0.005 (-0.10)	-0.105 (-3.98)***	-0.033 (-1.32)
q16	0.065 (1.25)	-0.060 (-2.23)**	0.020 (0.79)
q17	0.019 (0.36)	-0.123 (-4.51)***	-0.034 (-1.32)
q18	0.029 (0.54)	-0.123 (-4.39)***	-0.026 (-1.00)
q19	-0.013 (-0.25)	-0.185 (-6.52)***	-0.082 (-3.17)***
q20	0.019 (0.37)	-0.147 (-5.11)***	-0.038 (-1.47)
q21	-0.005 (-0.09)	-0.200 (-6.87)***	-0.086 (-3.30)***

q22	0.017 (0.32)	-0.182 (-6.17)***	-0.063 (-2.42)**
q23	-0.029 (-0.55)	-0.236 (-7.92)***	-0.114 (-4.35)***
q24	-0.071 (-1.36)	-0.254 (-8.79)***	-0.143 (-5.52)***
q25	-0.183 (-3.48)***	-0.358 (-12.96)***	-0.265 (-10.39)***
q26	-0.139 (-2.61)***	-0.315 (-11.42)***	-0.223 (-8.73)***
q27	-0.128 (-2.41)**	-0.300 (-10.81)***	-0.206 (-8.05)***
q28	-0.089 (-1.67)*	-0.268 (-9.63)***	-0.172 (-6.73)***
q29	-0.141 (-2.65)***	-0.332 (-11.76)***	-0.231 (-8.98)***
q30	-0.047 (-0.87)	-0.236 (-8.29)***	-0.131 (-5.09)***
q31	-0.073 (-1.37)	-0.269 (-9.34)***	-0.160 (-6.18)***
q32	-0.010 (-0.20)	-0.211 (-7.28)***	-0.100 (-3.83)***
q33	-0.026 (-0.49)	-0.242 (-8.19)***	-0.123 (-4.71)***
q34	0.050 (0.91)	-0.197 (-6.53)***	-0.075 (-2.82)***
q35	-0.024 (-0.44)	-0.271 (-8.95)***	-0.148 (-5.53)***
q36	0.018 (0.33)	-0.229 (-7.59)***	-0.107 (-4.01)***
q37	0.010 (0.19)	-0.238 (-7.82)***	-0.113 (-4.23)***
q38	0.035 (0.64)	-0.222 (-7.26)***	-0.095 (-3.55)***
q39	-0.026 (-0.46)	-0.279 (-9.03)***	-0.149 (-5.52)***
q40	0.011 (0.20)	-0.251 (-8.13)***	-0.121 (-4.49)***
R-squared	0.917	0.418	0.416
F-test		155.29***	
LM-test			0.000015***
Hausman test		88.94***	

Notes: The estimation results for Direct peg, Indirect peg, Floating and Other are estimated with the variable Currency union as base group.

The estimation results for all time variables from q2 to q40 are estimated with q1 as base group.

***/**/* significant at 1 %/5 %/10 % level. T-statistics are in parentheses.

Table A5. Breusch and Pagan Lagrangian multiplier test for random effects.

$$\ln \text{trade}_{ij}\ [\text{uniq}, t] = Xb + u[\text{uniq}] + e[\text{uniq}, t]$$

	Var	sd = sqrt (Var)
$\ln \text{trade}_{ij}$	5.556	2.357
e	0.094	0.307
u	0.353	0.594

Test: Var(u) = 0

chibar2(01) = 0.000015

Prob > chibar2 = 0.0000

Table A6. Hausman test.

Variables	(b) fe	(B) re	(b-B) Difference	Sqrt (diag(V_b-v_B)) S.E.
ln (GDP_{it} * GDP_{jt})	1.084	0.931	0.152	0.018
Direct peg_{ijt}	-0.089	-0.078	-0.011	0.002
Indirect peg_{ijt}	-0.087	-0.071	-0.016	0.002
$Floating_{ijt}$	-0.170	-0.182	0.013	0.005
$Other_{ijt}$	-0.132	-0.134	0.002	0.002
q2	0.052	0.054	-0.002	.
q3	-0.039	-0.033	-0.007	.
q4	0.017	0.029	-0.012	.
q5	-0.007	0.009	-0.009	.
q6	-0.014	0.003	-0.017	.
q7	-0.067	-0.045	-0.022	0.00142
q8	0.013	0.041	-0.028	0.00251
q9	-0.079	-0.046	-0.034	0.00330
q10	-0.029	0.011	-0.040	0.00423

q11	-0.086	-0.040	-0.046	0.00493
q12	-0.014	0.038	-0.052	0.00574
q13	-0.017	0.041	-0.058	0.00649
q14	-0.007	0.059	-0.065	0.00732
q15	-0.105	-0.033	-0.072	0.00815
q16	-0.060	0.020	-0.080	0.00915
q17	-0.123	-0.034	-0.091	0.01052
q18	-0.123	-0.026	-0.097	0.01120
q19	-0.185	-0.082	-0.103	0.01194
q20	-0.147	-0.038	-0.109	0.01261
q21	-0.200	-0.086	-0.114	0.01323
q22	-0.182	-0.063	-0.119	0.01385
q23	-0.236	-0.114	-0.121	0.01410
q24	-0.254	-0.143	-0.111	0.01287
q25	-0.358	-0.265	-0.093	0.01069
q26	-0.315	-0.223	-0.093	0.01057
q27	-0.300	-0.206	-0.094	0.01073
q28	-0.268	-0.172	-0.010	0.01095
q29	-0.332	-0.231	-0.101	0.01158
q30	-0.236	-0.131	-0.105	0.01208
q31	-0.269	-0.160	-0.109	0.01258
q32	-0.211	-0.100	-0.111	0.01287
q33	-0.242	-0.123	-0.119	0.01369
q34	-0.197	-0.075	-0.122	0.01406
q35	-0.271	-0.148	-0.123	0.01419
q36	-0.229	-0.107	-0.122	0.01404
q37	-0.238	-0.113	-0.125	0.01438
q38	-0.222	-0.095	-0.126	0.01458
q39	-0.279	-0.149	-0.130	0.01502
q40	-0.251	-0.121	-0.130	0.01501

Test: Ho: difference in coefficients not systematic
chi2(42) = (b-B) ‘ [(V_b-V_B) ^ (-1)] (b-B) = 88.94
Prob>chi2 = 0.0000

Table A7. Breusch-Pagan / Cook-Weisberg test for heteroskedasticity.

H0: Constant variance

chi2(1) = 694.14

Prob > chi2 = 0.0000

Table A8. Wooldridge test for autocorrelation in panel data.

H0: no first-order autocorrelation

F(1, 350) = 26.546

Prob > F = 0.0000