AN INVESTIGATION OF THE EFFECT OF THE EUROPEAN CURRENCY UNION (EURO) ON SECTORAL TRADE: AN APPLICATION OF THE GRAVITY MODEL OF TRADE

RUTH AWA

A Thesis submitted in partial fulfilment of the requirements of Robert Gordon University for the Degree of Doctor of Philosophy

**Aberdeen Business School
Robert Gordon University
Aberdeen, United Kingdom**

APRIL 2015

ABSTRACT

The introduction of the single currency (Euro) in Europe has been referred to as the 'world's largest economic experiment' and has led to major research on the effects of the adoption of a common currency on economic activity with considerable emphasis on its effect on trade flows at the macroeconomic level. However, the investigation of the euro effect on individual sectors has received very little attention and this provides the motivation for the research.

The main contribution of this thesis is to the sectoral analysis of the single currency's effect on bi-lateral trade flows, specifically the effects on the transport equipment manufacturing sector. In order to achieve this, a comparison of the different estimation methods applied in the gravity model literature will be employed to investigate this effect and to identify the factors affecting trade in this sector. This study uses a panel data set which comprises the most recent information on bilateral trade for the EU15 countries from 1990 to 2008. This research aims to build on the results obtained in previous studies by employing a more refined empirical methodology and associated tests. The purpose of the tests is to ensure that the euro's effect on trade is isolated from the other pro-trade policies of the European integration processes, particularly the introduction of the Single Market. The desirable feature of this approach is that, while other studies limit their attention to a particular issue (zero trade flow, time trend, sectoral analysis, cross-correlation, etc.), very few, if any, apply a selection of techniques.

Overall, the results demonstrate that the single currency's effect on trade in this sector is limited with only the fixed effects formulation with year dummy variables showing a significant positive effect of the euro. An obvious policy implication for countries looking to adopt a single currency is that they should be cautious regarding the potential for growth in intra-bloc trade in a particular sector, although they will benefit from the on-going process of integration.

Keywords: Currency union, Gravity Model, EMU, Panel Data Analysis, European Integration and Euro Effects on Sectoral Trade

DEDICATION

To my family

ACKNOWLEDGEMENTS

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LIST OF ACRONYMS

CIPS	CROSS SECTIONALLY AUGMENTED PANEL ROOT TESTS
CCEMG	COMMON CORRELATED EFFECTS MEAN GROUP ESTIMATOR
EC	EUROPEAN COMMUNITY
ECOFIN	ECONOMIC AND FINANCE AFFAIRS COUNCIL
ECU	EUROPEAN CURRENCY UNIT
ECB	EUROPEAN CENTRAL BANK
EEC	EUROPEAN ECONOMIC COMMUNITY
ECSC	EUROPEAN COAL AND STEEL COMMUNITY
EMS	EUROPEAN MONETARY SYSTEM
EMU	EUROPEAN MONETARY UNION
EMU11	FIRST 12 COUNTRIES TO ADOPT THE EURO EXCLUDING LUXEMBURG
EMU12	FIRST 12 COUNTRIES TO ADOPT THE EURO
ERM	EXCHANGE RATE MECHANISM
ERM II	EXCHANGE RATE MECHANISM II
EU	EUROPEAN UNION
EU15	EMU12 + DENMARK, SWEDEN AND UK
EURATOM	EUROPEAN ATOMIC ENERGY COMMUNITY
EUROZONE/AREA	COUNTRIES THAT HAVE ADOPTED THE EURO
FE	FIXED EFFECTS
GE MODEL	GENERAL EQUILIBRIUM MODEL
GDP	GROSS DOMESTIC PRODUCT
GMM	GENERALISED METHOD OF MOMENT
HICP	HARMONIZED INDEX OF CONSUMER PRICES
IMF	INTERNATIONAL MONETARY FUND
ISIC	INTERNATIONAL STANDARD INDUSTRIAL CLASSIFICATION
MU	MADDDALA WU TEST
OCA	OPTIMUM CURRENCY AREA
OECD	ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT
OLS	ORDINARY LEAST SQUARED
RE	RANDOM EFFECTS
RTA	REGIONAL TRADING AGREEMENTS
SGP	STABILITY AND GROWTH PACT
WTO	WORLD TRADE ORGANISATION

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CHAPTER 1

INTRODUCTION

1.1 Overview of the Thesis

Put simply, international trade refers to the exchange of goods and services between countries. It is a dynamic activity and one which evolves over time. The world's trading system has recently seen a great deal of regionalism and multilateralism, which has led to the growth of regional trading agreements (RTAs). Indeed, since the early 1990s, RTAs have become very common and by January 2014 the World Trade Organisation had received 583 notifications[1]. In essence, RTAs involve the coming together of two or more countries with the intention of reducing tariffs and simplifying import and export procedures. Most RTAs are formed on the basis of traditional trade policy structures. More sophisticated RTAs include regional rules regarding flows of investment, co-ordination of competition policies, agreements on environmental policies and the free movement of labour. Many countries, both developed and developing[2], are now coming together to form RTAs. Although these differ in terms of structure and organisation, they all usually have a common goal, namely, the lowering of trade barriers between the members and the elimination of tariffs on the trade of goods within the region. Among the more widely known are the European Union (EU) and the European Free Trade Association (EFTA).

The Economic and Monetary Union (EMU) is viewed as a progressive stage of economic integration in Europe based on a single market. The EU was formed in 1958 with the main goal being to build a common market. However, it became clear that closer economic and monetary co-operation was needed for the internal market to grow and this led to the eventual introduction of Europe's single currency. The EU integration process is still ongoing and several landmarks have been attained with regards to the integration in the last 10

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[1] World Trade Organisation, RTA Database. (2014). *Regional Trade Agreements.* Available: http://www.wto.org/english/info_e/cont_e.htm. Last accessed 5th May 2014.
[2] Examples of some developing countries include the six West African countries of Nigeria, Ghana, Gambia, Guinea, Sierra Leone and Liberia which form the West African Monetary Zone. These countries are already in the process of forming a currency union.

years. Currently, there are a total of 28 countries in the EU with 18 using the euro as their national currency. 11 European countries came together and formed a currency union in 1999 initially for wholesale transactions and later in 2002 for retail transactions. Indeed, as of 1st January 2014, 18 European countries had adopted the euro, namely, Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia and Spain.

Ever since the end of World War II, Europe as a whole has shown a desire to integrate its economic interests through the elimination of trade barriers. This began with the completion of the single market in 1992, subsequently increasing the possibilities for governments to reduce regulations on cross-border trade within and around Europe. The last step in the integration of Europe was the introduction of the single currency in 1999-2002. This replaced the national currencies of the first 11 participating countries, thus bringing an end to the autonomy of national monetary policy. The main aim behind the adoption of the single currency was to create a stable environment among the European member countries and so put an end to exchange rate problems, monetary tensions and macroeconomic imbalances. Amongst the many associated benefits, increases in bilateral trade were the most anticipated and would be facilitated as a result of the elimination of currency transaction costs and exchange rate fluctuations among the member countries. The positive euro effect on trade among the member countries has been analysed by several authors including Micco et al (2003), Flam & Nordström (2006, 2007), Baldwin & Taglioni (2006), Fernandes (2006), De Nardis et al (2008) amongst others, all showing trade increases ranging between 3% and 117%[3]. Since the euro's introduction, vital questions in the literature have revolved around the extent to which trade has increased as a result of the euro. A major issue arising in this field is whether the single currency has actually increased trade flows between its members or whether the trade increases (if any) were caused by other trade enhancing factors such as the ongoing EU integration or due to the geographical location of the member countries. Secondly, the extent of the Euro's effect on aggregate trade and that of individual sectors has to be considered. This impact

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[3] These results are obtained when analysing both aggregate and sectoral data with the former showing a greater effect than the latter.

is just as important for the Eurozone members as it is for the non-member countries which have yet to adopt the euro.

The euro was introduced for both political and economic reasons, with the main effects of the latter including a reduction in transaction costs, an enhancement of price transparency, increases in bilateral trade flows and the creation of a stable macroeconomic environment with low interest and inflation rates as well as the elimination of exchange rate uncertainty among the Eurozone countries. From an economic point of view, the euro was viewed as a step towards the completion of a fully integrated single market in the European Union. Also, according to a European Council 2004 report, the euro from the political perspective was aimed at giving more credibility to European institutions such as the European Central Bank by increasing its power. Several authors (DeGrauwe, 2012; Rickards, 2003; Baimbridge and Whyman, 2005) have concluded that the general consensus is that the euro is important for the participating countries and their industries because it influences the environment in which businesses compete and operate.

Over a decade after the euro's introduction, European Union trade as well as Eurozone trade represent a field which has been studied broadly and one in which researchers have analysed a wide range of topics and effects. This interest was ignited by the introduction of the single currency in Europe. Europe journeyed towards monetary integration with the hopes that the euro would lead to more integration between the markets of the member countries which would lead to a more efficient allocation of resources and more trade and investment among the members (Micco et al., 2003). There are different ways that the creation of a currency union could affect trade flows. The introduction of a single currency removes exchange rate fluctuations amongst the member countries thereby decreasing the uncertainty and risk involved in trade transactions. Exchange rate uncertainty can be reduced using hedging techniques but the downside to this is the fact that it is costly and it is sometimes impossible to fully hedge against exchange rate volatility.

The literature on the effect of exchange rate volatility on trade is inconclusive although there is a strong assumption which supports the idea that reducing or eliminating exchange rate uncertainty reduces transaction costs which lead to more trade and investment among the countries involved. Edison and Melvin (1990) analysed 12 studies with just 1 finding a positive relationship between reduced exchange rate volatility and trade, 5 of the studies arrived at inconclusive results while 6 found negative and significant effects.

The formation of currency unions however goes beyond the reduction or even elimination of exchange rate volatility. They are also formed to eliminate the transaction costs which countries have to pay when they trade in different currencies with different countries. Transaction costs are separate and independent of the volatility issue and can hinder trade flows between countries even when the exchange rates are totally stable. De Grauwe (1997) explains this by reporting the buying and selling spreads between the Belgian Franc and several other currencies. He found that the cost of exchanging Belgian francs for Dutch Guilders or the German Deutschemarks is similar to the cost of exchanging them for French francs, British Pounds sterling or US dollars regardless of the low volatility of the Belgian franc in relation to the Guilder or the Deutschemark. Secondly, the member countries in the currency union opt for a more liquid currency when they give up their national currencies, hence providing a means to hedge against exchange rate risk in their bilateral trade relations with the non-member countries. Lastly, in the formation of a currency union, the exchange rates among the countries involved are irrevocably fixed (1 French € = 1 German €) which removes the occurrence of fluctuations or volatility in the exchange rates of the member countries. Literature on the relationship between trade and exchange rate volatility does not take the above points into consideration. Hence it is important to study the trade effect of currency unions considering the introduction of the single currency (elimination of transaction costs) separately from the trade effect of exchange rate volatility.

The deliberation on the euro's trade effects has led to increasing academic interest. This was largely motivated by estimates detailed in a study by Rose (2000) who asserted that members of a currency union will trade with each other three times more in volume terms than they would with other countries.

This result led to a debate on the currency union effect on trade and whether the results achieved are an appropriate comparison for the European currency union. The trade effect of the euro is of cardinal importance because the member countries should know whether they would achieve the full benefits of a more integrated market, higher growth and increased trade and investments between the member countries. The formation of the currency union also comes with some disadvantages. The most obvious is the loss of monetary independence. This disadvantage according to Micco et al (2003) is very costly especially in cases where the cycles of the member countries are not highly correlated.

The Optimum Currency Area (OCA) literature which was pioneered by Mundell (1961) asserted that economies that are subject to asymmetric shocks and cycles should abstain from forming or joining a currency union unless conditions of price flexibility, labour and capital mobility are met. The endogeneity of the OCA theory was suggested by Frankel (1997) and Frankel and Rose (1998). They acknowledge the fact that sometimes the cycles of countries may not be highly correlated before the formation of the currency union but increased trade among the countries as a result of currency union membership could lead to increased cycle correlation. They therefore asserted that, if in fact membership in a currency union leads to increased trade flows which in turn lead to increased cycle correlation, then countries that did not satisfy the OCA criteria before the formation of the currency union can satisfy the criteria ex-post.

The euro effect on trade is not only important for the member countries but also for those countries that have not yet joined the currency union. This is why it is important to include non-members in the sample as a control group in order to answer the key question – Should they join the currency union? Although much of research has been undertaken analysing the euro effect on trade since the introduction of the single currency, most of these studies have used aggregated/country variables and the main issues were analysed from a total merchandise trade level between countries. Indeed, empirical studies of international trade have addressed the trade flows of specific industries but analysis of trade in sub-sectors or a particular commodity are not very common (Flam and Nordstrom, 2006a and b; Baldwin et al., 2005; Fernandes, 2006; De

Nardis et al., 2008). This area has received little in the way of academic attention which is a shortcoming that can be explained, in part, by a lack of available data. As a result of this gap in the literature, this thesis will focus on the impact of the euro on trade in the Eurozone countries, with particular attention paid to the transport equipment manufacturing sector (2 digit ISIC Rev 3 (34-35). Although many studies have examined the total merchandise trade flows between the Eurozone countries, the results are not indicative of particular industries and do not show their individual effect.

An important reason for the decision to study the euro effects on trade in this sector is the fact that the transport equipment manufacturing sector plays a very important role in Europe's economy as it affects the development and welfare of the countries. Factor mobility is a very important characteristic of economic activity because it involves the movement of people, goods, services and information. The economic importance of the transport equipment industry can be analysed from both macroeconomic and microeconomic perspectives:

- At the macroeconomic level, transportation is linked with the level of output, employment and income within a national economy. On average, this sector accounts for between 6% and 12% of the EU's annual GDP respectively.(Eurostat)

- At the microeconomic level, transportation is linked to producer and consumer costs. The importance of specific transport activities and infrastructure can thus be assessed for each sector of the economy. Transportation accounts for, on average, between 10% and 15% of annual household expenditure (Rodrigue et al 2013).

Europe's transport equipment manufacturing sector is significant to economic development because it is responsible for the transportation of both individuals and goods. The demand for transport equipment has risen as the volume of goods conveyed and the distance travelled by passengers has significantly increased. In Europe, this sector consists of over 35,000 enterprises with over 10 million people employed. With regards to output, the sector

generated EUR 291.0 billion of value added in 2011 (Eurostat, SBS)[4].

Furthermore, with Western Europe being in the top three largest automobile manufacturers[5] in the world with the United States of America and Japan, this sector is important to the economy and was chosen for this analysis for the following reasons-

Drives Economic Growth / generating revenue

This sector generated a turnover which represents 6.9% of EU GDP.

Creation of Jobs

A total of 12.9 million people were employed in the sector in 2013.

Vehicle Manufacturing in Europe

In the EU 16.2 million motor vehicles, trailers and semi-trailers are manufactured in 2013.

Global Exports

Being a global player in the auto industry, European vehicles are exported worldwide generating a €95.7 billion trade surplus as at 2013.

Generating Government Revenue

Motor vehicles accounted for over €385 billion in tax contributions in just 14 EU countries in 2013.

Encouraging Innovation

The sector is Europe's leading private investor in research and development with investment of over €32 billion in 2013.

(Source: European Automobile Manufacturers Association (ACEA, 2014).

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[4] Eurostat SBS. (2008). Transport Equipment- 12. Available: epp.eurostat.ec.europa.eu/cache/ITY...12/.../KS-BW-09-001-12-EN.PDF. Last accessed 5th May 2014.
[5] The manufacture of motor vehicles, trailers and semi-trailers is a subsector of the transport equipment manufacturing sector.

In analysing the single currency's trade effects, the methodological approach employed in this research is based on the well-known gravity model. The model has been widely accepted in international trade literature as one of the most successful empirical tools applied in the prediction of bilateral trade flows between countries. This will be used to ascertain whether or not the introduction of the euro has had an effect on intra-Eurozone trade. Gravity models have been widely used in the literature to find the determinants of bilateral trade flows, to analyse the bilateral trade relationship between regions and also to estimate the trade effect of currency unions. As mentioned earlier, Rose (2000) estimated that the introduction of a single currency could lead to an increase in trade by over 200%[6]. This conclusion led to serious deliberation in the literature. See Persson (2001), Alesina et al. (2002), Micco et al. (2003), Anderson and Van Wincoop (2004), Frankel (2005, 2008), Flam and Nordström (2006, 2007), Bun and Klaassen (2007), Berger and Nitsch (2008), De Nardis et al. (2008), Silva and Tenreyro (2011), Herwartz and Weber (2010) and Camaero et al. (2012). These studies all analysed the euro effects on trade and found positive effects ranging between 3% and 50% increases in trade flows between the member countries as a result of the single currency. This clear difference in estimates was due to the fact that more advanced econometric approaches were used which took into consideration many factors that were omitted in the study by Rose (2000). Secondly, the analysis in Rose (2000) was not specifically aimed at Europe or the euro zone trade but analysed the trade effect of currency union membership worldwide.

Up until recently, the gravity model has been seen "*as an intellectual orphan, unconnected to the rich family of economic theory*" (Anderson, 2011). The gravity model has become the workhorse that is used to analyse patterns of bilateral trade (Eichengreen and Irwin, 1998). The model emerged as a result of Newton's gravity equation in physics and has recently become commonly used for the analysis of spatial flows. In addition, Tinbergen also pioneered its use in international trade (Tinbergen, 1962; Pöyhönen, 1963; Linnemann, 1966).

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[6] The results obtained in the analysis of Rose (2000) cannot be used as a reference to the euro trade effect as the countries that were studied are not comparable to the member countries of the eurozone. This is explained in detail in chapter 4.

"The model works well empirically, yielding sensible parameter estimates and explaining a large part of the variation in bilateral trade". (Rose (2005).

However, its lack of a theoretical foundation is an issue which has long been discussed. More recently, the gravity model has made a comeback in the international trade literature. Crucial to this revival have been theoretical developments in the modelling of bilateral trade, thus providing the model with a more robust underpinning in trade theory (see, Feenstra, 2004; Anderson and Van Wincoop, 2004). In its traditional form, the gravity model explains trade flows through supply and demand factors (GDP and population) plus trade resistance (distance) and trade enhancing factors (common language, common borders, common colonisers etc.).

In summary, various estimations of the gravity model will be employed to analyse the euro's effect on trade in the chosen sector. The Pesaran CD-test for cross-sectional dependence and the modified Wald test for heteroscedasticity will be employed. These are two tests which have not been used in published sectoral studies. Although early gravity model studies using panel data techniques disregarded econometric issues pertaining to the non-stationary data, more recent studies have considered this more closely, e.g., Faruqee (2004), Berger and Nitsch (2008) and Fidrmuc (2009). Yet, most of the analyses are carried out on the assumption that there is an absence of correlation across the units in the panel. This is not a realistic assumption because the country pairs are either closely located or are involved in an integration process. Ignoring the cross-sectional dependence between the countries could lead to a bias in the results. Therefore, in order to take this into consideration, the Pesaran (2004 and 2007) techniques will be employed so that the unbiased estimates are obtained. In studies where aggregate trade was analysed, the use of these tests showed a much smaller euro effect than those that do not account for cross-sectional dependence. The Modified Wald test for groupwise heteroscedasticity has been used in aggregate trade analysis to determine whether heteroscedasticity was an issue. The presence of heteroscedasticity in this sample will be dealt with as follows: (i) by adapting the specification to see if some variables could be responsible (mainly with trends and dummy variables)

(ii) by the use of the Driscoll Kraay standard errors in the baseline model, and (iii) by the use the PPML in the panel model.

1.2 Aim and Objectives

The aim of this thesis is to investigate the trade effects of the introduction of the euro in the transport equipment manufacturing sector (ISIC[7] Rev. 3, no 34 -35) of the EU15 countries. These consist of the first twelve countries[8] to become members of the Eurozone and the control group of the UK, Denmark and Sweden which are member countries of the European Union that have not adopted the euro as their national currency. The reason for using the control group is to keep the effects of Europe's market integration constant over time and to isolate the trade effects of the single currency.

As previously mentioned, the euro was introduced for both political and economic reasons with the intentions of achieving low inflation, increasing price transparency, eliminating exchange rate fluctuations and encouraging trade flows among its members. With much emphasis placed on the trade effects of the euro in the literature, this study will use the gravity model of international trade to examine the sectoral bilateral trade of the Eurozone countries while contrasting and comparing the member states of the currency union with a control group of non-member countries. This will be achieved by including certain dummy variables which will capture not only the currency union effect but also the EU effect, as the latter may have influenced the increase in trade between the European countries. Most studies have used total merchandise trade flows when employing the gravity model to analyse trade flows in RTAs and currency unions.

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[7] The International Standard Industrial Classification of All Economic Activities (ISIC) is used by the United Nations statistics division to classify data according to the type of economic activity in areas of manufacturing, gross domestic product, employment and other statistical areas. It offers a complete structure where economic data can be collected and reported in a format that is designed for purposes of economic analysis, decision-taking and policy-making. Using the ISIC structure, the different economic activities are split into a categorized, four-level structure of mutually exclusive classifications aimed at simplifying data collection, presentation and analysis at detailed levels of the economy in an internationally comparable, standardized way.

[8] The dataset actually consists of 11Eurozone countries, since the trade data for Belgium and Luxembourg are reported together.

The level of the trade effect will vary by sector and thus it is important to not only analyse its effects on total trade flows but also to examine the effect on specific sectors, especially those which contribute significantly to the total economy of the countries/region. While investigating the trade effects of the euro, the issue of trade diversion is not included which according to Frankel and Rose (2000) is very important in the analysis of the trade effects of currency unions. With increased price transparency and competition expected within the euro zone countries, one major objective of the euro was to reduce the costs for the euro zone producers, thereby making them more competitive with the non-euro zone producers which should affect trade patterns. Trade diversion can be explained as a process whereby trade is diverted from efficient producers to inefficient producers as a result of the creation of a currency union. In its most basic form, trade diversion refers to any trade diverted away from efficient global producers due to the creation of a currency union. Some economists refer to trade diversion as a long-term loss of trade brought about by inefficient producers becoming more efficient after joining a currency union.

Therefore, in order to achieve the aim of this research, the two objectives of this study are listed below:

- Firstly, a gravity model analysis of the bilateral trade flows in the transport equipment manufacturing sector will be carried out in order to identify and isolate the trade effect of the introduction of the euro in the sector.
- Following Frankel and Rose (2000), the next objective will be to check for trade diversion between member and non-member countries. It is vital to know if the euro generates net trade for the member countries or whether the trade increases with other members come at the expense of trade with non-members. This will be carried out by including a dummy variable[9] that takes the value 1 when only one of the countries in the pair belongs to the euro zone.

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[9] If the coefficient of the trade diversion variable is negative, it can then be asserted that the euro zone member countries switched trade from non-members to member countries.

1.3 Research Questions

The purpose of this research work is to answer the following questions -

Question 1: Has the introduction of the euro had a significant impact on bilateral trade in the EU15 countries in the chosen sector?

Question 2: Has there been any evidence of trade diversion in this sector since the introduction of the euro?

Question 3: What are the other major determinants of changes in bilateral trade in this sector?

1.4 Scope of the Study

The time frame used in the research spans a period of 19 years between 1990 and 2008 inclusive. It is extremely important to study the effects of an event over long periods of time in order to capture the full extent of the ramifications. The study period begins in the 1990s when the creation of a "Border free Europe" was achieved. The single market is seen as one of Europe's greatest achievements and has led to the free movement of goods, services and people across the EU. By 1995, all of the current EU members were members of the European Union and in 1999 the European Monetary Union was formed. The single currency was introduced in 11 countries (joined by Greece in 2001) for wholesale, commercial and financial transactions only. Common notes and coins for retail transactions were introduced officially in 2001 to replace national currency notes and coins.

There have been discussions[10] regarding the decision to choose the EU12 countries as members of the Eurozone as opposed to all members of the Eurozone, currently standing at 18 in number. This choice was made due to the fact that the analysis will be more consistent with regards to the EU12[11], since they all joined the Eurozone at the same time. It should also be noted that for some of the regression equations (when time dummy variables are included), Greece may be excluded from the dataset because it only became a member in

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[10] Examples of studies that have used the EU12 as a representative sample in analysing the euro effect include those of Micco et al (2003), Baldwin (2005), De Nardis et al (2008), Serlenga, L. & Shin, Y. (2013).

[11] In the robustness test which includes comparisons across time, due to its late entry into the Eurozone, the trade data for Greece was excluded from the Eurozone group because it is important in this test to keep the EMU pairs constant throughout the sample.

2001. The second reason behind the selection of the EU12 countries is that these member states constitute the larger economies and therefore are the major players in the transport sector in Europe, thus meaning that they can be viewed as a representative sample of all the euro zone countries(Micco et al., 2003; Goldberg and Verboven, 2004; Bris et al., 2006). Due to a lack of data availability, Luxemburg will be omitted from the EU 15 countries because Belgium and Luxemburg were considered as one country since they reported trade data together until 1999. In the light of this, there will be 14 EU countries (although still referred to as EU15 in the text) in the dataset, i.e. 11 members[12] and 3 non-members.

1.5 Outline of the Study

The structure of the thesis is arranged as follows Chapter 2 provides the overview of the history of the European Monetary Union. There will also be an in-depth evaluation of the economic advantages and costs of the single currency's introduction. Following this, a section will be dedicated to the transport equipment manufacturing sector in Europe where the bilateral trade within the sector will be analysed both at the sector level and by sub-sector.

Chapter 3 will introduce and evaluate the gravity model, which is the main tool used in the literature to analyse bilateral trade flows between countries. The chapter will start with a general explanation of the model, beginning with the basic concept. It will then further examine the developments of the model over time which have seen it become an established technique in international trade analysis. The most recent literature on the model will be reviewed, with close attention paid to the alternative specifications and estimation methods used.

Chapter 4 will evaluate the relevant literature on the euro's effect on trade. This chapter will examine the empirical studies which have used the gravity model specifically for the analysis of bilateral trade in the Eurozone. This will include recent literature on the euro's effect on trade at the aggregate level and studies which have used sectoral data.

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[12] The 11 members refer to the first 11 countries that adopted the euro minus Luxemburg. They include: Belgium, Austria, France, Italy, Ireland, Germany, The Netherlands, Spain, Greece, Portugal and Finland. The 3 non-members include Denmark, Sweden and the UK.

Chapter 5 explains the conceptual framework and model building process of the gravity model equations which will be used. This chapter deals with the methodology employed and as such there will be an explanation of the data, the variables and the methods employed for data analysis.

The first specification of the gravity model will be carried out by means of Ordinary Least Squares (OLS) regression analysis. This method uses pair - specific variables such as common borders, common language and geographical distance between country pairs. With the rest of the models, revised forms of the traditional gravity model that are based on the panel data methodology are used. The Hausman test is used at this stage to assess the eligibility of using either the fixed or random pair effects.   In most gravity model analysis, the fixed effects estimation is preferred and as such the time-invariant country pair-specific variables such as distance, borders and common language will be subsumed in these country pair fixed effects

The second and third specifications used are the country pair fixed effects (Glick and Rose, 2001) and the importer and exporter fixed effects (Feenstra (2002). The key benefit of including the country pair fixed effects is its capability to capture all likely fixed factors between the country pairs which have affected the bilateral trade flows. The latter test on the other hand goes somewhat further and takes into account not only the characteristic of the country as a whole but also considers the specific characteristics for each country, once as an importer and once as an exporter.

The fourth specification includes year dummy variables in order to control for common shocks such as political changes and financial crises to evaluate any changes in the euro effect on trade over time.

The fifth specification of the gravity model includes the addition of a trend variable as advised by Bun and Klaassen (2007). This study re-examined the question of whether the introduction of the euro has increased trade. They concluded that estimates of the euro effect show trade benefits that range between 5% and 40% and highlighted the fact that the extent of the euro effect

clearly depends on the time period being analysed. They discovered that the country pairs have upward trends which the euro dummy variable captures. This they argue causes an upward bias in the euro effect. They therefore advised that trends should be included in order to avoid the *"omitted trending variable bias".* When this was included in their analysis, the euro effect was reduced to 3%. This extension according to Bun and Klaassen (2007), although used in other panel data studies (Cornwell, Schmidt and Sickles, 1990; Mark and Sul, 2003, among others), is a new development to the gravity model.

Finally, robustness tests are carried out to verify the results. The first follows the seminal study by Micco et al. (2003); this model is used to account for the year-specific changes over time by combining the year and trend dummy variables with the EMU dummy variable in order to detect the year specific effects of the euro. The second comprises the addition of lags to the GDP variable as a regressor in the equation. Bun and Klaassen (2002) considered trade as a dynamic process and both included lags to either the dependent variable and/or the income variable. Bun and Klaassen (2002) included both lags and found that trade is indeed a dynamic process and this should be taken into account in gravity model estimations. It is with this in mind that the present analysis includes a lag of the income variables as a regressor in the robustness tests.

Chapter 6 details the step by step applications of the methods discussed and examined in Chapter 5 and also explains and interprets the results. Chapter 7 concludes the thesis by critically evaluating and discussing the results, specifying the limitations of the research and highlighting areas for further investigation.

CHAPTER 2

THE EUROPEAN MONETARY UNION

'We must build a kind of United States of Europe. In this way only, will hundreds of millions of toilers be able to regain the simple joys and hopes which make life worth living'. (*Winston Churchill, 1946*)

2.1   Introduction

This chapter aims to look deeper into the history of the European Integration and the suitability of the creation of the European Currency Union. In order to achieve this, the Optimum Currency Area (OCA) criteria will be reviewed to assess the suitability of forming the currency union in Europe and the journey to the introduction of the Euro will be examined.

An Optimum Currency Area (OCA) is normally made up of countries which are highly integrated, particularly with regards to trade and other economic relationships. An OCA is therefore viewed as an area where it is ideal for the countries to share a common currency and also to have their own single monetary policy. This definition of an OCA may be too comprehensive and can more effectively be defined as

"*a region that is neither so small nor open that it would be better off pegging its currency to a neighbour, nor so large that it would be better off splitting into sub regions with different currencies*". (Frankel, 1999, p. 14)

The theory of optimum currency areas (OCA) was initiated by Mundell (1961) and is the most common approach used when analysing and reviewing monetary unions. Its aim is to determine the boundaries of an area within which a common currency would be ideal and identify features which will define an optimum currency area. Robert Mundell published his famous paper on "A Theory of Optimum Currency Areas" in 1961. It focused on the author's ideas and the criteria which countries must possess before successfully forming a

currency union. Mundell's work was extended by Alesina and Barro (2002) which led to the current policy deliberations about currency union formations. This came as a result of the fact that many countries around the world have adopted, or are in the process of, adopting currency unification. Major examples include: the creation of the European monetary union which consists of eighteen countries so far. A monetary union also referred to as a currency union involves several independent countries relinquishing control over the supply of money to a common authority and abandoning their national currencies to share a common currency. It eliminates the transactions costs incurred during bilateral trade transactions between member countries and also removes the risks and costs involved in exchange rate transactions. In Latin America, El Salvador and Ecuador are currently using the US dollar while Mexico, Peru and Guatemala are in the process of dollarization. Dollarization occurs when a country aligns its national currency with the US dollar. Countries go through the process of dollarization because of the greater stability in the value of the foreign currency over the domestic currency. The main disadvantage however is the fact that the country loses its right to power its own monetary policy by adjusting the money supply. In West Africa, six countries are in the process of creating a common currency while deliberations are in process among eleven countries in the Southern African Development Community concerning whether or not to introduce the US dollar as a single currency or to introduce a separate and independent currency union. In the Middle East, six of the GCC countries (Saudi Arabia, Bahrain, Oman, Qatar, and Kuwait) have stated clearly their desire to form a currency union by 2015. Also many countries have retained currency boards with either the U.S. dollar or the euro as the anchor[13]. (Alesina et al, 2003). Currency boards can be defined as a "government institution which exchanges its national currency for a foreign currency at a fixed rate of exchange", thereby protecting the economy from external shocks and internal mismanagement. They are implemented with the aim of controlling "the discretionary policy-making ability of the authorities with control over monetary and exchange rate policies" and are more suited to "developing countries with a long history of unstable exchange rates." The three essential factors to understand about currency boards include, firstly, an exchange rate of a country

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[13] Currency boards are, in a sense, mid-way between a system of fixed rates and currency adoption.

is fixed to an "anchor currency," secondly, the country has got the legal right to exchange domestic currency at the stated fixed rate whenever it wanted, and lastly, there is a long-term commitment to the system, which is set out directly in the central bank law. The major motivation behind countries using currency boards is to achieve a visible anti-inflationary policy, economic credibility and low interest rates.

Mongelli (2002) summarised the properties of an OCA in 3 stages. The *domain* of the OCA refers to the independent countries agreeing to adopt a single currency or to irrevocably peg their exchange rates;

Optimality refers to the OCA *criteria* which should be met before a common currency area is formed. These include mobility of labour and capital, price and wage flexibility, economic openness, product diversification, interest rate similarity, fiscal integration and political integration; and lastly

Sharing the above criteria leads to a decrease in the usefulness of nominal exchange rate adjustments within the currency area by fostering internal and external balance, reducing the impact of some types of shocks, and facilitating the adjustment thereafter.

Exactly 38 years after the paper was published, the euro was introduced as the national currency of the first 11 European countries to have adopted a single currency. At the time, it was introduced as a bank currency for wholesale transactions only and three years later the actual notes and coins were introduced and used as a means of retail payment. This phenomenon sparked a great deal of interest, with researchers analyzing Europe and the Eurozone countries' suitability to actually form a currency union.

The traditional Optimum Currency Area (OCA) criteria states that certain criteria should be achieved before countries can benefit from the formation of a currency union. In summary, these criteria include: the countries in a currency union should have a high similarity of business cycles, have strong trade links, and should have an effective adjustment mechanism that will have the ability to mitigate the adverse effects of asymmetric shocks. Frankel and Rose (1998) brought up the debate on the endogeneity of fulfilling the OCA criteria asserting that closer trade relations between country pairs could lead to the country pairs

achieving the other criteria such as increased symmetry of shocks between the countries involved or business cycle synchronisation. With a lot of criticisms about the traditional OCA criteria and the actual introduction of the European single currency,(which gave economists a real currency union to investigate), the modern approach rather analyses the advantages and disadvantages of currency union formation as a basis for the creation of a currency union.

The rest of this chapter reviews the OCA theory and investigates the suitability of the EMU as a currency union using both the traditional and modern theories. Finally the history of the Europe's integration up to the creation of the currency union is reviewed and lastly the Transport Manufacturing Sector of the EU15 is analysed.

2.2   The Theory of Optimum Currency Area

An Optimum Currency Area refers to the geographical area of countries which adopt a single currency or which use several currencies that have their exchange rates irrevocably pegged (Mongelli, 2008).
Indeed, the phrase 'Optimum Currency Area' was first mentioned in the seminal paper on "A Theory of Optimum Currency Areas" by Mundell (1961). He proposed that a currency area should be a region where borders do not have to coincide with state borders. He attempted to address the issue of a group of countries uniting to adopt a common currency and of the extent of a suitable area. At the time, this question was more of a theoretical enquiry because it was inconceivable that countries (especially developed) would actually abandon their national currencies to use a new single currency. However, this theory attracted much attention from researchers when the European Union accepted the introduction of a currency union.

Factor and labour mobility were both highlighted by Mundell (1961) as being very important in the formation of an optimum currency area. Mundell claimed that, the region is not optimal if the exchange rate regime within a region causes unemployment in one part or leads to increased inflation in another part as a result of the unemployment. He further explained that if there

is a shift in the demand for products in Country A to Country B which leads to price and wage rigidities, then this will lead to inflationary pressures in Country B and unemployment in Country A. If those regions have a fixed exchange rate, then it will be necessary for an alternative adjustment mechanism to be used to restore equilibrium. Labour mobility was the mechanism suggested by Mundell to restore the balance of payments back into equilibrium. He argued that labour from Country A will move to Country B if there is a high labour mobility, and that there will be no unemployment or inflationary pressures nor a need for either country to retain its own exchange rate because one common monetary policy will be suitable for both countries.

Thus, regions where there is a high movement of labour should according to Mundell, have a fixed exchange rate amongst its members/boundaries and a flexible exchange rate with the rest of the world. His theory also stresses the significance of price and wage flexibility as instruments to cope with idiosyncratic demand shocks. Hence, his approach to OCA posited that as long as labour mobility or price and wage flexibility exist in a region, then there will be no need for changes in its exchange rate and a single currency will be sustainable.

In conclusion, Mundell's theory states that there can be two countries A and B each producing different goods. The implication of a decrease in the demand from Country A's goods to Country B's goods caused by changes in consumers' preferences could lead to both a decrease in the demand and prices of the goods sold in Country A. For Country B, the effect of this, as shown in Figure 2.1, would be an increase in both price and quantity demanded. This downward demand shift would also result in increased unemployment and a trade imbalance in Country A with inflation rates simultaneously affected in Country B. With this said however, a common monetary policy cannot solve the problems of both countries in these situations. Whilst the effect of a restrictive monetary policy would help lower the inflation rates, the unemployment problems in Country A could deteriorate. A restrictive monetary policy is implemented with the aim of slowing down an economy's growth by reducing the credit and money supply extended by the banks. The overall reason for this type of monetary policy is to reduce inflation. On the other hand, an expansionary monetary policy is the opposite. It involves stimulating the growth of the

economy by increasing its money supply. In essence, this is achieved by reducing interest rates, with the main aim being to reduce unemployment. Implementing an expansionary monetary policy in the case of Countries A and B above will cause a reduction in Country A's unemployment while worsening inflation rates in Country B.

Figure 2.1: Mundell's Theory of OCAs
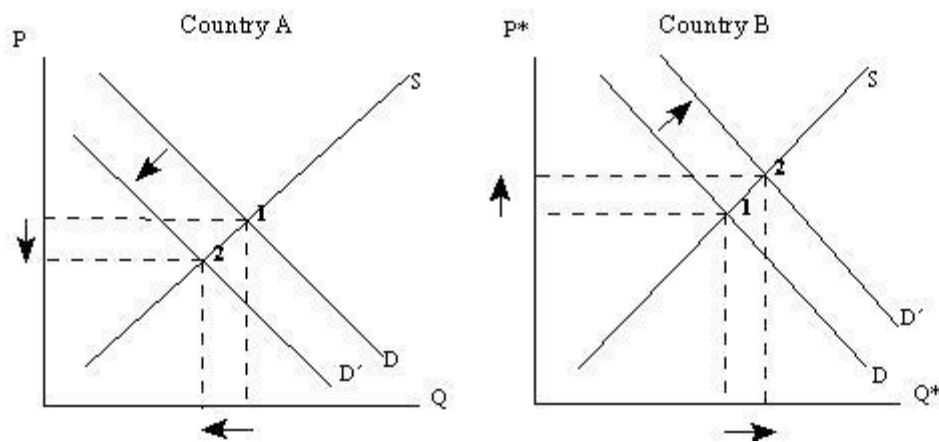
(Source: Patterson and Amati (1998). *Adjustment to asymmetric shocks*. European Parliament, Directorate-General for Research.)

Assuming that both countries are not members of a currency union and therefore have separate currencies, equilibrium can be restored by allowing Country A's currency to depreciate *vis a vis* the currency of Country B. However, in the event that both countries share a common currency, the unemployment experienced in Country A can be dealt with effectively through a number of methods, such as the implementation of an expansionary fiscal policy, a reduction in nominal wages and prices and labour migration. Mundell´s analysis therefore advised that a monetary union is appropriate when the impact of shocks on countries is symmetric (similar), while mobility of labour and wage flexibility is the main solution when the impact of the shocks is asymmetric.

Mundell's paper has been quoted and severely criticised in the literature over the years, with subsequent developments to the theory. In 1963, McKinnon went a step further and divided factor mobility into two different parts. The first was termed geographic factor mobility, as put forth by Mundell, while the second

was factor mobility among industries. He analysed a scenario where there was no factor mobility between regions (and in his analysis each region had specialised industries), thus making it challenging to differentiate between geographical and inter-industrial immobility. In his explanation, a negative demand shock affecting region B would lead to a fall in demand for B-type products. If there is an increasing demand for A-type products and region B is able to manufacture these products, then there is no need for factor movement between both regions. Conversely, in a case where region B is unable to manufacture A-type products, then factor movements from region B to region A can aid as an adjustment mechanism to avoid a reduction of income in region B. Both McKinnon and Mundell arrived at the same result, namely, that factor mobility between regions is a key criterion in the formation of a common currency area.

Kenen (1969), however, went further, explaining and analysing factor mobility as an important criterion in the formation of a currency union. He explained that

"*When regions are defined by their activities, not geographically or politically, perfect interregional labour mobility requires perfect occupational mobility*" (Kenen, 1969:pp 44).

This can only happen when labour quality is consistent among the countries belonging to the currency area or when the countries or their majority have the same skill requirement. Mundell's approach categorically states that the optimum currency area must be geographically small. Kenen (1969) also found another objection to Mundell's thesis when he argued that his regions cannot be found on any geographic map. Instead one must use input-output tables of trade between two regions.

The second most important criterion in the formation of an optimum currency area is the degree of openness. McKinnon (1963) defined this feature as the ratio of tradable to non-tradable goods, (See also Whitman (1967) and Giersch (1970 and 1973). Tradable goods are either import or export goods. He argued that the more open is the economy, the greater is the desire for a fixed exchange rate while a flexible exchange rate is beneficial if the economy is closed. The reasoning behind his theory is that there is a higher possibility that

foreign prices of tradable goods will be transferred to the domestic cost of living when an economy has a high degree of openness. This outcome would lead to a decrease of price illusion where the numerical/face value (nominal value) of money is mistaken for its purchasing power (real value) and exchange rates will depend on prices and wage contracts. This makes changes in the exchange rate less effective with regard to altering the terms of trade and less advantageous as an adjustment mechanism. Hence, a small open economy would find it advantageous to join a larger common currency area (McKinnon 1963). McKinnon (1963) suggested that economies with a high ratio of tradable goods should depend on other instruments like fiscal policy to solve balance of payment problems. In a nutshell, McKinnon's theory stated that a high degree of openness reduces both the efficiency of an independent monetary policy and the usefulness of exchange rate changes as a means of restoring competitiveness, since devaluation rapidly feeds through into domestic prices. This criterion will be examined later in the chapter. Indeed, it will be argued that, instead of it being considered as a criterion for the formation of OCA, countries actually become more open as a result of the currency union because member states tend to trade more with each other.

In his 1969 article, Kenen introduced the theory of product diversification as the third essential criterion in the formation of an OCA. In his previous research, he made it clear that perfect labour mobility does not actually really exist and as such he created this new criterion for situations where the economy has either fixed or flexible exchange rates. Kenen (1969: 49) argued that "…diversity in a nation's product mix, the number of single-product regions contained in a single country, may be more relevant than labour mobility". He also posited that highly diversified countries are more suitable contenders to join currency unions than the less diversified examples because the former are able to renounce exchange rate changes since they are not likely to suffer a recession caused by a shift in demand away from one product group (Presely and Dennis, 1976). He further stated that a well-diversified economy also possesses a diversified export sector and as such the industries are subject to different kinds of shocks. As long as these are uncorrelated, a positive shock from industry A and a negative shock from industry B will lead to a cancellation effect on the total exports, thus making them more stable. Kenen (1969) stated that a well-

diversified national economy will not have to undergo changes in its terms of trade as often as a single-product national economy but also noted that the export sector of a well-diversified economy will be affected if the country/economy is hit by macroeconomic disruption. In the light of this, countries which are adequately diversified are more able to deal with the costs of abandoning their national exchange rates and to benefit from a single currency. However, a diversified economy is a large self-sufficient state which has incomes from various sources and therefore has a smaller export sector than less diversified countries. Since the former has a smaller export sector, changes in the exchange rate have an impact only on a smaller part of the economy, thus eventually producing a lesser overall effect. As such, it could be argued that the less diversified economies must possess a greater degree of openness in order to import goods which they require and export goods in order to obtain funds to pay for their imports. This translates as Kenen's diversification criterion being changed into McKinnon's openness criterion.

Another important criterion in the OCA theory is that of inflation rate similarity. This leads to stability in the terms of trade between the countries, thus resulting in increased trade and current account transactions which could also lower the need for adjustments in nominal exchange rates (Fleming 1971). Fiscal and political integration also play an important role when defining currency unions (Kenen, 1969; Mintz 1970). Mintz (1998) stated that the most significant criterion to consider before a single currency is introduced is the "political will to integrate". A strong political will by the leaders in government supported by the public determines whether or not the currency union will be formed and also its duration. Cohen (2001) confirmed this in his study of seven currency unions and found that political factors actually dominate economic or any other factors in the successful currency unions. Tower and Willet (1976) agreed that political integration is an important criterion when it comes to forming a currency union area, stating that "a successful currency area needs a reasonable degree of compatibility in preferences toward growth, inflation and unemployment and significant ability by policy-makers in trading-off between objectives". Fiscal integration is also viewed as an important criterion when considering whether to adopt or join a common currency area because, if a common fiscal transfer system is in place following monetary integration, it will assist in reducing the

need for adjustments in exchange rates after a shock since the fiscal integration will aid the country affected by the shock.

Although the main contributors to the traditional theory of OCA include Mundell (1961), McKinnon (1963) and Kenen (1969), there are other authors, referred to as second wave, deserve mention when reviewing OCA literature. They include Corden (1972), Mundell (1973) and Ishiyama (1975).

All the theories and literature examined above are referred to as the traditional views or theories of the OCA. These are relevant when defining or determining the economic conditions necessary for monetary integration. Figure 2.2 summarises the criteria necessary for the formation of an Optimum Currency Area according to the traditional approach and a table explaining the effects of these criteria.

Figure 2.2: Major Conditions for the Formation of an OCA

Fiscal Integration
Kenen (1969)

Political and Financial Integration
Kenen (1969)

Inflation Rate Similarities
Fleming (1971)

OCA

Price and Wage Flexibility
Mundell (1961)

Degree of Economic Openness
McKinnon (1963)

Diversification in Products
Kenen(1969)

Mobility of Factors of Production + Labour
Mundell (1961)
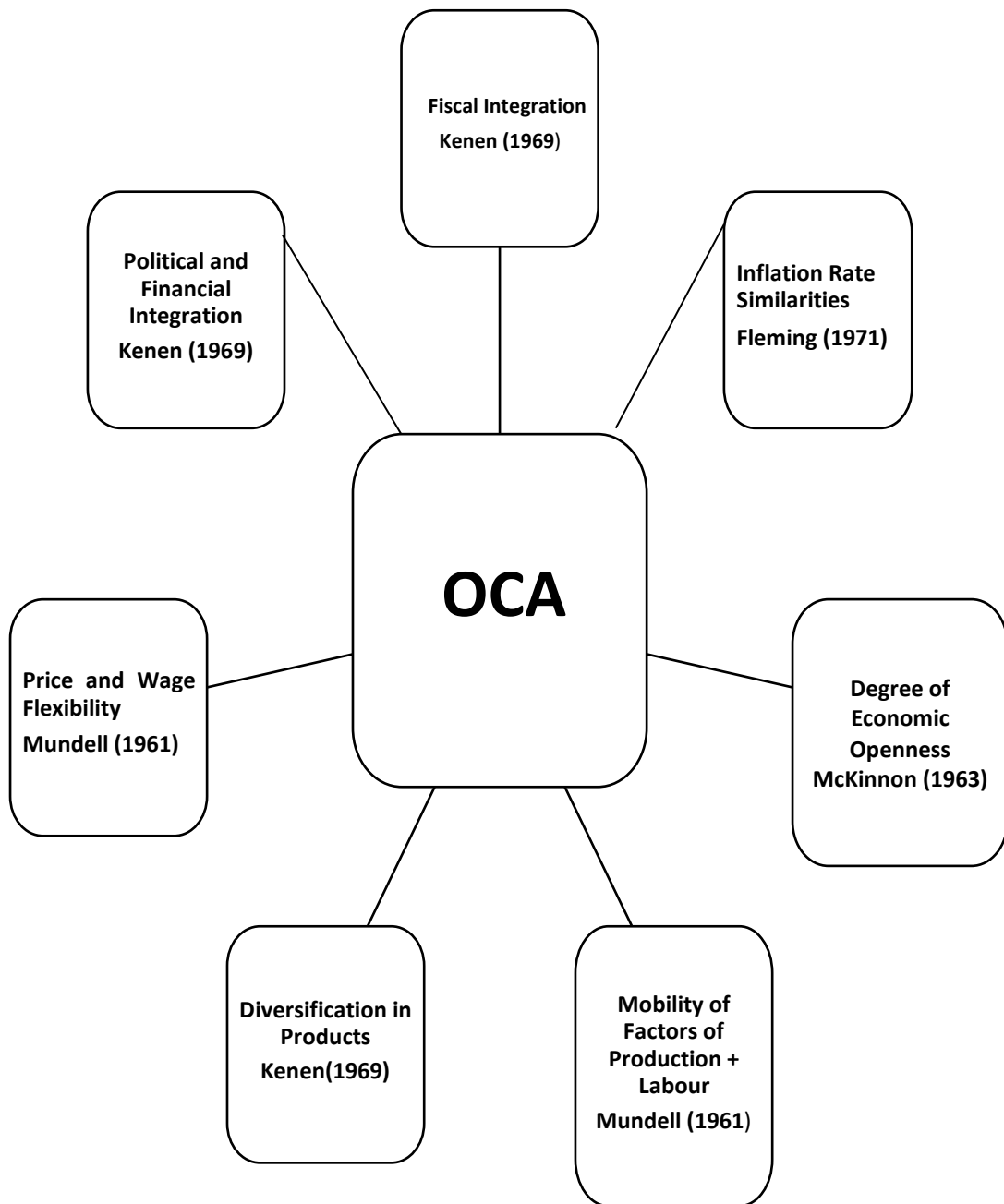
Source: Author

Table 2.1   The Most Important Features of OCA's

Variables	Effects
Mobility of Factors of Production	Countries which experience great mobility of production factors amongst themselves are likely to form or join a common currency area.
Openness	The more open is a country's economy, the stronger is that country's case for forming or joining a common currency.
Size	The larger is a country, the more attractive is a flexible exchange rate.
Specialisation	A country has a greater chance of meeting the criteria for monetary union membership ex ante than ex post due to increased specialisation of the countries forming the area.
Wage and Price Flexibility	It will be easier to overcome asymmetric shocks if there is wage and price flexibility in a common currency region. This feature will also make the common currency more stable.
Diversification	A more diversified economy is preferred to a less diversified economy when forming a common currency area.
Inflation Differential	It is more difficult to maintain a fixed exchange rate among countries if their inflation rates are not similar.
Usefulness of Money	An advantage of membership of a common currency area is that it enhances the usefulness of money. This effect, however, is more apparent in smaller and more open countries
Endogeneity	A country is more likely to join or adopt a common currency area ex post than ex ante due to increased business cycle correlation.

Source: Broz, (2005), "The Theory of Optimum Currency Areas: A Literature Review". *Economic Trends and Economic Policy. Vol. 15, no. 104. pp 53-78.*

2.3   Criticisms of the Traditional Approach of OCA

As pointed out earlier, the traditional theory of OCA alluded to several criteria which countries must meet in order to be able to form a currency union. While they are viewed as important in the literature, in reality these theories lack predictive power and have been termed difficult to measure. In 1999, the eleven European countries which formed a currency union did not meet the criteria highlighted by the OCA theory, compared to the regions in the United States. However, this did not present the reality. Tavlas (2003) explained that the issue with the theory is the fact that *"the attributes by which the optimality is judged doesn't have to all point in the same direction".* He went on to further explain that, although an economy might be considered open, thus suggesting a preference for the use of a single currency, it may also have a low degree of factor mobility with its bordering countries, implying that flexible exchange rates are desirable. The problem regarding the inconclusiveness of the OCA theory is made worse with the fact that the criteria are occasionally immeasurable and cannot be weighed against each other (Robson, 1987). Also the early OCA theory could not have projected the increasing significance of the services sector in post-industrialised economies. The services sector is by its nature more diversified, diffused and fragmented. This renders European economies more similar than just looking at their manufacturing sectors. (Mongelli 2008). Also on the topic of projection, the early OCA theory would not have been able to foretell the pervasive role of institutions in hindering product and labour market flexibility and mobility. In summary the traditional OCA theory was more interested in the assessment of the achievability of a monetary union based on the ability of a country to absorb economic shocks. This is viewed as being static as it assumes, for example, a given level of labour mobility or openness (Tavlas, 2004). Figure 2.3 summarises the weaknesses and limitations of the OCA criteria according to Torsten (1995).   A different approach which can be used as an alternative to meeting the OCA criteria is to assess the advantages and disadvantages of forming and/or joining a monetary union (these will be analysed in Section 2.8). This is more practical and relevant and also casts more light onto the European Monetary Union (EMU) in particular.

Figure 2.3 Criticisms of the OCA Criteria

It is based on fictitious assumptions, this makes the theory non-operational.

Underestimates the Advantages of sharing a common currency

OCA criteria are difficult to measure unambiguously

It overlooks the fact that "exchange rate developments might be dominated by speculative

Criticisms of the OCA Criteria

Difficulty in evaluating the OCA criteria against each other

It lacks operational indicators for openness, factor mobility and diversification and the assumption of the "money illusion" when measuring wage and price flexibility is unrealistic.

It is static, in that it does not consider possible changes in the behaviour of economic agents consequent upon the formation of a common currency area

Source: Author

2.4 EMU as an Optimum Currency Area

2.4.1 The Concept of Monetary Union

Broadly speaking, a monetary union occurs when different countries agree to share the same currency. Gros and Thygesen (1998) further define this concept as a comprehensive liberalisation of capital transactions and full integration of banking and other financial markets together with the removal of exchange rate fluctuations and the irrevocable locking of exchange rate parties. It is therefore important to note the difference between a monetary union, a

currency board and a fixed exchange rate regime. A fixed exchange rate regime can be defined as an exchange rate system where the value of the country's currency is either pegged to the value of another common currency (e.g. the US dollar, euro), to a basket of other currencies or in some cases to a measure of value, e.g. gold. In this system, the pegged currency rate changes according to the fluctuations of the reference value. A currency board on the other hand can be defined as a monetary authority, for example a central bank that is aimed at maintaining a fixed exchange rate with a foreign currency. The benefit of a currency board system is that issues of currency fluctuations no longer apply between the countries. While the disadvantages are firstly, that the country will lose its ability to set its monetary policy according to other domestic concerns and secondly, that the fixed exchange rate will fix a country's terms of trade, regardless of the economic dissimilarities between the country and its trading partners.

The creation of a single currency in Europe represents a major and unique phenomenon in the world economy. Europe's monetary unification process started in 1979 with the creation of the European Monetary System (EMS) but it took another 20 years for the single currency to be introduced. The introduction of the euro as a single currency used for all transactions by 12 countries in 2002 brought about debate amongst researchers as to whether or not the Eurozone satisfied the relevant criteria argued by the OCA theory. The suitability of countries coming together to form a currency union is based on certain factors which are linked to the economic integration of the countries involved. These factors, mentioned in the previous section and highlighted in Figure 2.2, were motivated by Mundell (1961 and 1973), McKinnon (1963), Kenen (1969), Corden (1972) and Tavlas (1994) and will be used in this section to address the issue of whether the Eurozone is an Optimum Currency Area.

2.5 The Eurozone as an Optimal Currency Area

In this section, existing data of the economic variables will be used to describe the current situation within the eighteen countries in the euro area for comparison with the aforementioned OCA criteria for optimal currency

integration. The eurozone refers to all the countries in Europe that have adopted the euro as their national currency. In order to find out if the euro zone is an optimal currency area, the theoretical OCA criteria will be evaluated for a period of twelve years between 2001 and 2012 inclusive.

It will also be taken into consideration that the EMU is a part of the larger process of European integration and therefore it will be evaluated as such. Frankel's (1999) OCA line will be used to explain the OCA criteria of economic integration (openness), income correlation within the currency area and flexibility of the Euro zone as a currency union.

2.5.1 Trade Intensity[14]

Countries are more likely to form a currency union if there is a high degree of trade among them. Therefore, when examining the possibility of joining a currency area from a trade perspective, the advantages are clear. Countries trading extensively with each other would stand to benefit immediately from sharing a single currency due to increased efficiency from decreased currency arbitrage opportunities and the elimination of foreign exchange transaction costs. The Eurozone countries have enough evidence to prove that they satisfy this factor of the OCA. Rose and van Wincoop (2001) analysed the effects of the EMU on intra –European trade and showed that the single currency will boost trade within the Eurozone by a growth of 50%. Bun and Klaassen (2002) also arrived at a similar conclusion estimating the trade growth effects to be approximately 40%.

2.5.2 Labour Mobility

According to Mundell (1961) mobility of capital and labour is one of the major criteria needed for a common currency area to be formed. Capital mobility has increased across various economies due to globalisation and the European Union has been no exception as it experiences high mobility of capital and

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[14] This will be discussed in more detail in Chapter 4

integrated financial markets[15]. This section will therefore focus on labour mobility as the criterion for a currency union formation. Mongelli (2002) conducted a study on the suitability of the Eurozone countries for forming a currency union and arrived at the conclusion that the countries were lacking in some of the important decisive factors. He stated that labour mobility across the EU countries and the Eurozone countries was quite low. The creation of the European Union's Single Market in 1992 led to the freedom of movement of people, goods, services and capital. However, labour mobility within Europe remains quite low when compared to the United States. This is mainly due to cultural, historical and language differences among the member countries, thereby discouraging people from moving from countries with unemployment issues to others. The comparison of labour mobility between Europe and the US started long before the creation of the currency union in 1999 and the results always indicate that labour mobility(in response to shocks such as unemployment) is less in Europe than in America. However, a recent study from OECD (2014)[16] provided facts that the 'migration reaction to an unemployment shock has become stronger in Europe than in the US. This change was attributed to the eastern and central European countries that have joined the European Union bringing the total number of EU member countries to 28. Regrettably labour mobility within the euro zone is very low compared to other parts of Europe. More than the rest of the EU the euro zone requires more mobility of labour in order to make adjustment to economic shocks less severe. The OECD report however fails to find any change between 2006 and 2011 in the responsiveness of migration to unemployment within the 18 countries of the euro zone.

From Figure 2.4, it is clear that the eurozone does not have the degree of labour mobility as intended by the EU Commission. The graph shows the total number of European citizens living (and working) in member states other than their own countries. It shows a large number of European migrants in Germany, Spain, France and Italy. Figure 2.5 on the other hand, using the same data,

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[15] Issing (2000) also observed that the financial markets in the Eurozone were more integrated as a result of fewer opportunities for currency arbitrage and reduced interest rate differentials

[16] Jauer, J., Liebig, T., Martin, J. P., & Puhani, P. A. (2014). *Migration as an adjustment mechanism in the crisis? A comparison of Europe and the United States* (No. 7921). IZA Discussion Paper.

shows the percentage of the total population that are migrants. Looking at both figures, Germany has almost 3million EU foreigners but the percentage of the foreigners to the total population is less than 5% and is not so significant for the country's labour force. It is the same for Spain, France and Italy. Vrnakova and Batuskova (2013) noted that the high percentage rates achieved for Belgium are as a result of the large number of foreigners employed by the European institutions based there and attributed Luxemburg's high percentage to a historical progress rather than high labour mobility.

Figure 2.4 Populations of Foreign Citizens 2012
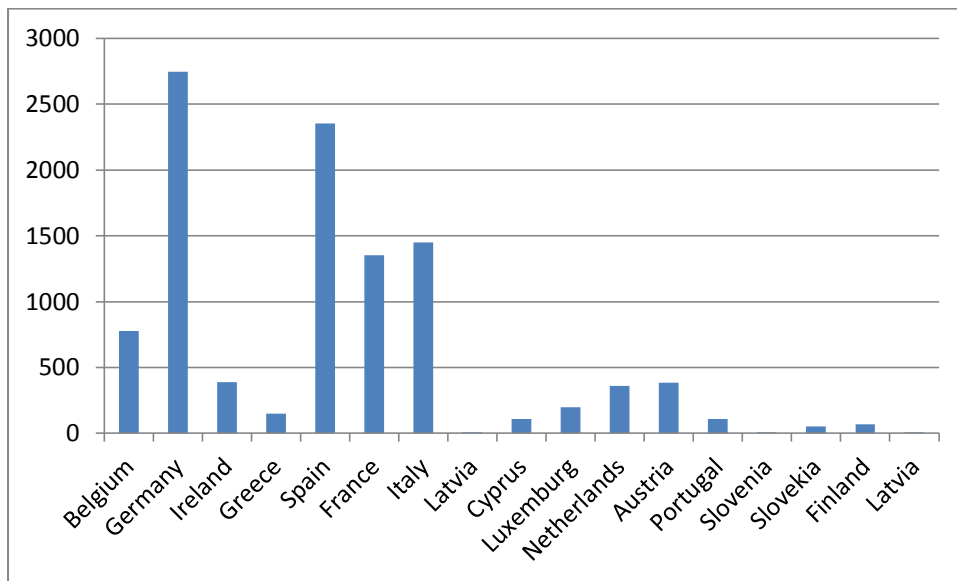
Source- Europe in Figures: Eurostat year book 2012

*population figures in thousands

Figure 2.5 Percentage (%) of EU Citizens living in other EU Countries
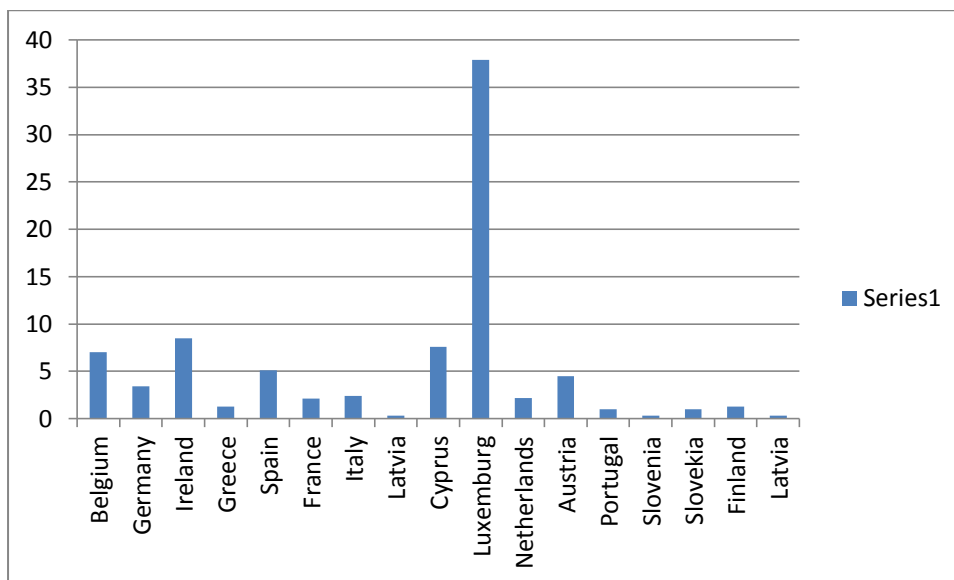
Source- Europe in Figures: Eurostat year book 2012

2.5.3 Wage and Price Flexibility

Economic literature proposes that, in the absence of independent monetary and exchange policies within monetary unions, wage flexibility is an important adjustment channel to asymmetric shocks particularly when labour mobility is limited, Heinz, F and Rusinova, D. (2011). Price and wage flexibility can be defined as the rate by which real wages and prices respond to macroeconomic conditions. This can therefore be measured as the responsiveness of real wages and prices to shocks, usually measured as unemployment and inflation variations. In Europe, wages and prices are not very flexible with member countries experiencing increasing wage costs annually. In 2013, the average hourly labour costs in Europe (EU28) were approximately €23.4 and €28.0 in the euro zone. However, this estimate covers the differences between the member states, with hourly labour costs ranging from €3.7 in Bulgaria, €4.4 in Romania, €5.8 in Lithuania and €6.0 in Latvia, to €39.0 in Sweden, €40.1 in Denmark, €37.2 in Belgium, €34.6 in Luxembourg, €12.4 in Portugal, €31.3 in Germany, €21.0 in Spain and €34.2 in France.

Figure 2.6 Inflation in Europe
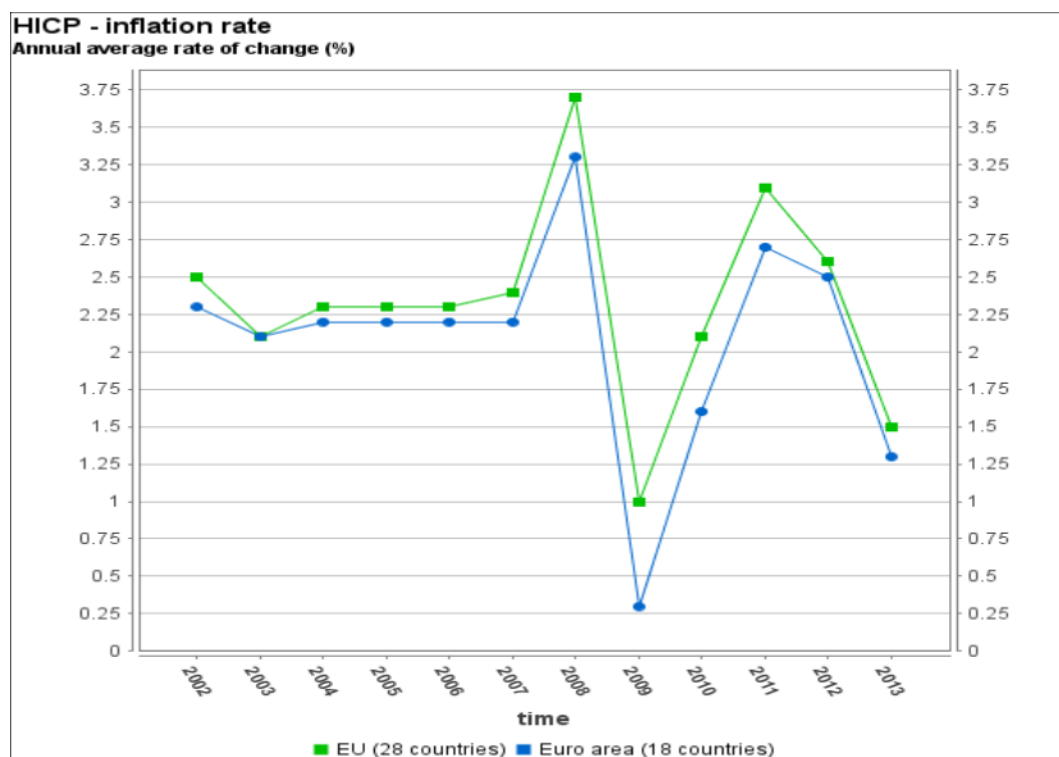
Source: Eurostat

The euro area inflation rate[17]   was estimated at 1.3 % p.a at the beginning of 2013. Between 2002 and 2013 as shown in Figure 2.6, the average euro zone inflation rate was 2.5% p.a with the highest point being 3.3% p.a in 2008. Fleming (1971) states that when countries have similar inflation rates over a period of time, the terms of trade between them will be stable and therefore encourage further trade volume between them and decrease the need for nominal exchange rate adjustments. In Europe, this OCA criterion should be achievable as the membership of the Exchange Rate Mechanism (ERM) encouraged the countries to adapt their economic strategies to achieve similar inflation rates at the cost of persistently high unemployment across most of the continent. However, it is evident from Figure 2.6 that, despite the strict anti-inflation policy applied by the European Central Bank, differences between the countries' inflation rates still exist. These reflect the varied economic conditions existing in the countries, income differences, tax variations etc. which point to a lack of fiscal union.

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[17] Inflation rate records a general rise in prices measured against a standard level of purchasing power

2.5.4 Economic Openness

McKinnon's (1963) study was centred on analysing the openness of a country as a share of tradable and non- tradable goods. He stated that a country with a high degree of openness is more likely to experience changes in the international prices of tradable goods which will then be transferred to the domestic cost of living. This would in turn reduce the potential for money and/or exchange rate illusion to be viewed by wage earners. (McKinnon, (1963). This OCA criterion according to Mongelli (2008) should be measured in different ways such as the total openness of an economy to trade with all other countries of the world; the level of openness with the other member countries which share a single currency; the share of tradable versus non-tradable goods and services in production and consumption; and the marginal propensity to import. The openness of a country measures the country's integration and is calculated as the average ratio of total exports and imports of both goods and services to GDP. A large number of the EMU member countries meet the openness criterion, as they have been able to show an increased average in the ratios of exports and imports to GDP. Mongelli (2008) noted that in terms of openness, the euro zone is comparable to the US because it is more closed as a whole than each of its member countries. There are concerns that the euro zone will gradually become less open as trade will be diverted from non-member countries to the member countries. There is some evidence from the euro- trade effect literature of trade diversion taking place although at a small pace could eventually lead to a reduction in the degree of openness of the whole euro area.

2.5.5 Economic Integration, Flexibility and Income Correlation

Mongelli and Vega (2006) conducted a closer examination of the variations in the OCA rating with the help of the OCA line motivated by Frankel (1999). Their focus was based on the three main dimensions of economic integration, income correlation and country flexibility. The first two are very important when assessing the benefits gained from a currency union. The authors argued that "*Countries that share a high level of either openness or*

income correlation amongst themselves will find it advantageous ceteris paribus using a single currency". Members of a monetary union are expected to experience macroeconomic shocks which are suitably correlated with those experienced in the rest of the union (*Income correlation*). Secondly, the member states should have sufficient *flexibility* in the labour markets to be able to adjust to asymmetric shocks once they are part of the union. Finally the member countries should possess an adequate degree of trade *integration* with the other members of the union in order to achieve the full benefits of using the same currency. (De Grauwe, 2006)

This trade-off is explained by the downward sloping "OCA line" in Figure 2.6.

The OCA- line indicates the gathering of all combinations of symmetry and economic integration among the countries for which the advantages and disadvantages of a currency union are in balance. The downward sloping line results from the fact that a decline in symmetry leads to an increase in the costs within the monetary union. These costs, which are normally macroeconomic in nature, arise because the loss of a national monetary policy instrument is more costly as the degree of asymmetry increases. Integration is a foundation of the benefits of a monetary union. The greater is the degree of integration, the more are the member countries likely to benefit from the efficiency gains of a monetary union. Therefore, any extra macroeconomic costs created by less symmetry can be compensated by further microeconomic benefits brought about by more integration (Mongelli and Vega, 2006).

Figure 2.7: The Integration, Income Correlation and the Optimum Currency Area
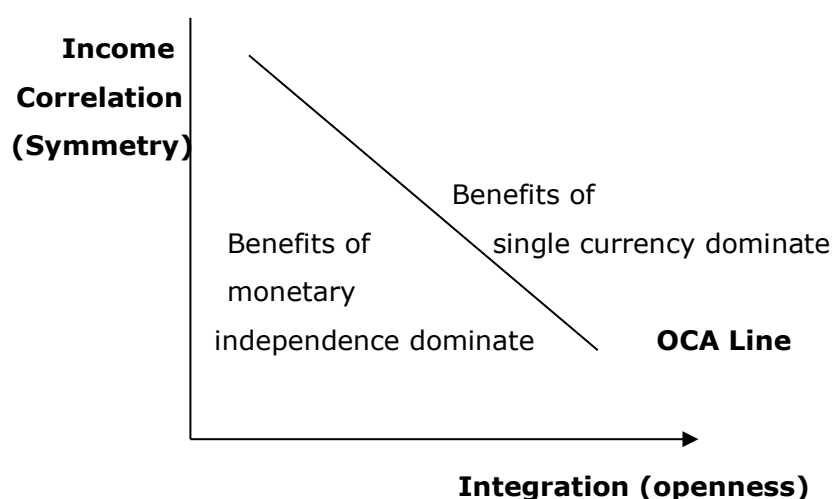
Source – Frankel (1999) OCA - line

Points on the right hand side of the graph indicate that the countries will benefit from a monetary union. De Grauwe (2006) and Mongelli and Vega (2006) both agree that the US and the euro zone countries will fall on the right side of the graph indicating that they stand to gain more than they would lose from forming a monetary union. This is due to a belief that the microeconomic benefits of monetary union offset any macroeconomic costs experienced. The authors also asserted that the EU countries would be located to the left of the OCA-line. This conclusion was reached based on the fact that despite the level of integration attained within the EU, there is very little flexibility and too much asymmetry between the EU countries to form a currency union and therefore the countries would not benefit from the efficiency gains of forming a currency union. However, the extent of economic integration and income correlation evolves over time and this evolution can be viewed in different ways. Most authors agree that economic integration increases among countries sharing a single currency, although there is disagreement regarding the extent to which the income correlation evolves. Depending on the degree of this evolution, the monetary union will need more flexibility.

The degree of overall flexibility[18] is another significant aspect used to review the benefits of monetary integration. Figure 2.8 shows the trade-off between flexibility and symmetry. The points on the OCA-line show the various combinations of income symmetry and flexibility for which the costs and the benefits of a monetary union are balanced. The line is negatively sloped because as the level of symmetry decreases, there is a need for an increase in flexibility (which is a source of benefit of a monetary union) in order to remain on the OCA line. To the right of the OCA-line, the benefits of the union exceed the costs and to the left there is insufficient flexibility for any given level of symmetry.

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[18] Flexibility, in this context captures price and wage flexibility, mobility of labour and other factors of production which make the economy more adaptable. Mongelli and Vega (2006)

Figure 2.8: Symmetry, Flexibility and Optimum Currency Area
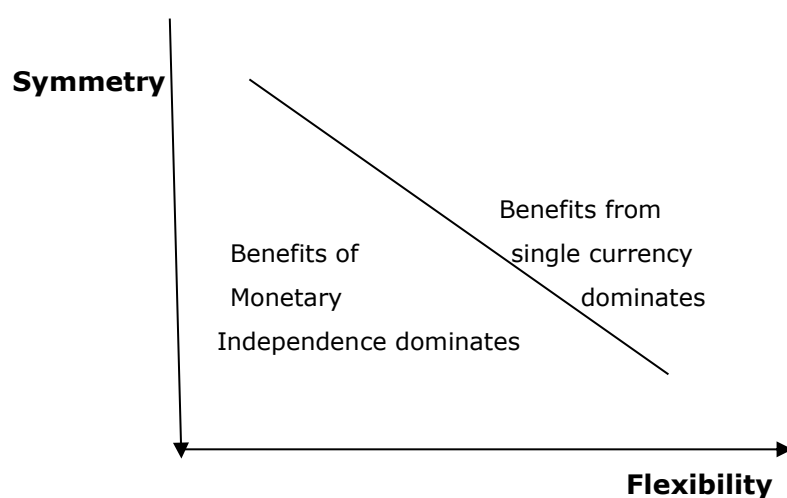
Source – Frankel (1999)

In summary,

- In the Eurozone, price and wage flexibility is considered to be low. Although there have been slight improvements in flexibility, there remains an additional need for structural reforms.
- In comparison with the United States, the member countries of the Eurozone are much more diversified and homogeneous. Mongelli (2002) stressed that within all European countries there is a high level of economic openness as well as high diversification in production.
- Issing (2000) also observed that the financial markets in the Eurozone were more integrated as a result of fewer opportunities for currency arbitrage and reduced interest rate differentials.
- Inflation rates in the Eurozone are currently at levels which are consistent with price stability.
- There is an absence of a fiscal union in the eurozone.

From the summary above, it is clear that the Eurozone is not an optimum currency area although it possesses some important OCA criteria. With this said however, it should be noted that the reasons behind the creation of the single currency were not purely economic but also political. Unfortunately, discussion of

these complex political reasons falls outside the scope of this thesis, although its importance and influencing power should not be neglected.

Bayoumi and Eichengreen (1993) argued that the Eurozone *ex ante* was not an optimum currency area, while Frankel and Rose (1997) predicted that countries coming together to form the European single currency may not satisfy the OCA criteria *ex ante* but would likely meet most of them *ex post*. Jean-Claude Trichet (2006) agreed with Frankel and Rose, stating that the optimality of a currency area need not be fully met before its creation the region may become an optimum currency area as a result of the formation of the currency union, which may be the case with the Eurozone.

While the Eurozone ex ante did not satisfy the OCA criteria and thus cannot be called an optimum currency area, it is clear that the Eurozone ex post has seen major advancements in intra-regional trade, financial integration and convergence of inflation rates, while there have also been major changes regarding the optimality issue for the Eurozone. There remains some expectation that the single currency will bring the member countries even closer by satisfying the OCA criteria over time.

2.6   An Examination of Integration of Europe

2.6.1 Introduction

A great deal of research has been carried out regarding the integration in Europe. Over time, this research interest has evolved. During the early 1950s and 1960s, the debates and discussion centred on the theories of European integration, with particular attention paid to the impact of this on the customs union agreement. (See Viner (1950), Meade (1955), Lipsey and Lancaster (1956), and Haberler (1964). In the 1970s and early 1980s, the focus shifted to understanding the effect of this integration on different economic activities, for example, agriculture, social effects etc. (See Shibata (1971), Grubel and Lloyd (1975) and Robson (1989). From the late 1990s to date, the main focus has been on monetary integration.(See DeGrauwe (2005) and Mongelli (2002). Different authors have defined economic integration in different ways although

the fundamental idea behind economic integration is that it involves the gradual eradication of economic boundaries between the member states (Balassa, 1961; Robson, 1989; Molle, 2001; Tsoukahs, 2003; Wallace and Wallace, 2003; Jovanovic, 2005). However, Balassa (1961) further expanded on this definition of economic integration, explaining that it is a 'voluntary process where the relationship between countries, although separated by area, intensifies and this integration could occur at different levels. He pointed out four different degrees of economic integration namely Free Trade Areas, Customs Union, Common Market and Economic and Monetary Union. This led to a growth in research in this field, with Hodgson and Herander (1993) adding another level of integration with the Preferential Trading Agreement. This occurs when trade restrictions are decreased between member countries but a high level of restrictions on goods imported from non-member countries is monitored. El- Agran (2004) further expanded this list to include a sixth type of economic integration known as political union. Table 2.3 summarises the characteristics of the different types of economic integration mentioned above

Table 2. 2 General Characteristics of Economic Integration

	Reduction of Trade Barriers	Removal of Tariff Barriers to Trade	Common External Tariff	Free Movement of goods & Labour	Monetary and Fiscal Unification	Central Parliament
Preferential Trading Agreement	❖					
Free Trade Area	❖	❖				
Custom Union	❖	❖	❖			
Common Market	❖	❖	❖	❖		
Economic and Monetary Union	❖	❖	❖	❖	❖	❖
Political Union	❖	❖	❖	❖	❖	❖

Source – IMF (1998)

There has been a great deal of empirical literature on the theory of economic integration since the concept was put forward over fifty years ago by pioneering authors such as Viner (1950), Lipsey (1957) and Balassa (1961). This research agrees with existing literature that the effects of economic integration are dependent on its form and should therefore be assessed within the context in which it occurs. For the interest of this study, the level of economic integration analysed is the Economic and Monetary Union (EMU). The economic integration in Europe is viewed as the most daring attempt to date, with many large countries coming together to increase both their political and economic relationships. Europe has already achieved a great deal of success when integrating its member countries and is currently working on fortifying the Economic and Monetary Union (Cardoso et al. 2006). The EMU therefore provides a solid benchmark to study the effects of its formation on both aggregate and sectoral trade, with the latter being is the main interest of this research. It is important that the historical background of integration in Europe is understood in order to appreciate the efforts which were necessary to achieve the current level of integration. The scope of this thesis does not stretch to a detailed step by step description of European integration as this would need a whole study of its own. With this said however, a brief summary of the major steps and processes involved in the integration, which have subsequently led to the creation of the monetary union, is now offered.

2.6.2   History of European Monetary Union

The monetary union in Europe in 1999 represented the first time in economic and political history that 11 separate countries came together to form a single monetary union while abandoning their national currencies to adopt a single currency of the euro. It is therefore not possible to understate the beginning of a new economic era in Europe (Bordo and Jonung, 1997). The European Union's single market, which is also referred to as the *"internal market",* is an economic entity established primarily for the promotion of economic integration through free trade within the EU in goods, services and labour. (Viner, 1950; Meade, 1955; Balassa, 1961; Cecchini, 1988). The theoretical underpinnings of the single European market embrace two

complimentary concepts, namely, economic union and monetary union, derived respectively from theories of international trade and of optimal currency areas (Balassa, 1961, Mundell, 1961; McKinnon, 1963; Krugman, 1991).

Economic integration can be defined as both a process and a state of affairs. When defined as a process it includes measures which are set to abolish any form of discrimination between economic units belonging to different countries. Economic integration, defined as a state of affairs, refers to the fact that the countries are devoid of all forms of discrimination (Balassa, 1991: 173-4). These definitions of economic integration are from the work of Viner (1950) and Meade (1955), while the static and the dynamic aspects of economic integration as a historic event and an on-going process are both encased. Economic integration, as explained, is capable of liberating resources for alternative productive uses, thereby increasing investment in the economy. This is the fundamental criterion of economic gain (European Commission, 1988: 17).

It has been noted by many scholars that European integration started several decades ago. Bieler, (2008) discussed between 1919 and 1945 the experience of Europe and the major challenges to its economic status. World War II was also a challenge to the European market because it led to huge disunity among the major countries. This led, in turn, to huge competition within the market and the depletion of the smaller countries in terms of economic supremacy. With the war coming to an end, the continent had reached exhaustion due to the huge divisions within the economic market. After the war, the continent established a huge potential for unity with the establishment of major political parties across the globe. France and Italy were among the leading countries which had experienced political instability and a growth of powerful political parties. The respective parties established a new meaning, to and a need for, integration among the European countries. In fact, they were regarded as having been a major example of dealing with the problems experienced in the post-war period. During this period the need to establish a politically and economically united Europe increased among major countries and acted as the major roots for integration.

The creation of the European monetary union began well before the treaties which established the European Community (EU) after the Second World War were agreed. EMU's historical background can be traced to political negotiations stretching from 1969 through 1979 until 1989. These eventually bore fruit ten years later in 1999 with the establishment of a monetary and economic union.

Ever since the Treaty of Rome in 1957, whereby a Common European market was declared as an objective, Europe has been steadily moving towards a common currency. Pelkmans (2001) explained that the Treaty reformulated its economic aims to be the following;

- Harmonious and balanced development of economic activities;
- Sustainable and non-inflationary growth, respecting the environment;
- High degree of convergence of economic performance;
- High levels of employment and of social protection;
- The raising of the standard of living and the quality of life;
- Economic and social cohesion and solidarity among member states

In order for these aims to be achieved, the Treaty of Rome made provisions for the establishment of a customs union, a common market and the development of common policies. Beginning in 1958, six European countries formed a Customs Union, which is a series of trade agreements whereby a group of countries charge a common set of tariffs on imports from the rest of the world while granting free trade among the member countries. (A free trade zone with common external tariffs is a Custom Union). They applied a single commercial policy with common external tariffs on imports, although integration of economic policy was minimal (Chernotsky, 2002).

Europe was devastated and divided following the conclusion of World War II and the people were wary and uncertain regarding the future, thus leading to the establishment of the European Coal and Steel Community (ECSC) in 1952 by the Treaty of Paris in 1951. The ECSC was formed by the six countries of Belgium, France, Germany, Italy, Luxemburg and the Netherlands as a common market where tariffs were eliminated between the member countries when buying and selling steel and coal.

In March 1957, the member countries of the ECSC signed two more treaties, forming the European Economic Community (EEC) and the European Atomic Energy Community (EURATOM) due to the success of the ECSC and the benefits offered by this customs union to the member states. The latter created a common market for atomic energy while the former created a customs union and common market for all other commodities.

In 1958, the European Commission established the Monetary Committee as an advisory body to the Council of Ministers of Economics and Finance (ECOFIN). In 1964, the Committee of the Central Bank Governors was established as part of the grand plan by the Commission, with the aim of achieving the formation of a monetary union. In 1970, the Werner Report was presented by the Heads of States of the European Commission, recommending that the monetary union could be formed within ten years. This was to be achieved in three stages.

The first stage was to see the EC governments coordinating the fiscal and monetary policies of their countries, thereby reducing exchange rate variability to less than +/- 1% of the rates as authorised by the International Monetary Fund (IMF) under the Bretton Woods System in 1944. This stage was intended to last for three years. The second stage would lead to the formation of the European Monetary Cooperation Fund (EMCF), which would assist the governments in stabilising the foreign exchange markets. In the last stage the exchange rates were to be fixed and the EC countries would coordinate their national fiscal policies, thus leading to substantial increases in the EC budget.

Due to the breakup of the Bretton Woods System in the early 1970s however, this was not possible, and on 13th March 1979, the European Monetary System (EMS) became effective. The three main components of this system were:

1.   The Exchange Rate Mechanism (ERM) - Its main objective was to permanently reduce exchange rate variability with the aim to achieve monetary stability, control inflation and encourage trade across Europe in anticipation of an Economic and Monetary Union (EMU) and the introduction of the common currency.

2.   The European Currency Unit –The ECU was a currency basket that serves both as a unit of account for official EU business and as the numeraire for

the European Monetary System (Atkin, 1998). The value of the ECU was calculated by converting fixed amounts of the currencies of the 12 countries into a common single reference currency. These countries included Belgium, Germany, Denmark, Spain, France, Great Britain, Greece, Ireland Italy, Luxemburg, the Netherlands and Portugal.In 1999, the exchange rates of the participating currencies were irrevocably set and eleven currencies became sub divisions of the euro. Although the UK and Denmark were in the ECU basket of currencies, they declined to join the eurozone, while Greece adopted the currency at a later date in 2001. Finland and Austria adopted the euro from the beginning but their currencies were not part of the ECU basket because they joined the European Union in 1995, two years after the ECU composition was frozen. The ECU was seen to be a very important step in the introduction and development of the Euro and as such the official ECU was converted at the rate of 1:1 to the Euro in January 1999. Indeed, the national currencies of the countries joining the euro were fixed against the euro on the same date. These locked rates were very important to the business sector as they helped companies to determine the euro value of existing financial assets and liabilities while also aiding them in denominating their prices in the new single currency.

3. The European Monetary Cooperation Fund (EMCF) – This was established to aid the weaker currencies. Each country contributed 20% of their gold and gross dollar reserves to the EMCF in exchange for readily available credit facilities which were denominated in ECUs, meaning that countries with troubled exchange rates could then borrow from the reserves and thus intervene in the foreign exchange market by buying back their own currencies.

The EMS was successful and the inflation rates were significantly reduced and converged due to the measures taken by high inflation countries in the ERM to adhere to the German Bundesbank's policies (Zestos, 2006). Following this came the approval of the Maastricht Treaty by the heads of governments of the states in December 1991. The treaty was signed on 7th February 1992 by the heads of the European Community in Maastricht, Netherlands for achieving complete European Monetary Union near the end of the millennium. In Article 2 of the Maastricht Treaty the main goals were stated as:

"The Community will be tasked with establishing a common market and an economic and monetary union and also through the implementation of the common policies". (Treaty of EU, article 2)

The summary of the Maastricht Convergence criteria are as follows:

- *Price stability: Inflation less than one and a half percentage points above three best performing Member States (at present would require inflation to be below 3.1 per cent)*
- *Sustainable public finances: Government deficit less than 3 per cent of GDP and government debt less than 60 per cent of GDP*
- *Durability of convergence: Long-term interest rate less than two percentage points above the three best performing member states in terms of price stability (at present this would require the long-term rate to be below 5.8 per cent)*
- *Exchange rate stability: Stable exchange rate against the euro as allowed for in ERM II, without severe tensions or devaluation against the euro*
- *Compatibility of national law with Treaty provisions: This refers to compatibility of national legislation with Articles 130 and 131 of the Treaty and the Statute of the ESCB/ ECB and covers central bank independence, prohibition of monetary financing and legal integration of national central banks in the Euro system.*

Source: www.ecb.int/ecb/orga/escb/html/convergence-criteria.en.html

1st January 1999 saw 11 European countries enter into the third stage of the European Monetary Union (EMU) where a new currency of 'The Euro' replaced the national currencies of the individual countries involved and the Euro system was formed. It consisted of the European Central Bank (ECB) plus the national central banks of the countries which adopted the euro and was responsible for monetary policy within the whole euro area. The single countries' governments remained in charge of fiscal policy under the binding constraints of the Stability and Growth Pact. In order for the countries to be a part of the monetary union (EMU), countries must meet strict criteria as stated in the 1992 Maastricht Treaty. The five key goals of the treaty are to -

- strengthen the democratic legitimacy of the institutions;

- improve the effectiveness of the institutions;
- establish economic and monetary union;
- develop the Community social dimension;
- establish a common foreign and security policy.

In 1999, the exchange rates of the participating currencies were irrevocably set and 11 currencies became sub-divisions of the euro. Until January 2002, the euro was used only as a unit of account for wholesale financial transactions between institutions. The last step was the introduction of euro notes and coins in January 2002 when the countries' original currencies were then taken out of circulation. Since then, the euro has been the only currency used in the Eurozone by the 18 countries of Belgium, Germany, Ireland, Spain, France, Italy, Luxemburg, Netherlands, Austria, Portugal, Finland, Greece, Slovenia, Cyprus, Malta, Slovakia, Estonia and Latvia. The new currency, along with a new European Central Bank (ECB), became the monetary system of the European Community.

EMU ACCESSION OF MEMBER COUNTRIES

1999 - Introduction of the Euro as a wholesale electronic currency in the countries of- Belgium, Germany, Eire, Spain, France, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland.

(The United Kingdom, Sweden and Denmark refused to join the single currency)

2001 Greece

2002 Introduction of Euro banknotes and coins for retail use

2007 Slovenia

2008 Cyprus, Malta

2009 Slovakia

2011 Estonia

2014 Latvia

2.7   Costs and Benefits of EMU Participation

The adoption of Europe's single currency has been tagged the world's most daring effort in terms of different countries coming together to reap the benefits of using a single currency. On 1st January 1999, 11 European countries[19] adopted the euro as their national currency, thereby agreeing to form and be a part of the European Monetary Union (EMU). Two years later, Greece joined the Eurozone by adopting the euro as the national currency. By 1st January 2002, all the member countries had completely abandoned their national currencies and the euro notes and coins were circulated within and among the Eurozone countries. Between 2007 and 2014, an additional six countries[20] joined the Eurozone and willingly replaced their national currencies with the euro. Taking into consideration the conditions[21] which countries must meet before qualifying to form a monetary union, the EMU countries do not have the necessary ingredients of, for example, the United States (De Grauwe, 2003). Despite this however, today the EMU is a reality.

Ever since plans were announced for the creation of Europe's monetary union, many studies have been analysing the potential costs and benefits of its introduction. Indeed, Artis (1991), Emerson (1992), Alesina and Grilli, (1993), Hallett and Vines (1993), Cohen (1998), Molle (2001), Pelkmans (2001), Redwood (2001), Dornbush (2002), Mongelli (2002), El-Agraa (2004), Leblond (2004), Tavlas (2004), Ratz and Hinek (2005), and De Grauwe (2012) are just a few of the authors to have analysed the costs and benefits of the monetary union.

In Section 2.3 where the weaknesses of the traditional OCA theory was discussed, it was mentioned that the modern approach is based on the analysis of the costs and benefits gained from monetary unification in order to fully understand the theory. This view is very important because in actual fact, the idea of positive balance between benefits and costs is the primary motive behind the formation of a currency union. There are different types of costs and benefits of monetary unification with some being lasting and others being one –offs, while in some cases they cannot be statistically verified due to the fact that they

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[19] The first eleven countries to join the Eurozone area are Belgium, Germany, Ireland, Spain, France Italy, Luxemburg, The Netherlands, Austria, Portugal and Finland.
[20] These countries include – Slovenia, Slovakia, Cyprus, Malta, Estonia and Latvia.
[21] See Friedman (1953), Ishiyama (1975), Mundell (1961) and Kenen., (1969)

occur over different periods of time, for example, examining the differences between the costs and benefits at the start of the currency's introduction in relation to the period when the currency has been well grounded in the international market. Also these costs and benefits may be different across the member states i.e. depending on the size of the countries or the level of inflation in the past. Therefore, it would be ideal to examine the effects on individual countries as this would paint a clearer picture on the costs and benefits of the currency union.

The next section examines some benefits and costs from the introduction of the euro. It is important to note that conclusions should not be drawn on these factors as Andrew Rose and Jeffrey Frankel stated that the impacts of the euro are expected to be fully displayed after 20 – 30 years.

2.7.1 Benefits

The benefits of the introduction of the euro have been studied extensively in empirical research papers covering different aspects of the economy as a whole. Bris et al. (2005) found a positive effect on corporate investment, while Bris et al. (2003) detected a positive effect on valuation (Tobin's Q) of firms from countries with previously weak currencies. Micco et al (2003), as well as Baldwin (2006), among others, have analysed the trade effects of the euro, with all results proving significant. (The euro and trade effects will be properly examined in the Chapter 4).

According to the ECB publication on the single currency benefits, firstly, the effective operation of the monetary policy framework of the European Central Bank (ECB) has yielded both direct and indirect single currency benefits which reveal well-anchored inflation expectations that have significantly contributed to achieving lower interest rates. This characterizes an important benefit for many of the member states as it aids in the reduction of public debt servicing while encouraging growth and investment. The average inflation rate in the first 10 years in the Eurozone countries was broadly on a par with the price stability benchmark of the European Central Bank (ECB) of close to but below a 2% annual rate of inflation, See Table 2.3. This represents sound evidence

regarding the effectiveness of the institutional structure in achieving macroeconomic stability. During the past decade, and in addition to the inflation rate performance, the ECB has also recorded a sharp decline in volatility in the Eurozone countries.

Table 2.3   Average Euro Area Inflation Rates

		Inflation	Volatility	
Countries	1990-1998	1999- 2008	1990-1998	1999-2008
Belgium	2.1	2.0	0.9	0.5
Germany	2.4	1.6	1.2	0.5
Ireland	2.4	3.4	0.8	1.1
Greece	12.0	3.2	5.9	0.5
Spain	4.4	3.1	1.7	0.5
France	2.1	1.8	0.9	0.5
Italy	4.4	2.3	1.6	0.4
Luxemburg	2.4	2.7	1.1	0.9
Netherlands	2.1	2.4	0.6	1.3
Austria	2.3	1.7	1.0	0.5
Portugal	6.2	2.9	4.1	0.8
Finland	2.5	1.6	1.8	0.9
Euro Area	**3**	**2**	**1.3**	**0.4**

Source – Organisation for Economic Co-operation and Development (OECD, 2012), European commission

Secondly, with respect to the single currency's impact on trade and financial integration, the effects are measurable as influential contributions following the discussion on the 'endogeneity of OCA' started by Frankel and Rose have used European and euro area data. With the use of the gravity trade model, the results of Micco et al (2003) showed a that bilateral trade between the member states of the euro zone increased by 5-20% when compared with trade with non-member countries. This estimate was further reduced by Bun and Klaasen (2007) to 3%. Baldwin (2006), and Baldwin, Skudelny and Taglioni (2005) also found that intra euro trade increased by an average of 5-10% however, stated that the estimated effect has a tendency to change depending on the estimation techniques used and the number of countries in the sample. Although there have been developments in the integration of several financial segments , the increase in Foreign Direct Investments (FDI) flows and cross-border Mergers and Acquisitions (M&As) in the manufacturing industry among

euro zone member states has experienced a notable rise. Petroulas (2007), in the analysis of the effect of the euro on FDI, pointed out that the increase in FDI flows attributable to the euro is estimated to be about 7%. Also Coeurdacier et al (2007) analysed the effect of the single currency on cross border mergers and acquisitions and explained that "the euro effect is very strong for M&A's within the same sector in the manufacturing industry" (pp.38). Their results suggest the euro almost tripled the intra euro area cross border horizontal M&A activity in this industry.

Mongelli (2008) pointed out that euro zone as a whole has got more resilience to external shocks than the individual member states ever had prior to the introduction of the euro. After it launch, the national economic policies became better coordinated, and of the risk of likely attacks and fluctuations on individual national currencies was eliminated.

The advantages of the euro can also occur as a result of its international significance such as seigniorage[22] and the fact that the single currency reduces the costs of carrying out international transactions. Papademos (2006) explains that the international role of the euro is decided by the investment decisions of private agents and public authorities out with the euro zone, while the ECB has an impartial policy position and does not encourage nor hinder the international use of the euro. The ECB (2008) report asserts that the euro has not only become very attractive as a vehicle currency in international trade, especially for the countries located close to the euro area because it reduces the cost of carrying out international trade for the residents of the euro zone., but also for financing and investment purposes, and as a reserve currency[23]. (see ECB (2008).

Even with all the aforementioned benefits of the single currency, it must be noted that some have yet to be fully realised. The euro was expected to lead to more price transparency so as to reduce price discrimination and market segmentation which in turn would therefore promoting and encouraging

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[22] The variance between the value of a country's currency and the actual cost to produce it. A positive seigniorage indicates that the government will make an economic profit and a loss if it is negative

[23]Mongelli (2008) indicated that the share of the euro as a reserve currency rose from 18% in 1999 to 25% in 2003 and has been relatively stable since then.

competition across the euro area. This impact however is still lacking in some markets for both goods and services with an example being the lack of convergence in the prices of cars prices.

2.7.2 Costs

Despite all of the above advantages, there are also various disadvantages of adopting a common currency. The main cost of introducing a single currency is the loss of independence over monetary policy and the loss of flexible exchange rate regime that can help absorb shocks. When a monetary union is established, the national central banks of the member countries do not have real power and thereby lose an instrument of economic policy. Broz (2005) points out that this cost are lower the higher the association of shocks between the potential member state and the anchor. Silva and Tenreyro (2010) point out the difficulty in assessing this loss due to the presence of a lot of factors (OCA criteria) that affect the efficiency of the use of monetary policy as an adjustment instrument[24]. Other significant costs of currency union formation include:

Changeover Costs

These costs result from switching to a new currency and include administrative, legal and computer hardware expenses such as re-denominating contracts and adapting vending machines. Administrative costs are connected with the creation of a supranational institution and they are distributed across each member country. Indeed, they could be decreased by a drop in the number of national institutions because some functions are redistributed and shared in other places.

Reduced Macroeconomic Stability Costs

When a national government accepts a common currency, it gives up certain policy instruments used previously to balance asymmetric differences in the country. The national governments no longer have the responsibility to set

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[24] For a more detailed literature on this cost, refer to Silva and Tenreyro (2010).

exchange rates and some monetary policies as these functions are handed over to the European Central Bank as the supranational institution.

Negative External Effect Costs

When a member country has a large budget deficit and is accumulating huge national debt, cost externalities[25] may flow to other countries. National debt can potentially affect the interest rates of the entire currency union.

Lastly, the introduction of the euro has seen eighteen countries, all with different economic performance, sizes and language, come together to use the same currency. The United States is viewed as a currency union which thus far has worked well because all the states have a common language and the labour market is mobile. For the Eurozone however, labour force mobility is restricted due to language and cultural differences. This will lead to some parts of the Eurozone being left extremely weak due to an inability to create employment compared to other parts where the economy flourishes and wages increase.

2.8   The Transport Equipment Manufacturing Sector in Europe

2.8.1 Introduction

The Transport Equipment Manufacturing Sector is a subsector of the manufacturing industry. Companies in this subsector manufacture equipment used for the transportation of both people and goods. Its importance and significance to the economy has led to the creation of an entire subsector dedicated to its activity. It is divided into two categories under the United Nations International Standard Industrial Classification (ISIC) of All Economic Activities, Rev.3. This consists of the manufacture of motor vehicles (No. 34) and the manufacture of other types of transport equipment (No. 35). Table 2.4 shows the different categories under each division

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[25]Externality can be explained as either a cost or a benefit that results from any activity which aims either to harm or improve a situation and the creator does not take these costs or benefits into account. In this context, an externality is a cost that results from the Eurozone membership and affects other members of the monetary union.

Table 2.4 Structure of ISIC Rev. 3 code 34-35

Division: 34 - Manufacture of Motor Vehicles, Trailers and Semi-Trailers

341 - Manufacture of motor vehicles

342 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers

343 - Manufacture of parts and accessories for motor vehicles and their engines

Division: 35 - Manufacture of Other Transport Equipment

351 - Building and repairing of ships and boats

352 - Manufacture of railway and tramway locomotives and rolling stock

353 - Manufacture of aircraft and spacecraft

359 - Manufacture of transport equipment n.e.c.

Source: United Nations Statistics Division

This sector is crucial to the economic development of the European Union countries as it is responsible for the provision of transportation for both people and goods. The sector's activities range from the manufacture of major vehicles to the supply of components and parts, with just one particular part of a vehicle often manufactured. The structure of the activities in this sector according to the European Business: Facts and Figures (2010) is based on an intricate pyramid-like association amongst the key producers and manufacturers and the numerous levels of parts suppliers. It is quite common to find groups of smaller companies located close to the major vehicle producers and manufacturers.

2.8.2 Structural Profile of Europe's Transport Equipment Manufacturing   Sector

In the EU27 countries, the transport equipment manufacturing sector recorded approximately 43,000 companies in 2004 and 45,700 in 2006, comprising both the main manufacturers and the components and parts manufacturers and employing a workforce of 3.2 million individuals in both years. The value added contributed by this sector was €177.7 billion and €195

billion in 2004 and 2006 respectively which was recorded as the fifth highest sectoral value added in 2006. The manufacture of motor vehicles, trailers and semi-trailers dominates this sector. Indeed, it was recorded as contributing 76% and 73.9% in 2004 and 2006 respectively of the sectoral value added and approximately 70% of the employment. In Division 35, which consists of Other Transport Equipment, the manufacture of aircraft and spacecraft has the most activity, with a contribution of 14.1% of the value added for the sector.

Within the European Union, the top five largest producers of transport equipment are all Western European countries. They include Germany, Italy, France, Spain and the United Kingdom. In 2004 and 2006 they collectively contributed 68.9% and 67.2% respectively to the EU27's value added for the sector. With regard to this sector, Germany is by far the dominant force. As can be seen from Table 2.5 below, in 2006 it added in excess of €78.7 million in value added, equating to over 40% of the EU27's total in this sector. In terms of employment, in the same year Germany employed almost 1 million people or 31% of the number employed in the EU27 countries. Germany is the major exporter of transport equipment in Europe with an average of 40% of the whole sector while the United Kingdom is reported to be the largest importer of transport equipment. However, the German transport equipment manufacturing sector is dominated by the manufacture of motor vehicles, trailers and semi-trailers, with little activity in the other subsectors. Other Western European countries are specialised in different sub divisions of the sector. For example, Greece, Finland and Sweden focus on the production and building of boats and ships while Italy also concentrates on the manufacture of motorcycles and bicycles. The tables below summarise the structural profile of the transport equipment manufacturing sector.

Table 2.5 Statistics of EU27 Transport Equipment manufacturing Sector

Category (2004)	No. of Companies	Turnover (€ million)	No. of Persons Employed (000)	Value Added (€million)
Total Sector (EU27)	43100	862231	3200	176718
Motor vehicles, trailers and semitrailers	18300	704000	2256	134000
Ships and boats	18600	33000	290	9900
Railway equipment	1100	20396	172	5423
Aircraft and spacecraft	2200	91000	380	25000
Other transport Equipment	**3000**	**12500**	**70**	**2900**

Category (2006)	No. of Companies	Turnover (€ million)	No. of Persons Employed (000)	Value Added (€million)
Total Sector (EU27)	45700	945417	3152	194970
Motor vehicles, trailers and semitrailers	18400	780001	2235	143992
Ships and boats	20800	41737	300	11226
Railway equipment	1100	22249	165	7052
Aircraft and spacecraft	2300	89067	384	29964
Other transport Equipment	**3000**	**11519**	**65**	**2727**

Source: Eurostat Structural Business Statistics (SBS)

Table 2.6 Ranking of the Top Five Member States

Country	Value Added(€million)			No. of Persons Employed (000)		
Rank	*2004*	*2006*	*2008*	2004	2006	2008
Germany	70.2	78.7	67.4	1014	980	912
France	26.6	27	26.8	427	416	
UK	25	25.3	23.4	357	326	300
Italy	12.2	15.4	15.4	262	274	285
Spain	11.7	12.4	12.6	228	216	214

Source: Eurostat Structural Business Statistics (SBS)

Figure 2.9: The German Transport Equipment Manufacturing Sector by Category 2008
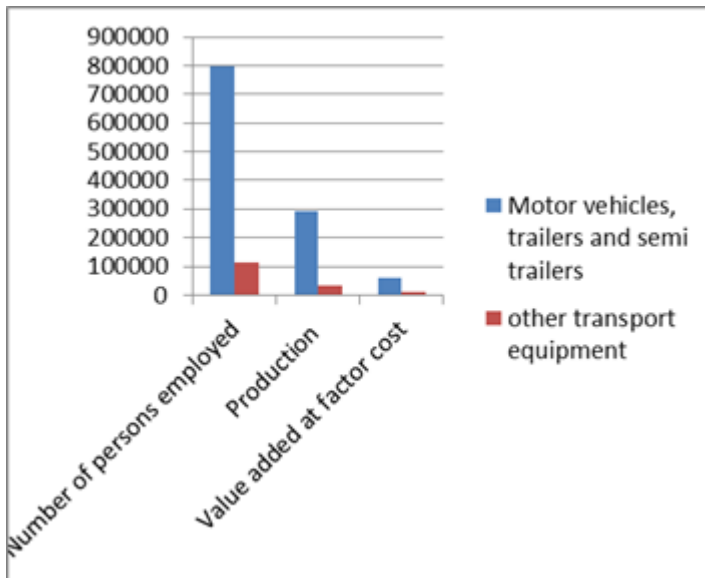
Source: Author's Composition from Eurostat (SBS)

Figure 2.10: Share of Transport Equipment Manufacturing Sector by Category 2008
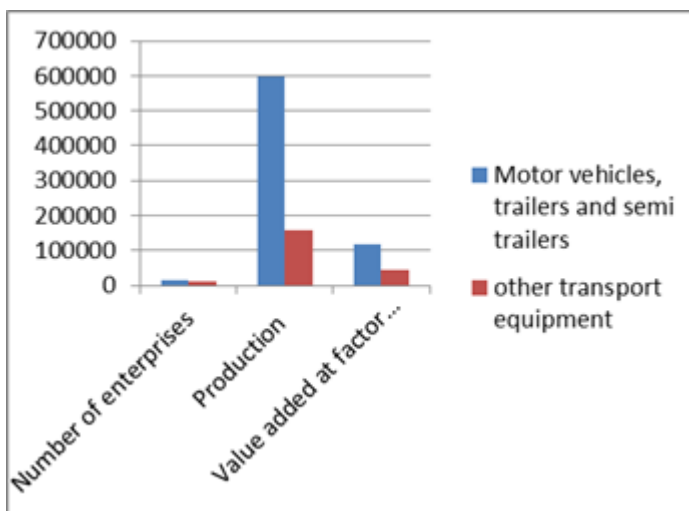
Source: Author's Composition from Eurostat (SBS)

2.8.3 Manufacture of Motor Vehicles, Trailers and Semitrailers

The manufacture of motor vehicles, trailers and semitrailers is divided into three main groups[26] of

1. Motor vehicles (341)
2. Bodies for motor vehicles, trailers and semitrailers (342)
3. Parts and accessories for motor vehicles and engines (343)

Donnelly et al (2002) asserted that the USA, Japan and Western Europe account for about 90% of the total output of the industry and pointed out that of the three markets, the European market is the largest and most competitive. The manufacture of motor vehicles, trailers and semitrailers comprises an average of two-thirds of the exports and half of the imports of the EU in this sector. Trade in this subsector led to a surplus in the EU of over €65 billion, with most of this coming from trade in motorcars made to transport less than ten people. Indeed, the surplus was mainly due to exports to the United States, other European countries, China and Japan (Berthomieu, 2005). This subsector is controlled by a small number of large enterprises which partner with smaller companies that provide parts and accessories and systems for the motor vehicles. In Europe, the main motor vehicle manufacturers include BMW, DAF, Daimler, Fiat, Ford of Europe, GM, Iveco, Jaguar, PSA, Renault, Volkswagen and Volvo, along with a few Japanese and South Korean companies with manufacturing plants located in Europe.

According to the International Organisation of Motor Vehicle Manufacturers (OICA)[27], the Western European countries (EU15) were responsible for producing 22.8% of the world's motor vehicles in 2007 and 21.5% in 2008, which was larger than the USA (12.34%) and Japan (16.4%). As previously noted, Germany is Europe's leading country in the manufacture of transport equipment in general with most of the production in motor vehicles. In 2008, Germany alone produced almost 50% of the EU27's value added for the sector.

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[26] This subsector however does not include the production of tyres, electronic and electric equipment and batteries used in the motor vehicles.

[27] Organisation Internationale des Constructeurs d'Automobiles

Table 2.7 Largest Motor Vehicle Producing Countries 2008

Countries/Regions	2008(million)	% of Total
Total (World)	70.5	100%
Japan	11.5	16.4%
China	9.9	13.2%
USA	8.7	12.3%
Germany	6.04	8.6%
South Korea	3.8	5.4%
France	2.5	3.6%

Source: OICA (www.oica.net)

Figure 2.11 Motor Vehicle Production per Region 2008
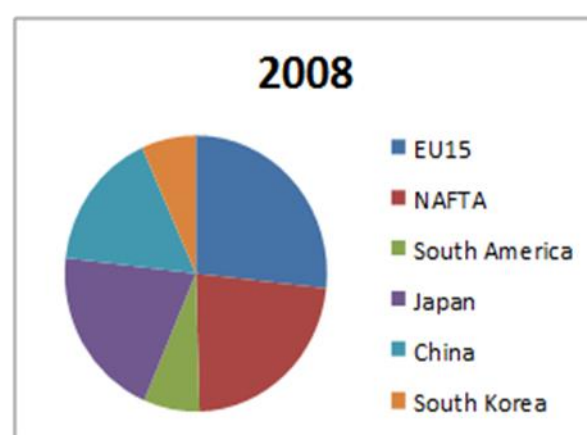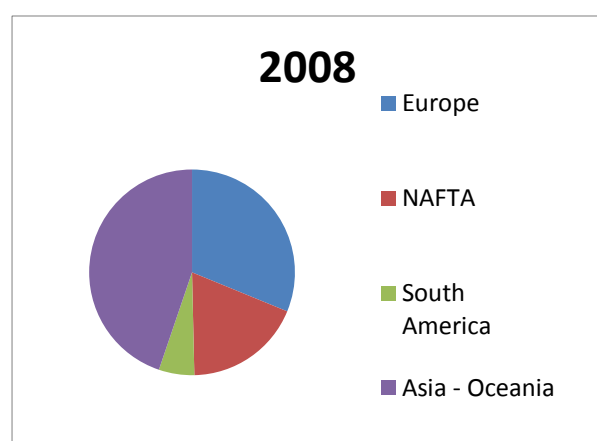
Source: OICA (www.oica.net)

Table 2.8 EU15 Motor Vehicle Production   2007 and 2008

Countries/Regions[28]	2006 (million)	2007(million)	2008(million)
Austria	.27	.22	.15
Belgium	.91	.83	.72
Finland	.32	.02	.02
France	3.16	3.01	2.57
Germany	5.81	6.21	6.04
Italy	1.21	1.28	1.02
Netherlands	.15	.13	.13
Portugal	.22	.17	.18
Spain	2.77	2.88	2.54
Sweden[29]	.33	.36	.31
UK	1.64	1.75	1.65
Total (EU15)	**16.3**	**16.7**	**15.2**

Source: OICA (www.oica.net)

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[28]Production for Denmark, Ireland, Greece and Luxemburg not reported

[29] Includes only the vehicles manufactured in Sweden and the vehicles for which Volvo Trucks did not specify the country of production.

Table 2.9   External Trade – Motor Vehicles, Trailers and Semitrailers

Countries/Regions	Extra EU Exports (€million)	Extra EU imports (€million)
Motor vehicles	87,978	38,805
Trailers and semitrailers	2,634	534
Motor vehicles parts and accessories	29,402	14,746
Total	**120,014**	**54,085**

Source: Eurostat (Comext)

Table 2.10   Snapshot of the Manufacture of Motor Vehicles, Trailers and Semitrailers Subsector

Key Indicators by Subsector	Number of Companies	Number of Persons Employed	Value Added	Turnover
	000	*000*	*€million*	*€million*
Manufacture of Motor Vehicles	2.3	1002.6	90000	526000
Manufacture of Trailers and Semi-trailers	7.7	159.2	6600	25300
Manufacture of Parts and Accessories	10.6	1010	45965	188803
Manufacture of Motor Vehicles, Trailers and Semitrailers (Total)	**20.5**	**2172.8**	**141063**	**740587**

Source: Eurostat (SBS)

Table 2.11 Country Ranking in the Manufacture of Motor Vehicles, trailers and Semitrailers (EU27)

Breakdown of Subsector ↓	Highest Value Added	Share of EU27 Value Added
	Country	*%*
Manufacture of Motor Vehicles	Germany	53.6
Manufacture of Trailers and Semitrailers	Germany	29.1
Manufacture of Parts and Accessories	Germany	36.3
Manufacture of Motor Vehicles, Trailers and Semitrailers (Total)	**Germany**	**47.4**

Source: Eurostat (SBS)

2.8.4 Manufacture of Other Transport Equipment

The manufacture of other transport equipment includes all goods with the exception of motor vehicles, trailers and semitrailers. This subsector of the transport equipment manufacturing sector comprises the building of ships and boats, manufacturing of railroad rolling stock and locomotives, air and spacecraft and also parts. In 2010, there were a total of 14,300 companies in this subsector, with 705,000 employees in the EU's 27 countries. In the same year, this subsector generated a total of €46.2 billion of value added, equating to 2.8% of the total manufacturing sector.

The manufacture of aircraft and spacecraft dominates this subsector by far in terms of both sectoral value added and employment, generating 59.8% and 48.8% of the total subsector respectively. This is closely followed by the manufacture of ships and boats. Table 2.11 and Figure 2.8 show the analysis of the various divisions of the subsector. In terms of country analysis, (see Figure 2.12) France alone generated 22.8% of the EU27's value added with the majority of this figure being from the manufacture of aircraft and space craft. This subsector is dominated by companies employing 250 people and over.

Table 2.12 Snapshot of the Manufacture of Other Transport Equipment

Key indicators by Subsector	Number of Companies	No. of Persons Employed	Value Added	Turnover
	000	*000*	*€mill*	*€millions*
Manufacture of Aircraft and Spacecraft	1.5	344.2	27,658	89,314
Building of Ships and Boats	8.7	182.5	8774	36,646
Manufacture of Railway Locomotives and Rolling Stock	0.9	103.7	6304	22,345
Manufacture of Transport Equipment n.e.c	3.3	61.2	2476	11,064
Manufacture of Military Fighting Vehicles	0.0	14.1	1003	3687
Manufacture of Other Transport Equipment	*14.3*	**705.6**	**46215**	**163051**

Source: Eurostat (SBS)

Table 2.13 Country Ranking in the Manufacture of Other Transport Equipment

Breakdown of Subsector	Highest Value Added	Share of EU27 Value Added
	Country	*%*
Manufacture of Aircraft and Spacecraft	France	27.5
Building of Ships and Boats	UK	20.4
Manufacture of Railway Locomotives and Rolling Stock	Germany	19.4
Manufacture of Transport Equipment n.e.c	France	8.8
Manufacture of Military Fighting Vehicles	France	37.3
Manufacture of Other Transport Equipment (Total)	**France**	**22.8**

Source: Eurostat (SBS)

Figure 2.12: Analysis of the Sectoral Structure of the Manufacture of Other Transport Equipment
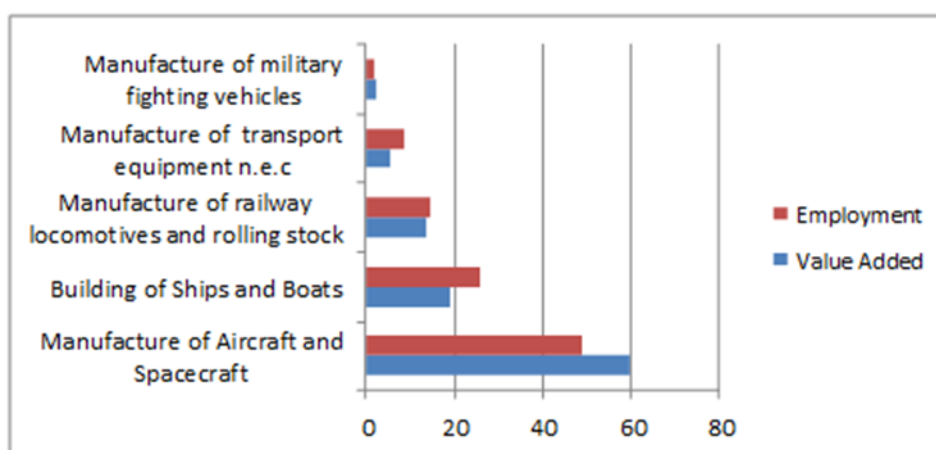
Source: Eurostat (SBS)

2.9   External Trade

The European Union is the world's leading exporter and second largest importer of transport equipment with an approximate value of over €140billion in exports in 2008. During the initial years following the introduction of the euro (1999 to 2003), the growth rate p.a. for European exports at 8% was faster than the world rate in this sector at 5%. However, transport equipment manufacturing is one of the EU's superior performing sectors in the trade of goods. In 2007, the EU27 recorded total extra EU exports and imports of

€1.9million and €.11million respectively. This equated to 16.4% and 8.3% of the total industrial exports and imports for the given year. However, the intra EU exports are recorded as 68.5% of the total exports in this sector. Over 68% of exports from the transport equipment manufacturing sector in the EU27 member countries were exported to fellow member countries which constitutes intra EU trade. Germany has remained the largest EU exporter of transport equipment both to the member and non-member countries, closely followed by France with an export value of over €187.5billion in 2006. The majority of Europe's exports are destined for the USA, Russia, China and Turkey, while most of the transport equipment imports come from the US, Japan, South Korea, Turkey and China. Figure 2.13 shows Europe's main trading partners, pointing out the significance of the Asian countries of Japan, China and South Korea to EU27's imports of transport equipment. The figures for the Asian countries combined constitute 35.6% of the total exports, which is still ahead of the USA.

Figure 2.13: EU27 Exports and Imports 2007
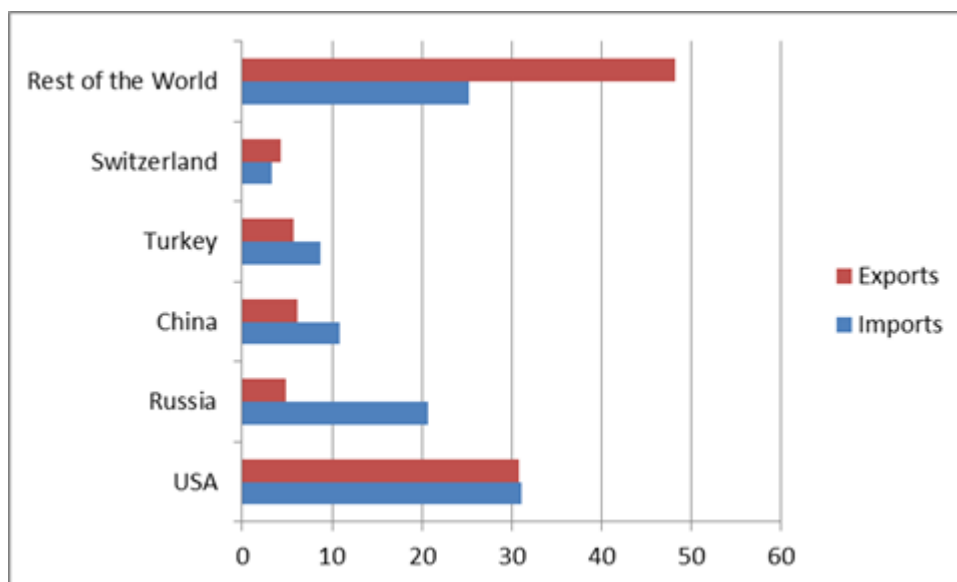
Source: Eurostat (Comext)

CHAPTER 3

GRAVITY MODEL OF INTERNATIONAL TRADE

3.1 Introduction

Following the Second World War, trade economists utilised a general equilibrium model to describe the patterns of bilateral trade flows between countries. It was based on the assumptions of two countries, two commodities and two factors of production and was appropriately named as the general equilibrium 2x2x2 model. It was noticed that aggregate trade flows between country pairs could be explained by the product of their economic size and the inverse of the distance between them. In the 1960s, this became known as the gravity model of trade.

It is a statistical analytical model used to analyse bilateral trade flows between countries. The data analysed could originate as international trade, foreign direct investment (FDI), effects of employment, migration etc. Studies in economics have, in the past, used science-based laws such as physics to analyse economic policies and in many cases this has been successful. Major examples include the use of the Lotka-Volterra's Prey – Predator model in the analysis of management strategy (Faure-Grimaud, 1997) and the use of William Farr's Epidemic Theory to explain technology innovation and diffusion, among others. The gravity model of trade is also an example of this type of relationship.

The gravity model of trade was derived from Isaac Newton's famous 'Law of Gravity' of 1687. This Law of states that gravity is universal and that all objects attract each other with a gravitational force. This force of gravitational attraction is directly dependent upon the mass of both objects and is inversely proportional to the square of the distance which separates their centres.

The Gravity Model, just like the Epidemic Theory and 'Lotka-Volterra's Prey-Predator model, is a concept borrowed from physics. It takes its foundation from Newton's gravity equation of:

$$F_{ij} = G \left\{ \left((M_i M_j) / D^2_{ij} \right) \right\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. \ 3.1$$

where F_{ij} represents the attractive force between objects i and j, G is the

gravitational constant, M_i and M_j are the mass, and D_{ij} represents the distance between the two objects. It is considered to be one of the most stable equations in economics (Barrett et al., 2005). The "Original Newton's gravity law explains that the power of gravity between two subjects is adequate to the product of masses of the two objects divided by the distance between them in the power of two" (Barrett et al., 2005: 67).

It is similar to that expressed in Newton's equation above, although the power of gravity (F) is replaced by bilateral trade and the weight of objects M_i and M_j are replaced by value of a country's GDP (Brun et al., 2005: 89). The latter serves as an indicator of the economic size of the country. Hence, it is *a* relationship model, which links various factors associated with international trade. Silva and Tenreyro (2003) reasoned that the economic use of the gravity model contends that a mass of goods or labour or other factors of production supplied at origin *i,* is attracted to a mass of demand for goods or labour at destination *j* but the potential flow of these elements from their origin to destination is regulated by the distance between them.

According to the law of gravity, larger objects tend to attract each other because the gravitational force is proportionate to the mass of objects. Likewise, increasing the distance between two objects makes the gravitational force weaker, since the law states that the force is inversely proportional to the distance between two objects. If the mass of an object is doubled, so is the gravity force and, if objects a and b are further away from each other, the attraction between them reduces. This is the foundation upon which the Gravity Model of Trade was based. Using this analogy in the analysis of trade, it can be explained as follows: a mass of goods supplied by country A is attracted to a mass of goods demanded in country B but there is a potential that this flow can be reduced by the distance between the two countries. Putting this simple analogy into an equation, it can be written as:

$$F_{ix} = \frac{A_i B_x}{D^2{}_{ix}}$$ .... Equation 3.2

In the equation above, F_{ix} shows the movement of goods between countries A and B and $D^2 ix$ represents the distance between the two countries.

The first person to use the gravity model was Ravenstein (1889), to analyse migration patterns in the UK during the 19th century. Following this, it was also used by a Finnish economist Pentti Pöyhönen (1963), and a Dutch economist, Jan Tinbergen (1962). However, it was Tinbergen (1962) who first used the gravity model to analyse international trade flows in his seminal article entitled 'Shaping the World Economy'. In his analysis, he changed the variables in the equation to country and economic variables, although the main idea of the model remains. In his explanation of the gravity model of trade, Tinbergen stated that larger countries tend to trade more with each other and that trade reduces between countries which are further apart from each other. The equation which he derived is known as the basic gravity equation and can be written as:

$$X_{ij} = G \frac{(GDP_i . GDP_j)\beta_1}{D^{\beta2}_{abij}}$$ .... Equation 3.3

Where

X_{ij} = Total value of Bilateral Trade between Countries i and j

GDP_i = Gross Domestic Product of Country i

GDP_j = Gross Domestic Product of Country j

D_{ij} = Distance between Countries i and j

G = Constant Term

The basic gravity equation applied to international trade flows explains that bilateral trade flows between countries are measured by the supply and demand conditions of the countries involved. The gravity model of international trade has been defined as the workhorse of international trade (Deardorff 1998). The model, when properly estimated, is able to approximate bilateral trade flows correctly and, according to Leamer and Levisohn 1995, 'it is one of the most stable empirical relationships in economics'. In the basic gravity equation 3.3 above, sometimes referred to as Tinbergen's equation, X_{ij} is the size of the

bilateral trade flows between country pairs and this figure is determined by the economic size of countries i and j measured in terms of GDP converted to US dollars and the geographical distance between the two countries. The distance variable is used as a proxy for transportation costs. The equation was expressed in a log–log form so as to ensure that the elasticity of the bilateral trade flow remained constant with respect to the three explanatory variables and thus it can be used as an econometric model. When Equation 2 is written in log-log form it is expressed as:

$$\ln X_{ij} = G + \beta_1 \ln(GDP_i . GDP_j) + \beta_2 \ln(D_{ij}) + \ln \varepsilon_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{Equation 3.4}$$

where the signs $\beta_1 \, and \, \beta_2$ represent coefficients which should be positive and negative respectively when estimated.

Equation 3.4 is the basic gravity equation which was estimated by Tinbergen in 1962 and, although successful at the time, it has undergone many changes which have improved its empirical properties. In Tinbergen's analysis using this equation, the trade flows were measured both in terms of exports and imports of total merchandise trade and therefore the analysis did not have any zero trade flows recorded between countries.

Both Tinbergen and Linnemann's empirical research on the gravity model show that bilateral trade is linked to the ideology of gravity where opposite forces define the volume of bilateral trade flow between countries by the level of income and size and the degree of barriers to trade. Included in the latter are transport costs, trade policies, historical and cultural differences, national borders, geographical characteristics etc. (Anderson and van Wincoop, 2003). The potential to trade results from matched export capacities and import demands at the microeconomic level. When analysing international trade flows on an aggregated level, per capita income, distance and historical and cultural relationships are the main macroeconomic factors which drive exports. This has led to the use of various combinations of these variables, such as gross domestic product and population with geographic distance, to predict the trade potential between countries. The gravity model has been used extensively in empirical research when analysing international trade flows (Havrylyshin and Pritchett, 1991; Frankel and Wei, 1993; Bayoumi and Eichengreen, 1997; Evenett and

Hutchinson, 2002). Although the views of the authors may differ and the methodologies and econometric issues were dealt with differently, the gravity equations used all have similar variables and characteristics. These features will be broken down into three groups.

Firstly, the gravity model is bilateral and aims to measure the effect of trade flows caused by a particular phenomenon between two or more countries. The dependent variable (left hand variable) in any gravity equation is explained by the mixture of macroeconomic variables for each country pair. In addition to the macroeconomic variables, proxies for transportation costs such as distance between the country pairs and other general market access variables are also included in a gravity equation. Secondly, gravity equations can be derived from several trade models (Deardorff, 1998). Whichever trade model is used, the gravity equation represents a conditional general equilibrium if multilateral (price) resistance terms are taken into account. Inferences regarding determinants of trade flows can be drawn due to their separability property (Anderson and van Wincoop, 2003). This means that trade flows across countries are separable from the allocation of production and consumption between countries. Thus, gravity equations establish a link between trade and its determinants, conditional on the observed production and consumption patterns, and drawing inference on trade flows from the underlying general equilibrium structure determining production and consumption allocations. In addition, due to the separability property, the gravity equation is not affected by the presence of non-tradable sectors in the economy as the non-tradable sectors do not affect the marginal productivity of tradable goods within a sector (Anderson and van Wincoop, 2003). Lastly, the general aim of using a gravity equation in international trade analysis is two-fold; firstly it seeks to investigate the factors responsible for the changes in the volume of trade flows and secondly it attempts to estimate the determinants of the nature of trade flows. Although all three points highlighted above are features of any gravity equation, it should be noted that there will be differences in each gravity equation. This is due to the fact that some equations are written to analyse the trade effects of borders, distance, trade preferences or regional integration and each equation must capture the particular uniqueness of the dataset. It should therefore be understood that the ideas of Sir Isaac Newton laid the basic foundation of the

gravity model and should not be wholly conceptualised without exploring its development by other theorists to find various applications of the model.

The next section of this chapter will review the studies which have contributed to the theoretical foundations of the gravity model. The theoretical development will be carried out chronologically. Following the theoretical justifications, there will be an examination of the possibility that gravity models can be derived from other trade theories. The third section will review relevant literature on major theoretical and empirical studies which have used the gravity equation to analyse international trade flows[30]. Finally, recent econometric contributions towards the gravity model estimations will be reviewed.

3.2   *Theoretical Justification of the Gravity Model of Trade*

As previously pointed out, the "Law of Universal Gravitation" was put forward by Isaac Newton in 1687, explaining that two forces are attracted to each other simply due to the product of the mass of the bodies divided by the squared distance between them and then multiplied by a gravitational constant (see Equation 1) (Head, 2003). This gravitational relationship between mass and distance was first utilised in the analysis of international trade flows by Tinbergen in 1962 and was the first theoretical justification for the gravity model. Tinbergen's gravity equation measures trade flows between country pairs using the monetary value of imports and exports as the dependent variable which should be equal to the independent variables of the product of the relative economic size proxied by the GDP of the countries. This is divided by the distance between the countries before finally being multiplied by a constant which measures the hindrance/ease of transaction between countries (Head, 2003). This relationship, as pointed out in the previous section, can be used to analyse various types of trade flows. This is the first justification for the gravity model of trade and can be seen in studies by Tinbergen (1962) and Pöyhönen (1963). They both concluded that the income/size of the country pairs and the distance between them have a statistically significant correlation with the

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[30] The focus will be mainly on studies that have taken trade costs into account.

expected signs. The second justification comes from Linnemann (1966) who analysed the trading activities of 80 countries by employing the gravity equation. Linnemann (1966) explained that the gravity model is an intuitive method, stating that bilateral trade flows are determined by potential supply and potential demand with factors representing the "resistance" (Linnemann, 1966) to trade between the supplier country and the demand country. The gravity model is seen as being a reduced form of this model. Distance in Linnemann's gravity model proxies the cost of transport, which drives a block between supply and demand. It should also be noted that the study conducted by Linnemann on global trade flows is the foundation for deriving the gravity model.

During the construction of the 'Linnemann' gravity model, he highlighted three main categories as factors contributing to trade flows between any pair of countries. These groups are listed below:

- The factors which specify the aggregate potential supply of country i (the exporting country);
- The factors which specify the aggregate potential demand of country j (importing country);
- The factors which represent resistance to trade flows from a potential supplier to a potential buyer for example transportation costs, tariffs etc.

The factors which specify possible demand and supply are determined by the same force, with Linnemann reasoning that the potential demand and potential supply in the world market should be equal. Linnemann further explained that a country becomes involved in international trade owing to the fact that its domestic production does not match exhaustively with the composition of its local demand. Hence, such production is not wholly adapted to local demand because the country has achieved comparative advantage in some lines of production, whereas other nations experience comparative advantage in other production fields, thereby leading to increased production volume for all the countries.

In order to establish the factors showing potential international supply and potential international demand, Linnemann based his study on both theory and

the findings of previous empirical studies. Linnemann began his explanation by noting that a country's production exists partly for the local market and partly for the international market. Ignoring the probable divergence between geographic commodity and national commodity and presuming a constant correlation between commodity and production, a country's potential international supply relies on its local commodity or income. This international supply also relies on the ratio between the domestic market and the production for international demand. This was expressed as:

DM/FM………………………………………..…………………………….. Equation 3.5

where

DM – Domestic Market

FM – Foreign Market

Based on the above ratio, Linnemann noted that variation between the elements can be satisfactorily explained by the variations in the country's population size. This justification was based on (i) the diversification of demand at greater levels of per capita income and (ii) the existence of economies of scale.

Linnemann established a hypothesis that the determination of potential demand and supply for a nation is systematically linked to (i) the size of the gross domestic or national product (GDP/GNP), (ii) the size of the population and (iii) the level of per capita income. In contrast, the factors which represent resistance to trade are tariff barriers and transportation costs, although they are divided into two groups of natural trade resistance and the artificial trade resistance.

The first group is made up of three factors, namely, time involved in transportation, transport cost and the economic horizon. The time element is viewed as an obstacle to trade, especially in the case of perishable goods. In addition, the length of time taken to transport goods can lead to the risk of missing out on other profitable opportunities. The second factor of transport costs pertains to the costs of shipping and transporting goods from one country to another. The last factor of the economic horizon of the country explains that countries which are similar to each other in terms of identical customs,

language, laws, habits and way of life tend to trade more with each other than countries with nothing in common. In his analysis, Linnemann simply measured the natural trade resistance by the geographic distance between two countries. He argued that distance encapsulates all the factors in this group and constitutes obstacles to trade between countries. Since the cost of shipping goods from one country to another country relies on various considerations, trade resistance between nations differs not only with geographical distance but also with the type of traded commodity, transportation surface and number of reloading operations.

The second is known as artificial trade resistance. This occurs when commodities are not allowed to pass the borders of a country easily. It could also arise as a result of the formation of a preferential trading area where member countries encounter less than normal trade resistance when trading among themselves and more resistance (normal) in their trading with non-members. As such, Linnemann included a preferential trade dummy in his analysis so that members of preferential trade agreements could be included in his analysis and also to correct for any deviations from average or normal trade resistance level.

In his final contribution to the development of the trade model, Linnemann merged the factors of potential demand, factors of potential supply and factors of trade resistance to derive one equation which could be used to explain international trade flows. As previously noted, the factors associated with potential demand and potential supply are population size, national income and per capita income, while the factors associated with trade resistance are preferential trade factors and geographical distance. The expression was developed based on the notion that "interactions in economic life are often of geometric rather than of arithmetic form" (Ferber and Verdoorn, 1962). The resulting equation after merging the three influential factors (eq. 6) is similar to Newton's gravitational equation.

$$X_{ij} = \beta_0 \frac{(E_i^{P)\beta_1} (M_j^{P)\beta_2}}{(R_{ij})\beta_3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{Equation 3.6}$$

where

X_{ab} -trade flow between both countries i and j,

β_0 - a constant,

E_i^P - total potential supply of country a,

M_j^P - total potential demand of country b, and

R_{ij} - resistance factors to trade between countries a and b

The three explanatory factors in the equation (6) are then substituted by their determined variables. Here, *Y* represent GDP (Gross National Product), *N* represents population size, *y* represents National Per Capita Income, *D* represents geographical distance and *P* represents Preferential Trade Factor. Given that E^P is a function of *Y, N* and *y,* it therefore follows that:

$E^P = \gamma_0 \, Y^{\gamma 1} \, N^{\gamma 2} \, y^{\gamma 3}$ ....Equation 3.7

where *γ1=1 and γ2* is negative based on the earlier theoretical explanation.

$E^P = \gamma_0 \, Y^{\gamma 1} \, N^{\gamma 2} \, y^{\gamma 3}$

Given that *y = Y/ N*, it follows that its coefficient is dependent; hence, the value of per capita income is not introduced as an individual variable. Instead, it should be included automatically in the exponents of the two other variables as expressed in the following equation.

$E^P = \gamma'_0 \, Y^{\gamma' 1} \, N^{\gamma' 2}$ ....Equation 3.8

A similar formulation can also be used for M^P, which represents potential supply as expressed below.

$M^P = \gamma'_4 \, Y^{\gamma' 5} \, N^{\gamma' 6}$ ....…..Equation 3.9

In theory, Linnemann's equation of the gravity model portrays that potential demand should be equal to potential supply and thus: $\gamma'_0 = \gamma'_4$, $\gamma'_1 = \gamma'_5$, and $\gamma'_2 = \gamma'_6$. These conditions have to prevail in an equilibrium situation. However, in short-term disequilibria conditions, these exponents are permitted to be different.

According to Linnemann's approach, the trade resistance factors were proxied using distance D_{ij} and preferential factors P_{ij} as shown in Equation 10:

$R_{ij} = D_{ij}^{\gamma 6} \, P_{ij}^{\gamma 6}$ ....…Equation 3.10

Combining Equations 7, 8 and 9, makes it possible to derive a gravity model similar to that of Tinbergen (1962) and Pöyhönen (1963), as shown in Equation 11 and 12. This is the basic gravity type trade flow equation formulated by Linnemann. It states that a small increase in the GNP/GDP of country a leads to an increase of δ_3 percent of exports from country b. In the equation below, the trade resistant factor R is proxied by the Distance (D – with a negative exponent) variable and the preferential trade factor (P – with a positive component). Linnemann also derived another model very similar to the Walrasian model with the same results, as shown in the following equations-

$$X_{ij} = \delta_0 \frac{Y_i^{\delta_1} Y_j^{\delta_3} P_{ij}^{\delta_6}}{N_i^{\delta_2} N_j^{\delta_4} D_{ij}^{\delta_5}}$$ ………………………………………………………………Equation 3.11

Or

$$X_{ij} = \delta 0 Y_i^{\delta_1} N_i^{-\delta_2} Y_j^{\delta_3} N_j^{-\delta_4} D_{ij}^{-\delta_5} P_{ij}^{\delta_6}$$ ……………………………………………Equation 3.12

In summary, the foundations of the gravity model use three major factors when determining international trade flows. These factors are i) economic forces at the origin of the trade flow, ii) economic forces at the destination of the trade flow and finally iii) economic forces which are either resistances to trade or trade enhancing.

Algebraically, the general common equation of the gravity model is

$$X_{ij} = \alpha_0 Y_i^{\alpha_1} Y_j^{\alpha_2} N_i^{\alpha_3} N_j^{\alpha_4} D_{ij}^{\alpha_5} A_{ij}^{\alpha_6} e_{ij}$$ …………………………………………..…………..Equation 3.13

or written in natural logarithms:

$$lnX_{ij} = ln\,\alpha_0 + \alpha_1 lnY_i + \alpha_2\,lnY_j + \alpha_3 lnN_i + \alpha_4 lnN_j + \alpha_5 lnD_{ij} + \alpha_6 lnA_{ij} ……$$Equation 3.14

where:

X_{ij} = trade flows from country I to country j

Y_i = income of country i

Y_j = income of country j

N_i = population of country i

N_j = population of country j

D_{ij} = distance between country i and j

A_{ij} = trade enhancing or resisting factors between countries I and j

e_{ij} = log normally – distributed error term

Using Linnemann's gravity trade equation, the gravity model can be summarised as follows.

The income variables which are usually proxied using GDP or GDP per capita are expected to have a positive effect on bilateral trade flow. From the suppliers' perspective, increased income is indicative of the fact that there is a greater level or production volume in the country which is available for export to other countries. For the destination country (demand side) and with all factors remaining constant, an increase in income will lead to an increase in imports.

The effect of population on trade flows can either be trade enhancing or trade resisting. A country with a large population may be self- sufficient and therefore rely less on international trade. In this instance, population size will have a negative effect on international trade flows. A populous country, on the other hand, aids division of labour, thus leading to the creation of trade opportunities in a wider variety of goods. In this case, population size is viewed as trade enhancing and would have a positive effect on international trade flows.

Distance obviously has a negative effect on trade flows between countries. The further away the countries are from one another, the higher are the transport costs involved, thus potentially leading to reduced profits. In addition, it should be noted that when dealing with disaggregated data, a larger negative effect is expected for certain goods which are difficult to transport and complicated to sell at a distance. Generally speaking, the trade resisting factors such as tarriffs will affect trade flows between countries and as such their coefficients are expected to be negative. The trade enhancing factors, on the other hand, affect trade flows favourably and therefore their coefficients are

expected to be positive. Examples of these include the dummy variables added to the gravity equation for countries which have the same language, share the same border, have/had a colonial relationship or are members of the same trading agreement.

Apart from Linnemann's model, the probability model can also be used to explain the gravity trade equation. This can be identified in the earlier works of Leamer and Stern (1970), who attempted to forecast international trade flows as stochastic trade flow events. They stated that trade flows between countries are uncertain in the absence of transport costs and alleged that countries seeking a trade agreement selected their trading partners based on a variety of probabilities. However, the approach was criticised owing to the latest micro-foundation proponents who argued that probability approaches lack theoretical foundations to derive a gravity model. The micro-foundations approach claims that there is no reality in critical 'theory of perfect commodity proxies' of the gravity model. Besides this, the probability approach was further challenged based on evidence showing that international trade flows are distinguished by their origin (Armington, 1969).

Anderson (1979) was the next to provide theoretical justifications for the gravity model. He did this by creating a gravity-like model where goods were differentiated by country of origin and this is commonly referred to as the 'Armington Assumption'. Under this, consumers had preferences defined over all the differentiated products. The gravity model was derived based on the following assumptions:
- Preferences are homothetic and identical across regions.
- Products are differentiated by place of origin.
- Share of national expenditure accounted for by spending on tradable goods is a stable unidentified reduced form function of income and population.

Anderson (1979) derived a model which was based on the Cobb-Douglas Theorem and the constant elasticity of substitution (CES) preference functions for all countries and weakly separable utility functions between traded and non-traded goods. With distance being the only trade cost used in the Cobb-Douglas preferences, Anderson's (1979) gravity model was written as in Equation 3.15:

$$X_{ij} = \left(\frac{GDP_i * GDP_j}{\sum_{j=1}^{N} GDP_j}\right) * \frac{1}{fdistance_{ij}} * \left[\left(\sum_{j=1}^{N} * \frac{GDP_i}{GDP_w}\right) \left(\frac{1}{fdistance_{ij}}\right)\right] \dots\dots\dots\text{Equation 3.15}$$

While Equation 3.3 and the Equation 3.15 above are almost identical, the addition of the CES preferences made the latter more complex. The result from this model states that larger countries import and export more. This was based on the assumption that all goods are traded, all countries are involved in trade and national income is calculated as the sum of both home and foreign demand for the distinctive goods produced by each country. The major limitation of Anderson's equation, which led to a more theoretical underpinning of the gravity model, is the assumption that all prices are constant[31].

Since Anderson's (1979) gravity equation did not include price terms, it led to the creation of another gravity equation by Bergstrand (1985). His gravity model involved price indices while he also used the CES preferences to derive an abridged gravity equation with which to analyse bilateral trade. While Anderson's gravity model was derived at the aggregate level, Bergstrand (1985, 1989) developed a gravity model based on the microeconomic foundation. He explained that the gravity equation is an abridged form of the general equilibrium of demand and supply systems. He also stated that the model of trade demand for every country is a result of maximising the CES utility function subject to income constraints in importing countries. In contrast, the model of trade supply is obtained from the method used by firms to maximise profit in the exporting country in which the resource allocation is determined by the constant elasticity of transformation. The gravity model of trade is obtained in this example where demand for trade flows equals supply of trade flows. He also pointed out that, since the gravity model (reduced form of the GE model) removes all endogenous variables from the explanatory part of each equation, income and prices can also be used as explanatory variables of bilateral trade flows. He therefore treated certain price terms and income as exogenous variables instead of substituting all endogenous variables. This solves the

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[31] In reality with asymmetric trade costs, prices differ across producers.

general equilibrium system while retaining these variables as explanatory items. The resulting model is termed a "generalized" gravity equation.

Bergstrand's gravity model is based on the assumptions of nationwide product differentiation by monopolistic competition and identical preferences and technology for all countries. With N countries, one aggregate tradable good, one domestic good and one internationally immobile factor of production in each country, Bergstrand's (1985) model is the general equilibrium model of world trade. This model was extended in his 1989 article (Bergstrand, 1989) where production was added under conditions of monopolistic competition among firms which use labour and capital as factors of production. Firms produce differentiated products under increasing returns to scale. Ever since the theoretical justification by Anderson (1979), it became very clear that the gravity model could be derived from various trade models including the Ricardian model, the Heckscher–Ohlin (HO) model, and the Increasing Returns to Scale (IRS) model. These models all use different methods with regard to the product specialisation which is gained in equilibrium. For the Ricardian model it is technology differences, while for the HO model it is factor proportions outside the vector space of diversification. Lastly it is increasing returns at the firm level for the IRS Model. During this era, international trade flows were analysed by the Ricardian model and the Heckscher-Ohlin (HO) model. Leamer (1974) used the HO model and the gravity model in a regression equation to analyse trade flows, although the two models were not theoretically integrated. Amidst various attempts made to strengthen the theoretical foundation of the gravity model, Deardorff (1998) and Evenett and Keller (1998) examined the usefulness of this model in assessing alternative theoretical trade models. Deardoff (1998) proved that the Heckscher–Ohlin (HO) model also contributed to the theoretical justification of the gravity model. This analysis was carried out in two stages. Firstly frictionless trade (no barriers of trade) and identical preferences were used where there was an assumption that trading partners are randomly chosen by consumers and producers. Secondly trade impediments were added under the assumption that factor prices are not equal. The results of the study showed that simple forms of the gravity model can be obtained from standard international trade theories and, as it describes and illustrates many other

international trade models, its use in empirically testing any of the models is 'suspect'.

In a study by Evenett and Keller (1998), the Heckscher Ohlin (HO) model and the Increasing Return to Scale (IRS) model were analysed. Their study aimed to investigate whether the empirical success of the gravity model could be traced to either of the two models. The study showed that different versions of both models can generate this prediction. Three major findings that resulted from their analysis were as follows, firstly, there is little perfectly specialised production due to factor endowment differences, thus making the perfect specialisation version of the HO model an unlikely candidate to explain the empirical success of the gravity equation. Secondly, increasing returns are an important cause of perfect product specialisation and the gravity equation, especially among industrialised countries. Lastly, to the extent that production is not perfectly specialised across countries, the study supports both the HO and increasing return models. Based on their findings, it was concluded that both models explain diverse components of the international variation of production patterns and trade volumes with important implications for productivity growth, labour and macroeconomics (Evenett and Keller, 1998).

The theoretical underpinnings for the gravity equation were further proposed in Feenstra et al. (1998). He advised that the empirical performance of the gravity equation specifically relates to the type of goods analysed. The study further demonstrated that the existing theory for the gravity equation depends on the assumption of differentiated goods and can also be derived from a 'reciprocal dumping model of trade in homogeneous goods'. Hypothetically, the gravity equation should have lower domestic income elasticity for exports of homogeneous goods than of differentiated goods because of the "home market" effects which depend on barriers to entry. In his study, the home market effect was quantified empirically using cross-sectional gravity equations, with the results revealing that domestic income export elasticity is indeed substantially higher for differentiated goods than for homogenous goods. In a later study, Feenstra (2002) analysed the CES monopolistic competition model where transport costs and other trade barriers are included and concluded that, when transport cost and trade barriers are included, it is necessary to consider the

overall price indices in each country. There is however a general assumption that both models cannot provide theoretical justifications for the gravity model because they do not involve aggregate bilateral trade flows in a multi-country world (Bergstrand and Egger, 2010).

The gravity model's cost element took on another dimension in Anderson and van Wincoop's (2003) study. Indeed, they argued that the gravity model shows an expenditure equation with the assumption of market clearing. However, the authors concurred with Linnemann (1966) and Deardorff (1998) that the gravity equation is one of the most successful models in the study of empirical economics. The gravity model attracts economic applications since it offers new explanations of the theory which lies behind the model as well as its specifications.

Bergstrand and Egger (2010) noted that many studies depended on the theoretical justifications of Anderson (1979) and Bergstrand (1985) where the role of price indices was not properly handled in the gravity equation up until 2003. This led Anderson and Wincoop (2003) to refine the theoretical justifications of the model by stressing the significance of properly accounting for the endogeneity of prices[32] in the gravity model. The study stressed that, although most studies have used appropriate data, the results will be biased as long as they have not controlled for relative trade costs. They created a gravity equation from a model of monopolistic competition in differentiated products with CES preferences. Theoretically, their gravity equation showed that bilateral trade was determined by relative costs and not the absolute costs between countries. It can be explained by stating that the tendency for country j to import from country i depended on the trade costs between country i and country j, relative to j's average "resistance" to imports (P_j) and to the average "resistance" facing exporters to country j (P_i).

The equation can be written as:

$$X_{ij} = \left\{ \frac{t_{ij}^{2-\delta}}{P_i^{2-\delta} P_j^{2-\delta}} \right\} . \left\{ \frac{GDP_i . GDP_j}{GDP_w} \right\} \quad \text{..Equation 3.16}$$

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[32] The price is determined by trade costs and Anderson and Wincoop (2004) defined trade costs as the total sustained in the process of transporting the goods to the final user. This however does not include the cost of producing the good itself.

where

δ = elasticity of substitution between the different types of goods

t_{ij} = bilateral trade costs between county i and country j

P_i and P_j = outward and inward multilateral resistances

Various studies have applied and published comments regarding the use of the gravity models stated above. In reference to Linnemann's model, it can be noted that it only supports perfect product proxies, which according to other authors is unrealistic. Despite the fact that criticisms of perfect commodity substitution dominate these studies, Frankel and Rose (2002) supported Linnemann's view that the initial introduction of the gravity model was theoretical, although it was reasonable to be applied in empirical studies. It is on this basis that Deardorff (1998) and Feenstra, Markusen and Rose (2001) contributed to the concept of the gravity model.

Deardorff (1998) identified income and distance as the core regressors in the model. This is in line with Linnemann's expression regarding combined factors of potential supply and potential demand. Feenstra, Markusen and Rose (2001) added to this view in Deardorff (1998) by asserting that the model can be used in empirical studies to differentiate between related economic theories.

The relationship behind the use of the gravity model exhibits a very high level of robustness despite differences in the economic tests to which it has been subjected (Barrett et al., 2005). In as much as Helpman (1989) stated that the economic use of the gravity model has been lacking and is unconnected to a majority of economic theories, he still agreed that it is one of the most successful models in empirical economic studies, which significantly arranges several variations in observations (Helpman, 1989).

In support of Helpman's view, Baier and Bergstrand (2006) stated that the gravity model is widely applied in economic studies which attempt to examine trade shifts as well as factor movement. From a modelling point of view, Baier and Bergstrand posited that the gravity model is well known for its significant application due to its prudent representation of the interaction of

various elements of economics between one or more countries (Baier and Bergstrand, 2006). The authors further added that the gravity model allows researchers to trace all parts of the presented economic elements (Baier and Bergstrand, 2006). This has made it possible for many researchers to explore the movement patterns of commodities and factors of production across borders or regions.

After conducting a cross-border examination on the application of the gravity model, Baier and Bergstrand (2006) noted that most of the gravity model studies analysing the border effect used it to analyse trade patterns of either two or three nations. They stated that the traceability of trade patterns among many countries has been made possible due to the modularity of the gravity model[33]. This concept therefore reflects the views of Helpman (1989) and explains the significance of the gravity model's modular nature. Anderson (2011) explains that the modularity of the gravity model makes it possible for disaggregation of goods at any scale and allows inference about trade costs.

From the modularity perspective, Helpman (1989) asserted that the way or pattern in which goods or factors of production are distributed depends on gravity force. This force is also determined by the magnitude of economic activities at every point in time and place (Helpman, 1989). It can be noted that modularity of the gravity model permits the use of disaggregated data. When the modularity concept is applied in full equilibrium, it is generally possible to deduce the costs of trade, which do not rely on any market structure or production model (Baier and Bergstrand, 2006). Based on this view, the gravity model shows that the extent to which trade occurs between two nations is not only controlled by supply and demand conditions at the countries of origin and destination respectively but also by forces which restrict trade processes between the two countries.

In agreement with the views of Linnemann (1966) in the generalised gravity model, Deardorff (1998) and Feenstra, Markusen and Rose (2001), and Baldwin and Taglioni (2006) also included distance as a measurement of transaction costs. The coefficients used in the model's equation are elasticity

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[33] This means that the gravity model is a combination of independent variables that can be combined in a number of ways.

measurements. However, Baldwin and Taglioni (2006) argued that taking the variable distance into the gravity equation can seem to be insignificant in the present globalised world where distance can quickly be surpassed. Logically, this view is quite real due to faster means of transport and communication. However, it can be challenged on the basis that globalisation can only improve communication between two countries but cannot reduce the physical distance between them. Thus, offshore trade will still be negatively influenced by distance. A consideration to include distance for the computation of the cost of international trade implied that the variable has an effect on bilateral trade (Helpman and Krugman, 1985). Distance tends to have an effect on trade in the sense that countries seem to trade less with each other as the distance continues to grow. (Helpman and Krugman, 1985).

Silva and Tenreyro (2003) stressed the unsuitability of the empirical methods used to estimate basic gravity equations. The problem is that log-linearisation of the empirical model in the presence of heteroskedasticity leads to unreliable estimates. As such, if the errors are heteroskedastic, the transformed errors will be generally correlated with the covariates. An additional problem of log-linearisation relates to the fact that it is not well-suited to situations of zero trade flows between countries. In a bid to deal with this issue, researchers have used various inadequate solutions, including truncation of the sample and further non-linear transformations of the dependent variable which have led to bias in the results. They argued that bias is present both in the traditional and the Anderson-van Wincoop (2003) specification of the gravity model, which includes country specific fixed effects. Silva and Tenreyro (2003) stressed that, even under the assumption that all observations on dependent variables are positive, it is not logical to estimate independent variables from the log-linear model. They advised that the non-linear model must be estimated using non-linear least squares (NLS) (see Frankel and Wei, 1993), although they also noted that this estimator ignores the heteroskedasticity. It was on this basis that they introduced the use of the Poisson Pseudo-Maximum Likelihood estimator. The PPML is straightforward, even when the dependent variables are not integers and when trade data suffers from errors. More importantly, it provides an ideal method of handling zero trade flows in the dependent variable. Two different experiments were carried out in their study. The first was aimed at reviewing the

performance of the estimators of the multiplicative and log-linear models under different patterns of heteroskedasticity. The second test investigated the estimator's performance in the presence of rounded errors in the dependent variable. The results clearly indicate that estimation based on the log-linear model cannot be recommended, except under very special circumstances as for example, when the estimates obtained provided insubstantial information on the parameters of interest. A noteworthy outcome from this set of experiments was the very inferior performance of the standard NLS estimators and the promising performance of the Poisson Pseudo-Maximum Likelihood Estimator. In conclusion, the authors found major differences between the estimates obtained with the proposed estimator and those obtained with the traditional method(s). These differences remain even when multilateral resistance terms or fixed effects are taken into account. These results therefore propose that the Poisson Pseudo-Maximum Likelihood (PPML) estimator should be used instead of the standard log-linear model not only to handle zero trade flows in the dependent variable but also when there is evidence of heteroskedasticity.

According to Baldwin and Harrigan (2007), the gravity equation explains the relationship between bilateral trade volumes, distance and country size. Indeed, although many gravity equations have been estimated, usually with "good" results, trade theorists have nevertheless suggested that there are different theoretical explanations for gravity's success. They explained further that the various potential explanations for this make it a problematic tool for discriminating among trade models[34] (Baldwin and Harrigan, 2007).

It is clear from the theoretical foundations that the gravity model can be derived under different conditions and assumptions. Therefore, it can be used to analyse and measure bilateral trade flows between countries in various types of market structure and conditions. The model can be used in various empirical applications in the analysis of international trade, for example, in estimating the cost of a border, for explaining trade patterns, identifying effects related to regionalism and for tabulating trade potentials. Due to its relevance as an empirical tool, the application of the gravity model of trade has become

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[34] The other traditional trade models will be discussed in detail at the end of the chapter. For a more detailed theoretical analysis of these models see Baldwin and Harrigan (2007).

extremely popular. In the words of Eichengreen and Irwin (1997), the model is "... the workhorse for empirical studies" in international trade. Since the early 1990s, the vast availability of international data necessary to fill the standard specification of the model, the relative independence from different theoretical models, and a bandwagon effect have all turned the gravity model into the empirical model of trade flows (Evenett and Keller, 2002).

Figure 3.1 highlights the major theoretical justifications of the gravity model of trade.

Figure 3.1   The Major Theoretical Developments And Justifications Of The Gravity Model Of Trade.

The Law of Gravity by Isaac Newton

Tinbergen (1962)
This study was the first to use the gravity model to investigate bilateral trade. Here, the GDP and Distance variables were used as proxies for mass/size and proximity. The gravity equation was formed using the Newtonian theory of gravitation.

Linnemann (1961)
In this study, Linnemann argues that the gravity model is a reduced form of the partial equilibrium model of export supply and import demand

Leamer and Stern (1970)
This study used the theories of the probability model to explain the gravity equation by forecasting international trade flows as stochastic trade flow events.

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┌─────────────────────────────────────┐
│         Anderson (1979)              │
│  The gravity model was derived       │
│  using a trade share expenditure     │
│  system which assumes identical      │
│  Cobb-Douglas or Constant            │
│  Elasticity of Substitution (CES)    │
│  preference functions for all        │
│  countries.                          │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│      Bergstrand (1985 and 1989)      │
│  Bergstrand in both studies derived  │
│  the gravity model from the trade    │
│  theories of monopolistic            │
│  competition developed by Paul       │
│  Krugman (1980). The main            │
│  advancements from the Anderson      │
│  study (1979) were the inclusion of  │
│  price indices and the development   │
│  of a gravity equation from a        │
│  microeconomic foundation- using     │
│  disaggregated data                  │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│      Evenett and Keller (1998)       │
│  The HO and IRS models were linked   │
│  to the development of the gravity   │
│  model.                              │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│        Feenstra et al (1998)         │
│  The empirical performance of the    │
│  gravity model was linked to the type│
│  of goods analysed and the authors   │
│  asserted that the theory of the     │
│  gravity model was derived from the  │
│  Reciprocal Dumping model of trade   │
│  in homogeneous goods.               │
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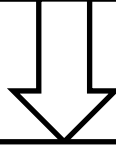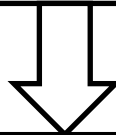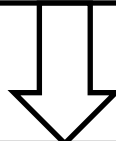
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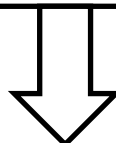
Deardorff (1998)
The gravity model was proven to have stemmed from HO trade model.

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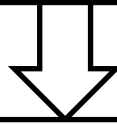
Anderson and van Wincoop (2003)
This study included the introduction of the Multilateral Resistance Terms to the gravity model estimation. They show that controlling for relative trade costs is crucial for a well-specified gravity model. Their theoretical results show that bilateral trade is determined by *relative* trade costs, i.e. the propensity of country *j* to import from country *i* is determined by country *j*'s trade cost toward *i* relative to its overall "resistance" to imports (weighted average trade costs) and to the average "resistance" facing exporters in country *I* and not simply by the absolute trade costs between countries *i* and *j* (Anderson and van Wincoop, 2003).

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Source: Author's Compilation

3.3   A Review of Empirical Studies on the Gravity Model of Trade

The gravity model of international trade stands at the top of the list when comparing empirical economic models. It has remained a reliable means of analysing bilateral trade flows using different methodologies and across different groups of countries. The model has shown consistent empirical robustness and explanatory power in the analysis of trade flows. Although the gravity model can, and has been used, to explain and predict trade flows between countries, a large number of studies have targeted the prediction and estimation of the trade effects of Free Trade Agreements (FTA). These are formed by a group of countries with the aim of reducing or, in some cases, eliminating tariffs and transaction costs between the member countries. This should result in increased trading among the member countries. Major examples of FTAs include the Euro-Mediterranean FTA, the North American FTA, and the ASEAN FTA. However, there has been a great deal of research over the last 30 years, focussing on the impact of this phenomenon and the various economic models which can be used to analyse the trade flows. There are two ways to model trade flows – by simulation or by econometric analysis.

3.3.1 Simulation Models

These models are used to analyse trade flows by replicating the phenomenon over time in order to predict its impact. "*They capture the underlying structure of the trade flows which comprise of activities like production, consumption and transportation and respond to inputs and estimate the potential impacts to the trade flows*" (Kepaptsoglou et al., 2010). They are used by policy makers to conduct an ex-ante assessment of the likely effects of a given reform. Occasionally, the reform may have already been introduced, '*but there is no available counterfactual available to benchmark its effects*' (WTO – Practical Guide to Trade Policy Analysis). The most frequently used simulation models in trade flow analysis are General Equilibrium (GE) models and Input-Output models (I/O). Both have been used extensively in this area of analysis, although the former is often preferred because it takes into consideration transportation costs and calculates trade flows endogenously. The Computable General Equilibrium Model is by far the optimum model for the ex-ante assessment of trade flows and for assessing the impact of FTAs on trade. CGE models have been commonly used in the analysis of various policy issues, e.g., fiscal and international trade policy (Shoven and Whalley, 1984), economic integration and other regional trading arrangements (Lloyd and McLaren, 2004), energy and environmental issues (Bhattacharyya, 1996), economic development and the distribution of income (Decaluwé and Martens, 1989), and dynamic models of tax policy evaluation (Pereira and Shoven, 1988). The CGE models are essentially computer-based and are used to predict the effect of future economic or policy changes. Despite its use in trade flow analysis, it has been disapproved by researchers because of the few number of parameters used in the model. In a CGE model, the statistical properties of the results are unknown and they are robust due only to the few parameters used since they are either guessed or borrowed from other studies and are not estimated. Valenzuela et al. (2007) added that the theoretical foundations of the model are weak and concluded that the CGE model should be combined with other econometric models to obtain improved results.

3.3.2 Econometric Models

In trade flow analysis, the most commonly used econometric model is the gravity model, which asserts that trade between groups of countries is a function of their size and the distance between them. Unlike the CGE model, the gravity model estimates many parameters, controls for other factors which affect trade and is supported by theory. It has been used extensively and has demonstrated excellent empirical robustness in the description of trade flows. Previously, the model was described as having no theoretical justification although authors such as Anderson (1979), Krugman (1979), Helpman and Krugman (1985), Bergstrand (1985, 1990) and Deardoff (1998) have derived theoretical explanations based on economic theory for the model. These were discussed in the previous section. Both the econometric and simulation models have often been used in the analysis and examination of trade flows but the gravity model of trade is by far the most widely used. Indeed, this model has many favourable characteristics, including robust performance and a lack of assumptions while estimating its parameters (Filippini and Molini, 2003). When analysing trade flows using the gravity model, the aim is not only to assess bilateral trade flows but also to examine the other factors which are responsible for trade increases/decreases and their policy implications. Literature on the latter has focussed on an investigation of the singular effects of specific variables on trade flows as well as the possible addition of new variables to the model. For example, Leamer and Levinsohn (1995) argued that results obtained from the use of the gravity model in the analysis of international trade are the clearest and most robust findings in economic research. Deardoff (1984) also stated that the gravity model's ability to analyse and explain the variation in bilateral trade flows and volumes makes it successful empirically. It is the model of choice for economic analysis of trade and is mainly used to estimate the impact of trade flows of Regional Trade Agreements (RTA), Monetary Unions, World Trade Organisation membership and international border blocs. It is also used when analysing the effects of potential barriers to trade and/or stimulants on trade flows. In most cases the gravity model takes the following format –

$$lnX_{ij} = \alpha_i . GDP_i + \alpha_j . GDP_j + \sum_{m=1}^{M} \beta_m . \ln\left(z_{ij}^m\right) + \varepsilon_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..\text{Equation 3.17}$$

z_{ij} represents a set of variables which are related to bilateral trade costs.

In order to review the empirical literature on the gravity model, the studies will be arranged in chronological order.

In his 1962 seminal paper, Tinbergen used the gravity equation to investigate the effects of economic integration. The gravity model in his analysis was simple and straight forward and focused on the aim of his study, namely the causes of deviations from normal trade patterns. He statistically determined the important variables responsible for the volume of trade between country pairs and compared the actual trade volume to the expected volume. In the theoretical comparison between the magnitudes of actual trade with expected trade, Tinbergen's results showed discrepancies, which are indicative of the fact that the exports of a country can either be receiving preferential treatment or can be discriminated against in the importing country. The implication of differences between the actual and computed trade relies on the reliability and accuracy of the theoretical variables of the magnitude of trade flows. The analysis was based on examining the causes of these deviations. His gravity equation consisted of three explanatory variables of GNP of the importing country, GNP of the exporting country and the distance between the countries. These explained the total value of exports from country a to country b. With these variables, Tinbergen created his equation as:

$$E_{ij} = \alpha_0 Y_i^{\alpha 1} Y_j^{\alpha 2} D_{ij}^{\alpha 3}$$ ……………………………………………………………….…………Equation 3.18

where

E_{ij} = exports from country i to j

Y_i = GNP of country i

Y_j = GNP of country j

D_{ij} = bilateral distance between country i and country j

This equation was based on the following assumptions. Firstly the estimations of the numerical values of the four $\alpha's$ were based on the assumption that deviations from the normal pattern of actual trade from most countries is not a normal occurrence and should therefore follow the usual pattern closely. Secondly, the trade flows in the analysis were limited to commodities because, at the time of his analysis, there was insufficient country data available on the import and export of services.

The first analysis was aimed at explaining the validity of the three explanatory variables used in his equation. He analysed the exports of 18 developed countries in his dataset in 1958. The exports were expressed in units of $100million, the gross national product was in units of $10billion and the distance was measured between the commercial capital cities of the country pairs. His gravity equation below was analysed using the least square method with a dataset of 306 (18x17) observations.

$$E_{ij} = \alpha_1 \ln Y_i + \alpha_2 \ln Y_j + \alpha_3 D_{ij} + \alpha_0^{'} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{Equation 3.19}$$

where
$$\alpha_0^{'} = \ln\alpha_0$$

Tinbergen then added some extra explanatory variables to his gravity equation using the same dataset and explained that the volume of trade is not determined solely by economic variables but that political factors can also impact on trade volumes. The main political factor to which he referred was membership of a trade agreement. He introduced dummy variables for the two trade agreements which were in force at the time, namely, the British Commonwealth and the Belgium-Luxemburg and Netherlands Union (Benelux). The third dummy variable that he introduced was the common border variable, which took the value of 1 if two countries shared a common border. The British Commonwealth dummy variable was given a positive value if the countries were members of the Commonwealth and 0 otherwise, while the Benelux dummy variable was zero for trade flows between all other countries and there was a positive value for trade

flows between BLX and Netherlands. The equation derived following the addition of the three new additional dummy variables is shown as

$$lnE_{ij} = \alpha_1 lnY_a + \alpha_2 lnY_b + \alpha_3 D_{ab} + \alpha_4 lnN + \alpha_5 lnP_c + \alpha_6 lnP_B + \alpha_0' \quad ....Equation\ 3.20$$

where
N = variable for common borders (neighbouring countries)
P_B = Benelux variable
P_C = Commonwealth variable

The results of this analysis showed that in both regression equations, the original variables (GNP of importer and exporter) remained dominant and in the second regression the results showed the expected signs were positive for all three variables with only the Commonwealth coefficient being significant.

The second analysis carried out by Tinbergen saw the dataset increase from bilateral trade flows between 18 countries to 42 countries (42x41=1722 observations) in 1959. At this time, the total export trade of the chosen 42 countries was approximately 70% of the total world trade. In this analysis the dummy variable was added to Equation 12, with the results showing a slightly higher regression coefficient than the previous equation.

His third analysis saw the introduction of yet another explanatory variable – a dummy variable representing all colonial relationships/preferential trade agreements between the countries. In his estimation, a value of 2 was given to countries which had preferential trade agreements or were in a colonial relationship, 1 was assigned to countries with semi–preferential trade agreements and 0 for country pair trade flows with no preferential trade agreement. Lastly, the Gini coefficient was applied to measure the degree of export commodity concentration. This variable was introduced because he thought that the trade flows and export values between a diversified country and one which specialises in a particular (or exporting fewer of a) commodity would be different. The value of the Gini index was 1 for countries which export a single product and it was reduced for more diversified countries. Due to the condition of comparability, the number of countries in the dataset was reduced

from 42 to 28 (756 observations) because the Gini coefficient was only calculated for countries with export statistics based on the three-digit SITC code.

Tinbergen's three sets of analysis were similar to the initial 3 explanatory variables used in all 3 equations, the main difference being the number of observations in each dataset. Tinbergen explained that the difference in the number of observations in the 3 datasets was the reason why the results of the absolute value of all coefficients used in the first analysis was lower than the second and third analyses. He went further to explain that the results from the estimations of the second and third analyses are more meaningful than the first analysis. In the first analysis, developed countries were used while the other two consisted of both developed and developing countries. This showed that in the first analysis the GNP was only an indication of the geographical size while it represented both geographical and economic size in the other two analyses. The second reason was that the distance variable was estimated more correctly in the countries included in the last two analyses because the countries were more remote from the West than the less developed countries in the first analysis. In conclusion, he stated that the results from the estimations with a wider coverage were more accurate than those which were solely based on the trade flows of the developed countries.

Linnemann (1966) further employed a trade flow equation 3.2 in a cross section study to examine global trade flows. The research adopted "a multivariate single-equation regression analysis" (i) to establish whether factors in equation 3.6 have a significant contribution in terms of explaining global trade flow, (ii) to approximate the numerical values of the parameters in equation 3.6 and (iii) to compute and analyse the differences between actual and standard trade.

To compare his results with those of Tinbergen, Linnemann used data from 1959 but considered a total of 80 countries, yielding 80 X 79 trade flows (6320), with zero trade flows being dropped.

The set of data above was applied to many categories of models. In the first set, the model below was approximated statistically by employing least square regression methods.

$$lnX_{ij} = \alpha_1 lnY_i + \alpha_2 lnN_i + \alpha_3 lnY_j + \alpha_4 lnN_j + \alpha_5 D_{ij} + \alpha_6 lnP_{ij}^{UUC} + \alpha_7 lnP_{ij}^{FFC} +$$
$$\alpha_8 lnP_{ij}^{PB} + \alpha_0'$$ ....Equation 3.21

With regard to the first series computation equation (19), the three preferences were: (i) P^{UUC} (British Commonwealth preference) and P^{FFC} (French Community preference) and P^{PB} (Belgium and Portuguese colonial preference). The computation was performed with only trade flow data. The findings were acceptable given that φ values had anticipated signs and were all significant. However, dependent export and import data as well as real and nominal income did not significantly influence the outcome of the study.

In the second series of calculating trade flows using equation (19), there was consideration of: (i) non-zero trade flows in the first series minus (ii) non-zero trade flows with elaborated values of the zero, as well as (iii) zero flows with an elaborated value greater than zero. However, only three preference variables were accommodated: (i) P^{UC} (Preferences for UK associates between one another), P^{FC} (Preferences for French associates between one another, and P^{UFPB} (Preferences for UK, French, Portuguese, and Belgium transactions with their own associated countries). In contrast with the first series, the tests for the second series of trade flows had new parameters with higher absolute values. In this regard, GNP values increased by almost half, coefficients of population were doubled and distance was increased by more than half the original values used in the first series tests. This suggests that the explained trade flow is more sensitive to differences in independent parameters[35]. As in previous studies, it was observed that the correspondence between explained and actual trade flow is significant when it comes to distinguishing the more important formulations in the presence of neglected factors like zero trade flows.

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[35] See Linnermann (1966) for a more detailed explanation.

In his third series of data Linnemann introduced a variable known as the commodity explanatory variable[36]. This was based on the proposition that trade flows from country i to country j will rise when there is a superior commodity composition which matches the imports of country j. Linnemann computed this by breaking down the composition into n-classes and comparing the n-aspect vector between every pair of nations. As in the first two tests, only non-zero observations were considered. Similarly, the study applied multiple regression analysis approaches. As opposed to previous tests, the preference variables were increased from three to five. These were P^{PB} (Preference of Portugal and of Belgium in transactions with their associated countries), P^{U} (Preference of United Kingdom in transactions with its associated countries), P^{F} (Preference of France in transactions with its associated countries), P^{UC} (Preference of UK associates among themselves), *and* P^{FC} (Preference of France associates among themselves). In this study, the incorporation of additional variables raised multiple regression coefficients. In addition, it was observed that systematic dominance of the exporting country's GNP parameter over the importing nation vanished. However, this did not improve the situation regarding many non-zero flows. Hence, it was concluded that variability in commodity composition can only change and improve the findings, although not in a fundamental way.

Indeed, Linnemann's model was later criticised for lacking price variables. This motivated Bergstrand (1985) to develop a gravity model from the general equilibrium model. Bergstrand (1985) reasoned that if total trade flows are differentiated by their country's origin, then Linnemann's gravity model omitted certain price variables which would lead to the gravity equation being incorrectly specified. He explained further that the gravity model should contain price variables because 'aggregate trade flows are differentiated by national origin'. He estimated a gravity equation which included price variables in order to demonstrate the solid evidence suggesting the existence of nationally differentiated products. Similar to Linnemann's model, Bergstrand used variables for preferential trading agreements as a proxy for tariff variables. Transport cost in Bergstrand's model is substituted by the distance between i and j's economic centres and a dummy variable for their adjacency. Bergstrand used aggregate price indices as a substitute for import price indices. Finally, Bergstrand

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[36] This variable should indicate the goodness of fit of country i's exports to country j's imports.

incorporated an exchange rate index to signify shifts in currency values between two countries. Therefore, Bergstrand's general gravity model was estimated based on the statistical data of 15 OECD countries for the years 1965, 1966, 1975 and 1976. This selection of different years was designed to help the study specify the stability of variable estimates from a given year to another year and from a given decade to another decade as well as from fixed to varying exchange rates. Thus, Bergstrand's equation can be expressed as:

$$PX_{ij}=aY_i^{\beta1}\ Y_j^{\beta2}D_{ij}^{\beta3}T_{ij}^{\beta4}E_{ij}^{\beta5}P_i^{\beta6}P_j^{\beta7}K_i^{\beta8}K_j^{\beta9}\dots\dots\dots\dots\dots\dots\dots\text{Equation 3.22}$$

where PX_{ij}= trade flow value from country i to country j,

Y_i = i's income,

Y_j = j's income

D_{ij} =transport cost factor substituted by distance between the two nations' economic centres and a dummy variable for their adjacency

T_{ij}=tariff variable between country i and country j, substituted by dummy parameters showing the prevalence of preferential trading

E_{ij}=currency exchange rate index showing country i's currency value for a unit of j's currency as the common base

P_i =i's export unit value

P_j = j's export unit value

K_i =country i's GDP deflators

K_j = country j's GDP deflators

As can be seen from Bergstrand's general gravity model equation, price factors were added while population size was omitted. It can also be noted that major indicators on the supply side include K_i and P_i while major indicators on the demand side are K_j and P_j. When looking at his results, all of the expected signs in a standard gravity model were achieved – the variables for preferential trading agreements, common borders and income all had positive signs while the

distance variable, as expected, had a negative coefficient sign.

Frankel wanted to establish the difference between the trade level within regions which can be explained through the usual economic factors affecting bilateral trade and the level of trade which is attributed to the effects of a regional trade agreement[37]. In order to achieve this, Frankel et al. (1995) analysed the trade patterns of 63 countries. The dependent variable in their study was total trade which included both imports and exports between the 63 countries. Geographical proximity was measured as the log of the distance between the capital cities of the country pairs while a dummy variable was added for adjacency to signify when the country pair sharing a common border. As such, the basic form of the equation can be expressed as:

$$\ln(T_{ij}) = \alpha + \beta_1\ln(GNP_i{}^*GNP_j) + \beta_2\ln(GDP_{pci}{}^*GDP_{pcj}) + \beta_3\ln(D_{ij}) + \beta_4(ADJACENTij) + \gamma_1(EA_{ij}) + \gamma_2(EC_{ij}) + \gamma_3(NAFTA_{ij}) + U_{ij}\dots \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{Equation 3.23}$$

where

T_{ij} = aggregate bilateral trade between countries i and j

GNP_i = i's GNP

GNP_j = j's GNP

GDP_{pci} = i' GNP per capita

GDP_{pcj} = j's GNP per capita

D_{ij} = distance between the two countries i and j

ADJACENTij = dummy variable for adjacency

EA_{ij} = East Asia dummy variable

EC_{ij} = European Community dummy variable

$NAFTA_{ij}$ = North American Free Trade Area

When applying the gravity equation (21) to data from 1965 to 1990, the results showed that the four standardised gravity variables were statistically

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[37] The East Asia (EA), European Community (EC) and the North America Free Trade Area (NAFTA) were the dummy variables added to the gravity equation to investigate the trade effects of membership in a regional trading agreement.

significant[38]. Frankel et al. later added a dummy variable for countries which shared the same language or had colonial relationships. The results went on to show that countries which had colonial relationships and shared the same language traded more (up to 65%) than with other countries. The languages used in the analysis were English, Chinese, Spanish, French, German, Dutch, Portuguese, Arabic and Japanese. They also went a step further and investigated the languages which were more important in affecting trade flows by adding a linguistic variable. They found that two Chinese speaking countries are 4 times more likely to trade with each other than other countries speaking the same language. They noted however that the introduction of the colonial and linguistic variables into the equation had very little effect on the other coefficients.

Frankel and Wei (1997) carried out an analysis of the East Asian region, attempting to establish the trade volume among the countries involved. The main aim of the analysis was to detect and quantify intra-regional bias. The dependent variable used in their analysis was the bilateral trade flows between the country pairs as applied in the earlier study (Frankel et al., 1995). The other variables used were similar to those by Frankel et al., with the main difference being the use of GDP in the present study as opposed to GNP used in Frankel et al. (1995). They estimated the equation using OLS regression equation. The data was used to analyse 63 countries in total for the years 1980, 1990, 1992 and 1994. The equation can be written as –

$lnX_{ij} =$
$\alpha + \beta_1 \ln(GDP_i GDP_j) + \beta_2 \ln(GDP_{PCI} GDP_{PCJ}) + \beta_3 \ln(Distance_{ij}) + \beta_4(Adjacency_{ij}) +$
$\beta_5(Language_{ij}) + \gamma(ASEAN_{ij})$ ……………………………………………………… Equation 3.24

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[38] In the results the estimated coefficient for the GNP ranged from 0.26 – 0.40 between 1965 and the 1980s, this proving that richer countries trade more and the coefficient on the distance variable in 1990 was -0.6 when included the adjacency variable. This shows that when the distance between two countries that do not share a border is increased by 1%, while there is a reduction in trade of approximately 0.6%

In their gravity equation, the last three factors are dummy variables capturing the effects of common borders, the same language and membership in a regional trade agreement. The other RTAs used in the analysis were the European Union (EU), North American Free Trade Area (NAFTA), Common Market for South America (MERCOSUR), the ANDEAN community[39] and the Australia New Zealand Closer Economic Agreement (ANZCERTA). The results indicated that the ASEAN variable was statistically significant and there was intra-regional bias in all the years under review. This means that any 2 member countries of the ASEAN trade agreement are 6 times more likely to trade with each other than any other 2 similar countries.

This section is not comprehensive due to the large number of global studies which have analysed international trade flows. As such, and for ease of reference, the next section will group the empirical applications of the gravity models into subheadings.

3.4   *Regional Trade Agreements and the Gravity Model*

Regionalism is defined in the Dictionary of Trade Policy Terms as "actions by governments to liberalise or facilitate trade on a regional basis, sometimes through free-trade areas or customs unions". Gravity models have been used extensively to analyse the trade effects of Regional Trade agreements (RTA). There are various forms of integration arrangements which aim to enhance trade between members, including preferential trading areas, customs unions, monetary or currency unions and free trade areas. In this section, RTA will be used as a generic descriptor when reviewing the literature on this topic. The main examples of RTAs include The European Union (EU), The European Free Trade Association (EFTA), The North American Free Trade Association, The Southern Common Market (MERCOSUR), The Association of Southeast Asian Nations (ASEAN) Free Trade Area (AFTA), and The Common Market of Eastern and Southern Africa (COMESA). The literature on the effect of RTAs goes back to

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[39] The Andean Community is a customs union comprising the South American countries of Bolivia, Colombia, Ecuador, and Peru while the MERCOSUR consists of Argentina, Brazil, Paraguay, Uruguay, Bolivia and Venezuela.

the 1970s and 1980s, with Aitken(1973) and Brada and Mendez (1985), although the renewed interest in the use of the gravity model to investigate the RTAs' trade effects of RTAs was a result of the upsurge in the number of RTAs formed in the last decade. This inspired extensive research into their economic and trade effects. Secondly, the development of theoretical justifications of the gravity model led to the model's recognition as an econometric tool in the analysis of trade flows. Lastly, the potential for using the framework for ex post as well as ex ante analysis (to predict trade potentials and therefore comment on potential adjustment problems) was also seen as useful. Research into regionalism in Europe has been subject to more enquiry than any other part of the globe due to the fact that the European Union is the most durable RTA worldwide and its succession of enlargements provides a series of natural experiments for researchers. The traditional gravity equation assumes that economic size and distance are the key factors in explaining the bilateral trade flows between two countries. Equation 1 was successfully used in the analysis of trade flows until recently. Indeed, this changed with the establishment of the model's theoretical underpinnings, stating that a dummy variable needed to be added to the traditional gravity model to look for the specific effect of the RTA on trade. If the RTA increases the trade among member countries, then the RTA dummy variable which represents the existence of an RTA between a country pair will be positive and statistically significant.

Table 3.1 shows studies which have used the gravity model to analyse the trade effects of RTAs.

Table 3.1 Gravity Model Analysis of the Trade Effects of RTAs

Study	RTAs	Time Period
Aitken (1973)	EEC, EFTA	1951 - 1967
Frankel and Wei (1993)	All RTAs	1965 - 1990
Frankel (1993)	All RTAs	1980 - 1990
McCallum (1995)	CUSTA, NAFTA	1988
Frankel, Stein and Wei (1995)	All RTAs	1965 - 1990
Gros and Gonciarz(1996)	CEECs, EU	1992
Finger, Ng and Soloaga (1998)	CARICOM, NAFTA AND MERCOSUR	1988-1996

Bayoumi and Eichegreen (1998)	EEC,EFTA	1956 - 1992
Soloaga and Winters (1999)	ALL RTAs	1980 - 1996
Sharma and Chua (2000)	ASEAN, APEC	1980 - 1995
Endoh (1999)	EEC, NAFTA, CMEA	1960 - 1994
Egger (2002)	OECD, CEECs	1986 - 1997
Hassan (2001)	SAARC,ASEAN,NAFTA,EEC	1996 and 1997
Sapir (2001)	EU, EFTA	1960 - 1992
Dhar and Panagariya (1999)	EC, EAST ASIA, NAFTA	1980 - 1991
Nilsson (2000)	EU, CEECs	1989 - 1992
Greenaway (2000)	ALL RTAs	1965 - 1993
Sharma and Chua (2000)	ASEAN, APEC	1980 - 1995
Nilsson (2002)	EU, ACP	1973 - 1992

Source- Greenaway and Milner (2002)

The results of the studies above all indicate significant increases in trade flows between member countries of an RTA. Even when distance is controlled for, member countries of RTAs still trade more with each other than they would with non-members. The trade increases, which emerge as a result of RTA membership, are based on the assumption that the RTA would lower the number of intra-regional barriers by elimination or reduction. Little research effort has been put into analysing the effect of RTAs where there is no effective liberalisation and therefore negative trade effects. In the few cases where the trade effect on RTAs with little integration has been analysed, the results are either negative or absent. Ng and Soloaga (1998) and Soloaga and Winters (1999) found negative trade effects for MERCOSUR while Sharma and Chua (2000) analysed the trade effects of ASEAN and found no trade increases among the countries. Similarly, Hassan (2001) examined the trade effects of ASEAN and SAARC in Asia and for both RTAs found negative trade effects.

In recent studies however, the research questions have been extended beyond whether or not the formation of an RTA aids trade increases among the member countries. When analysing the trade effects of RTAs, the main objectives in the recent studies are aimed at answering one or more of the following questions:

i.   Are RTAs a natural feature of international trade? (do countries tend to trade more with their neighbours?)

ii.   Do RTAs have a specific effect on trade? (do RTAs actually stimulate intra-regional trade?)

iii.   Can the effect of RTAs on trade be estimated?

iv.   How do RTAs affect trade with non-members?

Frankel, Stein and Wei (1995) introduced a dummy variable in order to investigate whether regional trade blocs are natural. They argued that countries geographically located close to one another would trade more among themselves, regardless of whether or not they are members of the same RTA. After they had controlled for the major factors which aid trade increases among countries (common borders, common language and distance) the result showed that, in Latin America and Western Europe, the answer was positive but negative in East Asia and North America.

Studies which predict trade potentials analyse the additional extent to which bilateral trade will increase among countries following the formation of an RTA. The majority of studies examining trade potentials have analysed the RTA effect between the EU and the CEEC. For more in-depth literature, see Hamilton and Winters (1992), Gros and Gonciarz (1992) and Nilsson (2000). The objective behind this kind of analysis is two-fold. Firstly it aims to quantify the potential trade effects and secondly to use this as a basis for speculating on potential adjustment pressures which might follow from further integration (Greenaway and Milner, 2002). The major discovery in terms of the trade potential between the EU and CEECs is that the formation of the EU RTA arrangements has encouraged substantial growth in EU-CEEC trade.

The last strand of RTA trade effects are those which utilise the gravity model in determining the effect of an RTA on non-members. A great deal of research has focussed on measuring trade creation and trade diversion effects of RTAs. Frankel et al. (1995), Frankel and Wei (1995, 1996) and Frankel (1997) analysed the trade creation and diversion effects of RTAs using the gravity model. In their estimation of the model, they included two dummy variables for intra-bloc and extra- bloc trade to capture the trade diversion and creation

effects. The intra bloc dummy was equal to 1 where both countries belonged to the same RTA and 0 otherwise, while the extra-bloc dummy was equal to 1 only if one of the countries in the country pair was a member of the RTA. Their results found that there were trade creation in NAFTA, EU, EFTA, APEC and ASEAN and trade diversion in EU and NAFTA. Other studies which have examined the trade creation and diversion effect include Ghosh and Stephen (2004), Tang (2005), Benjamin (2004) Sucharita and Stephen (2004) among others.

The dummy variable added to the gravity equation is meant to show the trade effects of RTAs by capturing all the characteristics of a specific region. However, there may be certain other characteristics which are actually trade enhancing (apart from tariff removal among members, for example (sound infrastructure) which are not added to the explanatory variables in the gravity equation.

In addition, when analysing the trade effects of RTAs, it should be noted that results vary depending on the type of data utilised. When using disaggregated data, the results will differ across sectors because the margin of preference resulting from RTAs also differs across sectors.

Anderson and Wincoop (2004) also carried out a gravity model analysis using sectoral or disaggregated data and concluded that the traditional idea that bilateral trade flows are explained by the source and the GDPs of the countries may not yield accurate results as the exporter's GDP does not reflect the country's comparative advantage in that sector. Some alternative measures used in place of the GDP are an industry's output data for the exporting country or the use of sectoral fixed effects.

Many post-2003 studies examining the trade effects of RTAs have been driven by econometric and theoretical contributions. Baier and Bergstrand (2007) showed that the most credible assessments of the average effect of an RTA on bilateral trade flows are gained from the theoretically-motivated gravity equation using panel data with bilateral fixed and country-and-time effects. They stated that the alternative methods used to identify the trade impact of RTAs[40]

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[40] Such as instrumental variables using cross-section data

are 'compromised by a lack of suitable instruments' (Baier and Bergstrand, 2007). Their results indicate that being a member of an RTA nearly doubles the volume of bilateral trade between two member countries' after 10 years.

Baldwin and Taglioni (2007) however, used country-pair fixed effects, importer-time fixed effects and exporter-time fixed effects to analyse the trade effects of the EU and the Eurozone countries. They found very little integration in the EU and no effect from the Eurozone's membership on trade among the member countries.

3.5 Common Currency Areas and the Gravity Model

The use of a common currency among a group of countries tends to increase trade through the removal of exchange rate uncertainty and reduction in transportation costs among the members. The main goal of a currency union is to encourage economic activity among the members, including trade. Although there has been extensive research in this area, there remains no general agreement regarding this problem. Gravity-like models have been used to analyse the exchange rate variability and/or currency union effect on trade (Abrams, 1980; Thursby and Thursby, 1987). However, the interest in this area of research was sparked by Rose (2000) when he analysed the trade effects of introducing a common currency and concluded that a common currency membership can increase bilateral trade flows by an outstanding 235%. Rose and Wincoop (2001), in their analysis of 143 countries, introduced a dummy variable which was equal to 1 when a country pair are both members of a currency union and 0 otherwise. Their results showed that currency unions reduce monetary barriers to trade and lead to more trade and welfare among the member countries. In 2004, Rose analysed evidence from 19 studies on the currency union's effect on trade flows and concluded that trade flows are doubled if the countries use the same currency. These results pose the question as to 'Why are the trade effects of the currency union so large?' Research has discovered that the effect of a reduction in exchange rate uncertainty on trade is minimal and in most cases negative among countries (Anderson and Wincoop, 2004). Baldwin (2005) reviewed the issues related to the gravity model estimations using a currency union dummy variable and identified extremely large trade effects of the currency union. As this is the main discussion in the

present thesis, this subheading will be properly analysed in the next chapter on The Euro Effects on Trade.

3.6 *Distance and the Gravity Model*

The distance variable is very important in the estimation of gravity equations. The significance of distance in explaining bilateral trade is one of the most remarkable successes of the gravity model. The negative effect of distance on trade is intuitive but holds up empirically and reflects transportation costs. Leamer and Levinsohn (1995) found that the average distance elasticity is around -0.6, meaning that trade flows are reduced by 60% due to a 100% increase in distance between countries. In their words, they stated that "*the role of distance in the gravity equation has produced some of the clearest and most robust empirical findings in economics".* Distance has been used as a proxy for trade costs in several studies. Indeed, in their analyses, Baldwin and Taglioni (2006) found that distance was negatively correlated with international trade flows and obtained results between -0.75 and -0.91 depending on the specification of the model. Disdier and Head (2008) carried out a meta-analysis of 103 studies in order to determine the factors affecting the distance measure. Their results revealed a negative distance effect with 90% of the estimates used ranging between -0.28 and -1.55. Similar negative results were obtained from Peridy (2005) when he estimated the distance effect using the Hausman-Taylor model. However, in a similar analysis carried out by Egger (2002) using the Hausman-Taylor model, he found a positive yet insignificant distance effect. In his analysis, 7 of the 8 time varying variables had around the same size and significance as the fixed effects. Serelanga and Shin (2004) found positive, insignificant results on the distance effect when the Hausman–Taylor model was estimated with dummy variables.

It is clear that most of the studies regarding the distance effect on trade show a negative relationship. This proves the point alluded to by traditional theories of the gravity model that the more distant countries are from each other, the less is the trade volume between the countries. It should, however, be

noted that the distance variable can also be affected by the model specification chosen (Egger, 2002; Serelanga and Shin, 2004).

In addition to the topics highlighted above, the gravity model has also been used to analyse different scenarios. It has been used to investigate the effects of non-tariff barriers (NTBs) on trade. See Harrigan (1993), Lee and Swagel (1997), Head and Mayer (2000) and Chen (2002). Harrigan (1993) investigated bilateral trade for 28 industries in OECD countries in 1983 and found that NTBs have very little effect on trade. Head and Mayer (2000) also failed to find a positive relationship between trade using sectoral data and NTBs. In addition, gravity models have been used extensively to analyse the border effect on trade. A popular research study on this topic was that conducted by McCallum (1995) who used the standardised gravity model to examine the effects of the US-Canada border on trade patterns between the countries. His results showed that national borders should not be neglected in calculating trade flows between countries because they have a decisive impact on trade. Head and Ries (2001), Eaton and Kortum (2002) and Anderson and Wincoop (2003) have all examined the border effect on international trade.

3.7   Political Factors and the Gravity Model

The gravity model has also been used comprehensively to analyse political factors. It has been observed that trade, political conflict and political cooperation are likely to affect each other in various ways[41]. Conflicts in and among countries may reduce trade through protectionism (Reuveny and Kang, 2003). They further explained that, as the conflicts within the country or region increase, traders will be faced with more political restrictions which may, in extreme cases, stop trade altogether. It should also be noted that the impact of trade on conflict and cooperation varies depending on the country pairs involved. The authors explained this by stating that, in the European Community (EC) for

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[41] The relationship between bilateral trade flows and conflicts can be explored in two ways. Firstly, it can be based on the idea that trade is a cause of peace because it implies economic gains; or trade is a cause of conflict because it implies competition and raises vulnerability to potential foes. The second group however argue that the hostility brought about by conflicts is the factor that reduces trade. Both types of study have reported significant empirical results. See Reuveny and Kang (1996,1998), Polachek (1992, 1997) and Boulding (1962)

example, the members' bilateral trade flows are linked with friendly relations. In contrast, with countries like US–Japan, US–China, or certain pre-World War I major powers, the trade flows seem to be associated with disputes. Earlier studies such as those by van Bergijk and Oldsesma (1990), Gowa and Mansfield (1993), Summary (1999), Pollins (1999) and Mansfield and Bronson (1997) have used gravity-like equations to analyse the effects of political issues such as conflicts, alliances etc. The gravity model was also utilised by Reuveny and Kang (2003) and Polachek and Seiglie (2007) to investigate the simultaneity between conflicts and trade. Reuveny and Kang (2003) made use of the trade study of Bergstrand (1985) and the conflict studies of Polachek (1992, 1997) and Boulding (1962). The analyses used yearly data from 1948 to 1992 of total values of bilateral trade while two indicators for conflict and for cooperation were used to measure political relations. The results of their gravity-like equation supported their initial hypothesis that bilateral trade and conflicts and cooperation actually affect each other. As such, "an increase in bilateral trade causes either conflict or cooperation, while a change in conflicts and cooperation causes an increase or a decrease in bilateral trade flows".

Other studies which have used gravity-like models to analyse political factors have looked to investigate the possible link between economic and political liberalisation. See Barro (1999), Acemoglu et al. (2008), Bockman and Dreher (2003), Sturm and de Haan (2003), and Giavazzi and Tabellini (2005) among others. Mansfield et al. (2000), on the other hand, investigated the influence of the political regime (autocracies and democracies) of countries on international trade. They concluded by stating that a country pair consisting of two democratic countries tends to trade more than a country pair consisting of a democratic and an autocratic country. Other studies have analysed the effect of wars and violence on international trade flows (Bloomberg and Hess, 2006; Martin et al., 2008; Glick and Taylor, 2010), while scholars have also investigated the effect of similarity in governance and institutional quality on trade flows between countries (De Groot et al., 2004).

3.8   *Language and the Gravity Model*

Communication promotes bilateral trade both internationally and in domestic markets. Indeed, this is the reason why all empirical studies applying the gravity equation introduce a common language dummy variable in their models to capture the trade enhancing effects of countries sharing a common language. The three main studies in this area are those by Hutchinson (2002), Melitz (2008) and Fidrmuc and Fidrmuc (2014). Hutchinson (2002) investigated the influence of the English language on US trade in goods, with results showing that the ability to speak English among traders aids trade in the US. The limitation to his research however was that he based his analysis on the US, where the main language spoken is English, and thus the results cannot be used to answer the global question of whether or not "proficiency in English enhances international trade".

In a more recent article, Melitz (2008) agreed with the notion that a common language boosts trade between countries but went one step further and investigated the different ways in which language can increase bilateral trade flows between countries. His results showed that common languages can boost trade between countries in two ways by communication and by translation. His results also showed that the English language, although dominant globally as a language, does not 'particularly boost foreign trade, while the other European languages as a whole do'. Lastly, in their study entitled 'Foreign Languages and Trade' Fidrmuc and Fidrmuc (2014) analysed the effects of the major European languages on trade among the European countries and also found that a common language between countries boosts bilateral trade between them but also that English has a significant effect on bilateral trade flows among EU member countries. However, the other European languages such as German and French showed only weak and mixed results. As such, the study concluded that English, at least in Europe, is a main driver of international trade. The study also emphasised the importance of European, specifically Eurozone countries which do not have English as their native language making positive efforts to learn the language as this can increase trade for the countries. They stated that

"although adopting a common currency is costly because a country must give up its national currency and autonomy over monetary policy, improving linguistic skills in English does not require abandoning national languages. Substantial gains are available at relatively little cost: encouraging the learning of English could well, metaphorically, allow countries to pick up $100 bills lying on the sidewalk" (Fidrmuc and Fidrmuc (2010).

Lee (2012), argued that previous studies have focussed on the effects of common languages on aggregate trade in goods and therefore concentrated his analysis on 'assessing the effects of English as a global business language on the bilateral services trade on the sectoral as well as aggregate level'. The analysis was carried out using the theory-based gravity model of Anderson and van Wincoop (2003, 2004) and was estimated using the Poisson Pseudo-Maximum Likelihood (PPML) to deal with the zero trade flows in the dataset which consisted of 22 OECD countries with 34 of their major trading partners. The results suggested that the OECD member countries trade more in services with those countries which have achieved a higher level of English proficiency. Bergstrand and Egger (2010) pointed out that

" the gravity model has been extensively used to estimate the impact of various factors on the volume of trade flows between countries; an entire survey would be required in order to comprehensively cover all these topics". Bergstrand and Egger (2010 pp 32)

The major empirical studies which have used the gravity model as an econometric tool in international trade analysis between1999-2009 are shown in Appendix 1.

3.9 *Major Econometric Issues with the Gravity Model*

Although the empirical background of the gravity model shows that it has been widely tested, developed and applied extensively in understanding international trade flows, it is still associated with certain problems which researchers have tried to resolve in order to justify its validity and applicability in econometric studies. These issues are addressed below.

The gravity model has been referred to as the "workhorse of empirical studies in international trade" (Eichengreen and Irwin, 1998) and has been used extensively over the last half century in studies analysing international trade flows. It is an important tool for policy makers and researchers alike who are concerned with examining the trade effects of various policies because of its ease in testing the effect of trade related policies. In its traditional form, the model had only two variables of GNP and Distance and assumed that the volume of trade between a country pair is positively affected by their national income (size) and negatively affected by the distance between them. The negative sign for the distance variable is due to the increased transportation and transaction costs resulting from the distance between the countries. However, over the years and through the theoretical justifications of the model, researchers have now consistently included more variables that are used to boost or resist trade with a view to enriching the analysis of trade effects between the country pairs and ensuring the results of the gravity model analysis are robust. It has also become common practice when estimating the gravity equation to include dummy variables used to identify particular effects such as common language, common borders, cultural and historical similarities, the existence of regional trading blocs/agreements, monetary and currency unions amongst others. Regulatory policies and country characteristics both political and institutional have been pointed out as factors which can affect the trade flows between countries.

With its success in the analysis of international trade flows in goods, recent years have also seen the gravity model used to analyse international trade flows in services (e.g., Kimura and Lee, 2006). Even with all of its success in the analysis of trade flows in both goods and services, the model still has a few very important shortcomings which, if not properly handled, can bias the results of the analysis. This section highlights the major theoretical and empirical

problems with the gravity equation, stating the available solutions given in the literature. The major issues associated with the gravity model are discussed below.

3.9.1 Gravity Model Using Disaggregated Data

Many studies have analysed the trade effects of common currencies using aggregate data. The major reason for this is that these studies are mainly interested in the effect of the introduction of a single currency on trade as a whole. Theoretically speaking, earlier literature on the gravity model, such as that of Anderson (1979), used the Armington assumption described earlier in the chapter where products were differentiated only by their country of origin and this was consistent with the gravity model. In addition, more recent studies such as that of Augier et al. (2004) and Molinari (2003) have contributed to the debate with the former arguing that it is quite normal for a country to export more of the goods which it has in abundance and noted that this may lead to endogeneity problems when analysing bilateral trade with disaggregated data. The latter argues that the model is unsuitable for an analysis using disaggregated data because it fails to take the determinants of comparative advantage into account, which are important when examining trade effects at a sectoral/industry level.

Eaton and Kortum (2002) argued against the statement made above by indicating that the determinants of comparative advantage are not included in the gravity model. They noted that, as long as "product differentiation is caused by factors other than the country of origin, the model is compatible for disaggregated data analysis". See Deardoff (1995) and Bergstrand (1989). It is also worth noting that all gravity model analysis is generated from a disaggregated level (product or sectoral level) and then aggregated to total trade. For example, in Deardoff (1995), the relevant output variable used was the sectoral output and it only matched the GDP when aggregated over all sectors.

It is not very straightforward when applying the gravity equation to analyse sectoral trade flows or trade in one particular good. In the monopolistic competition model, it is assumed that larger countries produce more varieties of

goods and this contributes to an increase in their trade. As such, they do not necessarily engage in trading more of each good but in trading more goods in total. Therefore, the idea that trade flows between country pairs i and j in sector k are increasing in i's GDP is not necessarily warranted. Hummels and Klenow, 2005) explained that economic growth in countries leads to an expansion of trade both at the extensive and intensive margins with trade in more products and more volume for each product respectively. Thus, at the risk of finding an insignificant coefficient for exporter GDP, the gravity framework is therefore justified to predict trade in one particular commodity. Trade barriers are of particular importance both at the aggregate and disaggregated level when analysing trade flows. However, aggregation of trade barriers into overall indices omits much useful information and this justifies their usual absence from aggregate gravity equations. With this said however, when analysing sectoral trade flows or trade flows of a particular good, the unsound pretext of aggregation is absent and trade barriers must be included in the equation. At the sectoral level the gravity model is a valid econometric tool for the analysis of the effect on trade flows. Nevertheless, it should be noted that GDP used in the gravity equation as a proxy for economic mass when analysing trade flows with aggregated data is not always a valid proxy for demand and supply when disaggregated data is used. In cases like this, when country fixed effects are included in the equation, the right specification of the gravity model should include sectoral dummy variables. It is advisable when analysing trade flows at industry or sectoral level to proxy for industry size rather than country size. Baldwin (2005) explained the economic issue behind this issue:

"When using sectoral trade data, however, the mapping between L [endowment of factors] and E [expenditure on imports] and GDPs is less clear. On the importer's side, one can think of using the corresponding sector's gross value added. However, the imports demand for, say, chemicals arise from many sectors other than the chemicals sector. On the export side, one can think of using sectoral production as a proxy for the number of varieties, but sector production data is difficult to get for long time periods and a broad sample of countries. Moreover, such sectoral value added measures are typically fraught with many measurement problems".

Due to the fact that sectoral data can be difficult to obtain or are unavailable in some cases/countries, a few authors have used the total GDP as a proxy for economic size. Examples include Evenett and Keller (1998), Feenstra

et al. (1998) and Portugal and Perez (2008). Indeed, all carried out sectoral trade flow analysis using aggregate size variables. Moreover, Rauch (1999), in a bilateral trade flow analysis, used GDP as a proxy when examining the impact of common language and distance on various commodities.

Baldwin et al. (2005) also performed an analysis using both aggregate and sectoral variables. For the sectoral variables, they used value added per sector deflated by overall manufacturing producer prices for the exporter and the same measure of apparent consumption described above for the importer.

It can thus be concluded that the use of disaggregated trade data on gravity models is not only possible but ensures a more solid theoretical foundation. As discussed in the earlier section, the gravity model provides enough justification for the analysis of different trade theories and is therefore justified to be used with disaggregated data. The major issue which arises when using disaggregated data is the management of zero trade flows.

3.9.2 Dependent Variable

The dependent variable in a typical gravity model faces four main issues. These include the type of goods or economic activities to be added when defining the trade flows, the conversion of trade values denominated in domestic currencies, the issue of deflating the time series of trade flows and lastly the issue of zero trade flows which was discussed in the previous section.

In many studies using the gravity model, the dependent (left hand) variable is usually the total bilateral trade between two or more countries. There are however three choices available for the researcher in the traditional gravity model namely, total export trade flows, total import trade flows and average bilateral trade flows which is a combination of import and export trade flows. The choice of the dependant variable depends on the situations faced by the researcher when gathering data for the analysis. The theoretical underpinnings of the gravity model favour the use of unidirectional import or export data. However, a lack of data availability or differences in the reliability of data may lead to the researcher averaging the bilateral trade flows. This is carried out by

averaging country i's exports to country j with country j's exports to country i. Each trade flow is seen as an export by the origin country and an import by the destination country. As such, four values must be averaged to obtain the averaged bilateral trade which will then be log linearised. Averaging bilateral trade flows deals with the following issues of:

1. The systematic under reporting of trade flows by some countries

2. Outliers

3. Missing observations

While there may be more ideal methods used to deal with the problems listed above, both historic and current literature in international trade justifies the use of this method. In some cases, averaging the bilateral trade flows should be carried out with care because, if undertaken incorrectly, mistakes can occur and averaging is not always possible econometrically in all cases. For example, it may be impossible to average bilateral trade flows when the direction of the flow is a vital piece of information.

It is worth mentioning again that the results will be biased if the researcher uses the log of the sum of bilateral trade instead of the sum of the logs as the dependant variable. This mistake has been made even in recent research in international trade analysis. However, it will not create a bias if the bilateral trade is balanced. Notwithstanding, if the countries in the treatment group have large bilateral imbalances (as in the case of the EU), then this error (the log of the sum) will lead to the treatment variable being overestimated and would imply that the trade flows used in the dataset are overestimated (Baldwin and Taglioni, 2006).

Another issue which has arisen in the gravity model literature is 'in the expression of trade values' in nominal or real terms. When using the standard cross-sectional gravity model, this issue is of no consequence as 'data for a single year will give equivalent results regardless of any uniform scaling factor applied' (Shepherd, 2012). In contrast, when using a time series context, the way in which the trade values are expressed becomes an issue which must be dealt with properly or else the results will be biased. In theory, trade flows should be expressed in nominal, not real, terms. According to Shepherd (2012), the main reason for this choice related to the notion that 'exports are effectively

deflated by the two multilateral resistance terms, which are special price indices. Therefore deflating exports using different price indices, such as the CPI or the GDP deflator, would not adequately capture the unobserved multilateral resistance terms, and could produce misleading results'.

Baldwin and Taglioni also agreed with this, stating that the trade values should be estimated in nominal terms and expressed in a common numeraire (a common monetary denominator of say US$) due to the fact that the gravity equation is viewed as an expenditure equation. Theoretically, it is not correct to deflate trade flows and empirically can lead to complications with the identification and availability of the appropriate deflators (See Baldwin and Taglioni, 2006).

In summary, the most common mistakes observed in the gravity model literature have been divided into three categories by Baldwin and Taglioni (2006) as seen below.

Gold-Medal Error

Many studies have chosen to omit the multilateral resistance factor. Following Rose and van Wincoop and other authors, Baldwin and Taglioni proposed that the solution to this mistake is to include country dummy variables in cross-section data and country-pair fixed effects in panel data analysis. Nevertheless, country-pair dummy variables are time-invariant and therefore cannot solve the problem fully. Most studies have added country-specific time dummy variables[42] to the estimations to deal with this mistake.

Silver-Medal Error

Certain studies using the gravity model work with averaged bilateral trade instead of direction-specific trade as the theory suggests that the gravity model holds for each and every unidirectional trade flow. The modified CES expenditure function of the gravity equation as explained by Anderson and van Wincoop states that the model is naturally multiplicative. This means that calculation of the average of bilateral trade flows should be geometric (the sum of the logs), as opposed to arithmetic (log of the sums).

Bronze-Medal Error

Most studies have used real trade flows instead of nominal values of trade flows, which is a common mistake made by many scholars. Since there are global trends in inflation rates, the inclusion of this term probably creates biases via spurious correlations. This mistake can be avoided through the inclusion of time dummy variables. See Rose (2000). The time dummy variables included can correct the false deflation procedure because bilateral trade flows are separated by the same price index.

Baldwin and Taglioni, however, pointed out that using the fixed effect model along with Hausman-Taylor is one of the superior estimation techniques used in the analysis of the gravity model of international trade. This is because it deals with "unobserved heterogeneous individual effects and its correlation with both time-varying and time-invariant regressors to avoid any potential bias".

3.10   Econometric Contributions

As previously discussed, the gravity model was derived from a mixture of traditional trade theories, although recent research employing the gravity model in the analysis of international trade flows relies on the theoretical justification of the model set out by Anderson and Wincoop (2003). The gravity model, which is based on a monopolistic competition model with constant elasticity of CES preferences, (see Equation 14) is presently viewed as an important yardstick in empirical work. The major econometric issues that are associated with the gravity model are i) Endogeneity, ii) Accounting for multilateral resistances and iii) Dealing with the issue of zero trade flows.

These three issues will be discussed below.

3.10.1   Endogeneity Issues

When estimating regressions using Ordinary Least Squares (OLS), the basic assumption is that the errors are not correlated to the dependent variables. There are, however, a number of reasons why in some cases the variables are correlated with the error terms. The major reasons include measurement errors, omitted variables and endogeneity. From an econometric point of view, endogeneity of an explanatory variable violates the first OLS

assumption by creating a correlation between that variable and the error term. A common example of endogeneity in gravity models is the issue of tariffs.

To explain the issue of endogeneity, a simple example is given below

X = AB + E

A = XY + D

It is obvious that the current value of A depends on the current value of X, and as such A is most probably influenced by current shocks to X. The equation can be rewritten as

X = (**XY+D**) **B**+**E**

This equation violates the OLS assumptions as A and E are correlated.

Endogeneity bias when not properly treated can lead to inconsistent and biased OLS estimates. The two ways in which this issue can be handled are the adhoc solutions, which involve substituting the endogenous variable with a proxy that does not have the same problem. Although this method is straight forward and simple to implement, the major limitations to this approach are that the interpretation of the results may be difficult since the variable added was just a proxy and not the main variable intended for use and secondly, that the proxy variable may not have dealt with all the endogeneity issues depending on the seriousness of the problem. The second method used to deal with endogeneity bias is the Instrumental Variable (IV) estimation.

Anderson and Wincoop (2004) explained the origin of this bias in different ways. In much of the empirical literature dealing with the issue of endogeneity, authors who are concerned that trade flows can affect output use the instrumental variables for output. The most common instruments used are population and factor endowments (Anderson and Wincoop, 2004). Examples include Harrigan, (1993), Wei, (1996) and Evans, (2003). Another cause of this bias is when the proxies used for trade costs are endogenous. An example of this would be membership of a currency union or a free trade agreement. It has been argued that countries join a currency union because they already have close trade links with each other and not for the general reason that they want to benefit from the advantages of trade. The literature is familiar with this issue and the informal evidence on this is mixed. In order to deal with this issue, economists have used the instrumental variable estimation, which involves the

addition of a variable that is related to exchange rate volatility (or currency unions) but is unaffected by trade considerations (Estervadeordal et al., 2003). Based on casual evidence, Rose (2000), stated that trade does not necessarily play a major role in the choice of becoming a member of a currency union. However, Estervadeordal et al. (2003) argued that in his analysis, "Countries appear to have joined the gold standard as a result of their trade dependence on other countries that happened to switch to gold" (2003: 12).

Rose went on to test for endogeneity by using instrumental variables and came to the conclusion that currency unions have a significant effect on trade. Other authors to have used this approach include Alesina et al (2002) and Barro and Tenreyro (2002).

Whilst there are various techniques available, the most common IV estimator is the two stage least squares (TSLS) estimator. However, in order for this estimator to produce superior results, it must meet certain conditions. Firstly, there must be as many instruments as there are likely endogenous variables. In most cases, it is preferable to have an extra instrument. It is a necessary condition for model identification to have the same number of instruments as the (potentially) endogenous variables. However, the advantage of having extra instrumental variables comes into play when performing extra diagnostic tests which show the soundness of the instruments (Shepherd, (2012). Secondly, the added instrumental variables must be strongly correlated with the prospectively endogenous explanatory variables[43]. Lastly, the instruments must be excluded from the second stage regression equations so that they can only influence the dependent variable through the potentially endogenous variable[44]. Baier and Bergstrand (2004) used this method in their analysis, explaining that the economic factors which are responsible for trade can also be used to explain the formations of free trade areas. As the name

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[43] An F-test of the null hypothesis is carried out in each of the first stage regressions to test whether the coefficients on the instruments are jointly equal to 0. These tests must be reported when the TSLS estimator is used.

[44] The Hansen J-Statistic can be used to test if this condition is satisfied. For this condition to be satisfied, the null hypothesis for the test is that the residuals from both the first and second stages of the regression are not correlated. If this is met it can be assumed that the exclusion condition holds. A high value of the test statistic (low probability value) is indicative that the instruments are not validly excludable, and the TSLS strategy needs to be rethought. Like the first stage F-tests, these tests should be reported when they are available.

suggests, they ran the OLS twice. They first estimated the possibility of an FTA formation between a country pair and then ran another regression using the instruments for the FTA dummy. Some authors to have used this technique include Carrere (2006) and Egger et al. (2009). Baier and Bergstrand (2007) argued that in order to avoid endogeneity bias, the panel data techniques which include fixed effects can be used .They stated that this method will also capture the lagged influences and incorporate the exporter and importer time effects while simultaneously taking care of the limitations of the TSLS approach using cross sectional data[45]. Another advantage of this method, as explained in their article, is that the panel approach 'allows estimates of the "timing" of EIAs' effects on trade flows between short run and long run'..,(2007: 9).

3.10.2 Multilateral Trade Resistance

Anderson and van Wincoop (2003) indicated that bilateral trade flows are influenced by both the trade obstacles which exist at the bilateral level (Bilateral Resistance) and by the relative weight of these obstacles with respect to all other countries. They described this concept as the Multilateral Resistance. After this theoretical contribution, omitting Multilateral Resistance Terms from a gravity equation is considered a serious source of bias and an important issue that every researcher should handle when estimating a gravity equation. (Benedictis and Taglioni, 2011).

The new version of the empirical gravity model highlights the fact that trade flows between countries are not only determined by the basic Newtonian factors of economic size and distance but also by the ratio of 'bilateral' to 'multilateral' trade resistance. Bilateral trade resistance can be described as the extent of the barriers to trade between countries i and j while multilateral trade resistance refers to the barriers which both countries i and j face in their trade with all other trading partners (Adam and Cobham, 2007.)

The introduction of multilateral trade resistance to a gravity equation differentiates the 'new' version of the gravity model, as developed by Anderson and van Wincoop (2003, 2004), from the 'traditional' version used by earlier researchers such as Rose (2000). The key criticisms of the previous literature

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[45] This approach, according to Baier and Bergstrand (2007), does not satisfy the 'exclusion restriction' condition with confidence. See Baier and Bergstrand (2007, 2011) for a more detailed literature on this.

which used the gravity model to study the trade effects of currency unions such as that of Rose (2000) and Frankel and Rose (2002), were focussed on the fact that multilateral trade resistance was not controlled for in the analysis. This led to a 'severe upward bias to the estimated effect of currency unions on trade, thereby leading to the implausibly large point estimates emerging from these early studies' (see Baldwin and Taglioni, 2006).

The gravity model is based on monopolistic competition models and, although easy to derive, can become a problem when taking into account the multilateral resistance terms as these variables are not observable. In their bid to deal with this issue, Anderson and Wincoop (2003) employed a custom non – linear least squares program and estimated the general equilibrium comparative statistics. Another method used by authors is to employ price indices as proxies for the multilateral resistance terms (Bergstrand, 1985, 1989; Engel and Rogers, 1996; Baier and Bergstrand, 2001). It should, however, be pointed out that using price indices as proxies for the MR terms may not be appropriate because, although they may function as price indices, they are not comparable to price data like CPI and PPI. They are also dependent on trade costs, world prices and an intra – sectoral elasticity of substitution.

An alternative method used to account for MR terms in the gravity model is the use of country specific fixed effects[46]. After Anderson and Wincoop (2003) employed this technique, it has been widely used in gravity model analysis.

In 2009, Baier and Bergstrand pointed out that the fixed effects technique has a few drawbacks which could bias the results in the model. He noted that there is a difficulty in generating the country/country pair comparative statistics while using the fixed effects technique. Secondly, he pointed out that the FE subsumes most of the country specific explanatory variables, thereby estimating just the partial effects of the variables. They explained that 'the multilateral price terms are critical, but non-linear estimation is not' (Baier and Bergstrand (2009). They state further that adequate results can be achieved using ordinary least squares (OLS) with a 'first-order log –linear Taylor series expansion to approximate the multilateral price terms'. Baier and Bergstrand concluded by

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[46] As noted in Anderson and Wincoop (2003) and Feenstra (2003)

stating the three main advantages of using this technique. Firstly, this technique permits the use of a simple log-linear gravity equation that supports the theoretical relationship between bilateral trade flows, regional and world incomes and bilateral multilateral and world trade costs. Secondly, they confirmed that when using this method, the comparative statistics are attained easier by estimating 'the reduced form gravity equation which includes the academically inspired exogenous bilateral, multilateral and world resistance terms'. Lastly, the methodology proposed works efficiently and effectively to explain 'world trade flows'.

3.10.3   Estimating Gravity Model with Zero Trade Flows

This is viewed as an issue with the analogy between Newtonian gravity and trade. In Newton's gravity model, the gravitational force between two bodies can be very small but never zero, while trade flows between country pairs could actually be zero. In the gravity model dataset, this condition exists when bilateral trade between two countries is in fact zero. Linnemann (1966) pointed out that almost half of the world's bilateral trade flows are zero. This issue has become a major problem in international trade flows and, from an empirical point, the zero trade flows increase with the level of disaggregation and the inclusion of poorer and smaller countries. According to recent evidence, there is an increasing existence of zero trade flows in bilateral trade relations (Haveman and Hummels, 2004) with 33% of the bilateral trade matrix completely empty and half of the 158 countries not trading with each other. Around 50% of the observations in the studies by Helpman, Melitz and Rubinstein (2008) and Silva and Tenreyro (2006) showed zero trade flows. The traditional gravity equation is written in a log – log form and particular attention should be taken when zero trade flows are present in the dataset. Using logarithms effectively drops such observations from the sample because log (0) will be undefined (Haveman and Hummels, 2004) and it is impossible to raise a number to any power and get zero while zero trade flows cannot be treated with logarithmic specifications (Benedictis and Taglioni, 2009). Thus, the main reasons for the presence of zero trade flows between countries and their management in a gravity model dataset must be identified. Baldwin and Harrigan (2007) and Hallak (2006) asserted that zero trade flow reports in international trade studies truly reflect the non-existence of trade between the two countries. The implication is whether or not

zero observations should be omitted. Silva and Tenreyro (2006) explained in more detail the reasons for the zero trade flows between countries and the solutions used in the literature. In their article entitled 'The Log of Gravity', they gave three major reasons why countries have zero trade flows between them. Firstly, they explained that this happens simply due to the fact that certain country pairs did not actually trade within a given period. They explain further that, when the zero trade flows are caused by this, it does not create a problem if the gravity equation is estimated in multiplicative form. However, there is a problem if the log-linear form of the gravity equation is estimated when there are observations where the dependent variable is zero.

In order to deal with this problem, different theories and approaches have been suggested and used. (See Frankel, 1997, for an explanation of the approaches). The most commonly used empirical method involves the omission of the country pairs with zero trade flows from the dataset and estimating the log-linear form by OLS. According to Haveman and Hummels, (2004), dropping the zero observations is not recommended but instead should be avoided. In some cases, certain authors, instead of completely removing the zero trade flows- $X_{ij} = 0$, rather replace the zero values with small positive trade flows and estimate the model using $X_{ij} + 1$ as the dependent variable. Others use a Tobit estimator to deal with this problem, although it only provides a solution if the zero trade flows have resulted from truncation and the truncation value is known. If the zero trade flows result from selection then the Tobit estimator cannot completely solve this problem. (See Felbermayr and Kohler, 2006). The methods mentioned above all lead to inconsistent estimators of β. In addition, with regards to the extent to which these inconsistencies will be subject to the specific features of the sample and model used, there is no convincing evidence that they will be insignificant.

The second reason behind the occurrence of zero trade flows could lie with rounding errors[47]. For example, in cases where bilateral trade flows are recorded

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[47] There are a number of other errors that can affect trade data, as described in Feenstra, Lipsey and Bowen (1997).

in thousands of US dollars, certain pairs of countries with bilateral trade which did not reach the minimum value will have zero trade flows recorded against them for that period. Silva and Tenreyro explained that, in the case where' these rounded-down observations were partly compensated by rounded-up ones', then the general consequence of these errors would not have a major impact. However, they noted that rounding down of trade flow figures is more common when dealing with either small countries or countries that are far apart from each other. In these cases, 'the probability of rounding down will depend on the value of the covariates, leading to the inconsistency of the estimators'. Lastly, they explained that zero trade flows can be attributed to missing observations which were incorrectly recorded as zero.

Literature has shown that zero trade flows must be handled properly in order to obtain robust results. This has led to researchers seeking solutions to this problem. Another way to deal with zero trade flows is by the use of the Heckman procedure with the most popular estimator being the Heckman 2 stages least squared estimator. This approach, used by Heckman (1979), introduces the inverse of the Mills ratio[48]. The shortcoming of this procedure is that variables which explain the zero trade flows are required. Helpman et al. (2008) used the regulation costs of a firm's entry as the variable explaining the zero trade flows. Although this choice was theory driven, due to limited data Helpman et al. opted for a different measure in their analysis, namely, religion. Indeed, this is not ideal because it affects "both the intensive and extensive margins thereby violating the exclusion condition" (Benedictis and Taglioni 2009). The choice of the optimal variable to use is still open to debate and further research is needed on this topic.

The log-linear gravity models cannot account for zero trade flows and thus the estimation of a dataset with zero trade flows has moved from the OLS estimators to the non-linear estimators. As explained earlier, Silva and Tenreyro (2006) proved that even the non-linear estimators performed weakly and therefore are not ideal when there is evidence of heteroskedasticity and zero trade flows. The PPML estimator was introduced by Silva and Tenreyro (2006) to

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[48] The Mills ratio, pioneered by John Mills is a ratio of the probability density function over the cumulative distribution of a distribution (Benedictis and Taglioni, 2009).

deal with the issue of zero trade flows in the analysis of international trade. The PPML aims to deal with this issue by removing the bias resulting from heteroscedasticity in the error term in most gravity equations. Using this estimation technique, the authors did not agree to the estimation being carried out in log form and felt that it should rather be estimated in levels. Indeed, they argued that this method provides a natural way of dealing with the zero values in a trade dataset. Silva and Tenreyro recommended the use of a Poisson Pseudo Maximum-Likelihood (PPML) estimator, using a log-linear function instead of a log–log function. Westerlund and Wilhelmsson (2009) also used this estimator to deal with the zero values in gravity model datasets. Baldwin and Harrigan (2007) and Egger et al. (2009) discuss the issue in more detail.

3.11 Conclusions

At this point, it is evident that the gravity model has been applied in a wide range of empirical studies which seek to examine the effects of trade-flows between countries. Most of the recent studies have developed their augmented gravity equations from the traditional gravity models developed by Tinbergen (1962) and Linnemann (1966) with the inclusion of more explanatory variables to help measure the trade effect thoroughly. Appendix 1 contains a list of studies that have used the gravity model in their analysis of international trade flows. Although the review suggested that the problems with multilateral trade resistance in the gravity model remain to be fixed, its associated econometric problems, such as zero trade-flows, endogeneity and disaggregated data use, have been acknowledged and resolved through empirical studies, hence leaving the model as a very powerful tool in economic analysis of international trade.

CHAPTER 4

MEASURING THE TRADE EFFECTS OF THE EURO

4.1 Introduction

A currency union is an arrangement where countries come together and irrevocably freeze their exchange rates at a constant rate with the view of reducing or eliminating uncertainty associated with volatile exchange rates. The European Monetary Union (EMU) went the extra mile to create the Euro as a single currency to replace the national currencies of the member countries for both retail and wholesale transactions and as a store of value, a unit of account and a standard of deferred payment. The euro was viewed as the last stage in the completion of the European single market and one of its major objectives is to boost trade among the member countries. The perception behind the euro's trade boosting effect is that the member countries should gain from reduced exposures to exchange rate fluctuations, greater price transparency and the elimination of transaction costs.

The creation of the EMU has sparked much interest regarding the euro's effect on trade and as such there is a growing body of literature relating to the single currency's impact on trade. In economics, the effects of monetary policy and institutions represent a major area of interest and research. The EMU started with 12 countries abandoning their national currencies and adopting the same currency with the hope that the single currency would further integrate the member countries' markets and allow for a more efficient allocation of resources, as reflected in an increase in trade and investment flows (Micco, Stein and Ordonez, 2003). Advocates of the Monetary Union believed this would be the case even though there was little empirical evidence regarding such effects at the time of the writing of the Cecchini Report (European Union 1990). There are numerous ways in which a monetary union can affect trade, including the elimination of bilateral nominal exchange rate volatility, which in turn reduces the risk and uncertainty involved in trade transactions. Although this risk could

be avoided by hedging, it involves cost and resources. Kenen (2003) pointed out that it is not always possible to fully hedge against this risk because the producers are not certain of the price they will receive for their exports or pay for their imports nor about the demand for and supply of their products. This means that the producer could be unaware of the domestic value of foreign currency earnings and payments and the value that should be hedged and sold in the forward market. The trade effects of common currencies,can be measured in different ways. Firstly, a common currency can boost trade through the reduction of exchange rate volatility. This is one of the major effects and involves the abandonment of the countries' national currencies, thus resulting in irrevocably fixed exchange rates among the members of the currency union. It also provides a vehicle for the members to hedge against exchange rate risk in trade with non – member countries. Secondly, there are the effects of setting up a tangible single currency which will be discussed in the next section. These two aspects, although related, are very distinct because a currency union goes beyond the elimination of exchange rate volatility among the member countries. Indeed, it is also responsible for the removal of other transaction costs which are known to affect trade. Clark et al. (2004), De Nardis and Vicarelli (2003), and Berger and Nitsch (2005), all found that, although exchange rate volatility can lead to an increase in trade among member countries, it is viewed as just one of the barriers to trade and hence it is argued that the credibility of the introduction of a single tangible currency which eliminates transaction costs actually boosts trade. Literature on the impact of exchange rate volatility has inconclusive results, although there is some evidence suggesting that the bilateral nominal exchange rate volatility has negative effects which, although quite small, have reduced over time and can vary widely in significance. Edison and Melvin (1990) analysed 12 studies, with 6 revealing negative and siginificant results while one reported that the effects are positive and significant and 5 gave inconclusive reports. IDB (2002) also mentioned a few studies on this issue which suggest that the impact is higher in developing rather than developed countries where hedging mechanisms may not exist.

A single currency has other positive effects apart from the elimination of exchange rate volatilty. Indeed, factors such as transaction costs can discourage trade even in situations where bilateral exchange rates are perfectly stable (See

De Grawe, 1994). Transaction costs have been estimated to be about 0.5% of GDP for the European Union and about 1% of GDP for smaller countries with currencies that are not internationally traded (Emerson et al. (1992). This chapter focusses on analysing both the effect of currency unions (elimination of transaction costs) and exchange rate volatility on trade. The former, which is referred to as the Rose Model of the common currency effect on trade, is of more relevance to this thesis.

The aim of this chapter is to emphasize the motivation for this study by reviewing existing literature and research on Europe's currency union and the relationship between the introduction of the currency union and sectoral bilateral trade flows between member countries.

4.2 The Effect of Exchange Rate Volatility on Trade Flows

Increase in trade flows among members of a currency union is arguably one of the major benefits of adopting or joining a monetary union. It is a general assumption that the removal of exchange rate uncertainty aids international trade flows among member countries. This assumption, however, is not empirically or theoretically grounded, as most studies have not found a positive link between reductions in exchange rate uncertainty and trade.

The breakdown of the Bretton Woods System of fixed exchanges rates in the early 1970s led to extensive research into the exchange rate volatility- trade link, which has been analysed both empirically and theoretically. The theoretical aspects of the relationship between exchange rate volatility and trade have been examined using partial equilibrium models and general equilibrium models. Earlier research regarding the impact of exchange rate volatility on trade were analysed using the Partial Equilibrium Framework. In this model, the exchange rate is used as the only variable while other explanatory variables which are likely to impact on trade are held constant. Within this model, the trade-volatility link is based on the traders' attitude to risk, the market environment, hedging opportunities available and the accessibility of a domestic market.

The results obtained from studies using this model to analyse the exchange rate uncertainty – trade link are two-fold. One the one hand, the results show that exchange rate uncertainty can have an adverse effect on trade

flows. This could be explained by the fact that exchange rate uncertainty leads to an increase in the uncertainty of the base currency value profits in foreign currency, which would lead risk adverse firms to reduce export sales. However, the second strand of literature shows that an increase in exchange rate uncertainty actually does have a positive impact on trade flows. These results are based on the restrictive assumptions of the partial equilibrium models. The results obtained by this group in the literature focus on the profit opportunities which are produced from fluctuations or uncertainties in exchange rates. Table 4.1 is a selection of studies which have used the partial equilibrium model to analyse the volatility - trade relationship. Based on the results of the literature in the table, it is clear that the impact of exchange rate volatility on trade is dependent on the assumptions used in the model. The studies which show a negative impact are based on the risk attitude of the exporter, the lack of hedging opportunities, the exporter's profit being totally dependent on exchange rate risk and the volume of exports not being dependent on the level of exchange rate. It is also evident from the table that, when some of these assumptions are relaxed, results indicate that exchange rate uncertainty has a positive impact on trade.

Table 4.1 Empirical Studies of the Relationship between Exchange Rate Uncertainty and Trade using Partial Equilibrium Models

Study	Exporters Risk Attitude	Product Market Environment	Hedging Opportunities	Accessibility of Domestic Markets	Exchange Rate Volatility-Trade Relationship
Clark (1973)	Averse	Perfect competition	Limited	No	Negative
Ethier (1973)	Averse	Perfect competition	Yes	Yes	Negative
Hopper and Kohlhagen (1978)	Averse	Perfect competition	Partial	Yes	Negative for risk averse agents
Caballero and Corbo (1988)	Neutral	Competitive	No	No	Positive
De Grauwe (1988)	Averse	Perfect Competition	No	Yes	Varies depending on the degree of aversion
Frankel (1991)	Neutral	Monopolistic Competition	No	Yes	Positive
Secru and Vanhulle (1992)	Averse	Monopolistic and Price taking	Yes	No	Positive
De Grauwe (1994)	Averse	Price Taking	No	No	Positive
Broll and Eckwert (1999)	Averse	Price Taking	No	Yes	Positive
Barkolus, Baum and Caglayan(2002)	Averse	Perfect Competition	No	No	Negative
Campa (2004)	Not dependent on the risk attitude	Perfect Competition	No	No	No Impact

Source: Authors Compilation

More recent literature, however, has used the General Equilibrium Framework, which does the opposite of the previous model. It takes into account all the variables and aspects of the economic environment which might influence trade in order to provide more understanding of the volatility – trade relationship. The general equilibrium models show that the main factors which cause exchange rate fluctuations also lead to major changes in other macro-economic variables. Clark et al. (2004) used this fact to explain why the results of the relationship between exchange rate volatility and trade using the partial equilibrium models are ambiguous. He stated that the model totally ignores the impact of other macro-economic variables. He used depreciation as an example, stating that " *a depreciation in a home country's currency as a result of monetary expansion leads to higher import price and reduces imports, but higher demand generated by monetary expansion could offset part or all of the effect of exchange rate depreciation*" (Clark et al., 2004).

4.3 Empirical Literature on the Link between Exchange Rate Uncertainty and Trade

Early work on the volatility- trade link was carried out by Hopper and Kohlhagen (1978) who used a model developed by Either (1973) for traded goods. They investigated the impact of exchange rate volatility on bilateral trade flows for the G-7 countries with the exception of Italy and found no evidence of a negative effect. Using a similar model to that used by Hopper and Kohlhagen (1978), Cushman (1983) lengthened the size of the sample and replaced the real exchange rates used in the earlier analysis with nominal exchange rates. He investigated the volatility-trade effect on the bilateral trade flows of 14 sets of industrialised countries and found a negative and significant effect of exchange rate volatility in 6 of the cases. Moreover, in 1984, the IMF carried out a similar analysis using a different version of Cushman's model to estimate the bilateral exports between the G-7 countries from the first quarter of 1969 to the last quarter in 1982. Their results showed a significantly negative coefficient in two cases while the effect was significantly positive in the rest.

Clark et al. (2004) explained the reasons why the early results of the volatility- trade link are not robust. They first explained that this could be a result of the fact that the sample period over which the exchange rates showed a

significant variation was relatively short. Secondly, the theoretical considerations of the volatility – trade link do not offer any support to the notion that exchange rate volatility has a negative effect on trade. Thirdly, they pointed out that the specifications used in estimating the equations were inadequate as they consisted of just a few macro-economic variables from standard trade models used at the time.

However, more recent work on this topic has utilised the gravity model to analyse the volatility–trade relationship. This has found significant evidence that there is a negative relationship between exchange rate volatility and trade flows. As explained in the previous chapter, the gravity model has been extensively and successfully used to investigate and analyse international trade flows. In its traditional form, the model explains bilateral trade flows between countries and/or regions as depending positively on their size which is usually proxied by the GDP and sometimes population and negatively on the transportation costs involved in bilateral trade. Distance is used as a proxy for transport costs, thus impeding trade flows.

The major concept of the model is that countries with larger economies are inclined to trade more in absolute terms, whereas distance is used as a proxy for transportation costs and it should impede bilateral trade flows. A per capita income variable is also added to some gravity equations to symbolise specialisation; wealthier countries are inclined to be more specialised and also tend to have a larger volume of international trade for any given GDP level (Dell and Ariccia (1999).

Abram (1980) was the first study to use the gravity model to analyse the volatility – trade link and found a statistically negative relationship between them. Brada and Mendez also investigate this effect in 30 countries between 1973 and 1977 to find the effect on the exchange rate system on the volume of bilateral trade flows. Their analyses showed an unexpected result that trade flows were actually higher between countries that had flexible exchange rates than between countries with fixed exchange rates. They explained the results stating that the relationship between an exchange rate system and trade does not necessarily work through the volatility channel. They asserted that the exchange rate system may have an impact on the commercial policy, thus prompting increases in the level of trade. Eichengreen and Irwin (1995)

investigate the degree by which trade blocs and currency agreements affect trade flows. The gravity model estimation showed an increase in trade as a result of currency arrangements and a negative effect of exchange rate volatility on trade. Frankel and Wei (1993) examine the likelihood that the stable exchange rates in the 1980s significantly contributed to a rise in interregional trade. The results show a negative effect of the volatility trade link.

With a dataset on the EU trade flows, De Grauwe and Skudelny (2000) investigate the volatility-trade link between 1962 and 1965. Their results also found a negative relationship. Pugh (2002) analyses the effect on long term exchange rate uncertainty in 14 Western European countries between 1984 and 1990. The justification for the period used was to differentiate between the members and non-members of the Exchange Rate Mechanism (ERM) of the European Monetary system (EMS).Of the 14 countries used, 7 belonged to the ERM and the results indicated that a reduction in exchange rate volatility over long periods of time could lead to increases in trade flows. For the non-members, the estimates indicated that had they been members of the ERM, they would have benefited from between 6-11% increase in trade.

Depending on the analysis, many studies have used additional dummy variables to account for those factors which would ordinarily boost trade between countries, such as common borders and language, colonial history, member of the same FTA etc. When using the gravity model to investigate the volatility - trade link, some measures of exchange rate variability are added to the basic equation to ascertain whether the proxies have a separate, specific effect on trade flows after the major factors have been considered.

Dell and Ariccia (1999) used the gravity model to investigate the effects of exchange rate volatility on the bilateral trade with data from the EU15 countries. In the analysis, exchange rate uncertainty was proxied using different variables, all of which gave consistent results that 'there was evidence of a small but significant negative effect of bilateral volatility on trade'. Rose (2000) also used the gravity model to test for the effect of volatility on trade in 186 countries for five year intervals between 1970 and 1990. His main measure of volatility was the standard deviation of the first difference of the monthly logarithm of the bilateral nominal exchange rate which was computed over five years prior to the

year of estimation. His results were similar to those of Dell and Aiccia. More recently however, Tenreyro (2003) disputed the above results, arguing that the methods used are plagued by a variety of sources of systematic bias[49]. Indeed, the analysis was carried out using the same measure of variability as Rose (2000) for a broad sample of countries using annual data from 1970-1997. The analysis was aimed at addressing the estimation issues in previous studies. The study proposed the use of a pseudo-maximum likelihood (PPML) technique and developed an instrumental-variable (IV) version of the PPML estimator to deal with the endogeneity. In the analysis, it is clear that, when the issues are not identified and treated and the analysis is carried out using the OLS method, there is a small effect on the volatility trade link. In contrast, when a suitable method is used without taking endogeneity into consideration, there is a 4% increase in trade. However, when endogeneity is taken into account through the use of instruments, exchange rate volatility has no effect on trade (these results are robust on the choice of instruments). In conclusion, the results of the analysis carried out showed that exchange rate variability does not affect trade flows. The elimination of exchange rate variability alone does not create any significant gain in trade.

The above studies have all investigated the volatility – trade link using aggregated trade flows. McKenzie (1999) explained that 'because sectoral data do not constrain income and price elasticities across sectors, one should employ sector specific data[50] when analysing the relationship between trade flows and exchange rate movements'. Cote (1994) argues that the reason for the negative relationship between volatility and trade stems from the fact that aggregate data is used rather than sectoral data. Bini-Smaghi (1991) was one of the first studies to analyse the impact of exchange rate on sectoral data. The analysis on the intra EMS manufacturing sector between 1976 and 1984 showed that volatility affects trade negatively. Belenger et al (1998) investigates different sectors in USA and Canada and find a significant negative relationship in the volatility trade relationship in the automobile sector and industry supplies sector, while a positive relationship (although not significant) was found in the food

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[49] See pages Tenreyro (2003) for a detailed explanation of the causes of this bias and proposed solutions
[50] See Klein (1990), Belanger et al.(1992), Peridy (2003), De Vita and Abbott (2004), Saito (2004), Mckenzie (1999), Doyle (2001) and Byrne, Darby and MacDonald (2006).

sector. Rapp and Reddy (2000) analysed the US sectoral exports to six industrialised countries. Their results showed both negative and positive estimates which show the importance of sectoral analysis. The results are indicative of the fact that individual sectors are affected differently by the exchange rate volatility and results using aggregated should not be conclusive. Koren and Szeidl (2003) used disaggregated data to establish the volatility – trade link and found very small effects stating that ' the elimination of exchange rate variability only leads to a change in export prices of only a few percentage points'. Broda and Romalis (2003) also used disaggregated data and found that exchange rate volatility leads to a reduction in trade in differentiated products relative to trade in commodities, although they also noted that the effect is negligible.

The results from the analysis of the relationship between exchange rate volatility and trade is inconclusive. Theoretically, an increase in exchange rate volatility could lead to more trade if the companies are equipped to make good use of the increased profit opportunities. Although some studies have found a positive effect many studies have found that exchange rate uncertainty deters trade and fail to find a link between the two. This result weakens the debate that the introduction of a common currency leads to increased trade, but it should be noted that the negative result obtained is based on the assumption that the introduction of a single currency equates to the reduction of exchange rate uncertainty to nil. The effect of the single currency should be analysed directly so as to judge is desirability.

In conclusion, the negative estimates obtained are established on the interpretation that an increase from exchange rate risk as a result of will lead the risk averse traders to move from risky to less risky ventures which in turn reduces trade. Also exchange rate volatility could have an indirect effect on trade through the effect of exchange rate volatility on government policy. De Grauwe (1988) elaborates on this stating that exchange rate fluctuations could lead to misalignment problems resulting in high levels of unemployment and losses of output in countries where the currencies are overvalued. In the bid to avert these losses, the affected countries enforce protectionist barriers that result in a decrease in trade flows and output.

Similar to most theories in economics, there is another interpretation which supports the hypothesis that exchange rate uncertainty actually leads to a greater volume of international trade. This view originates from the fact that an increase in exchange rate volatility produces a profit opportunity for firms when they can protect themselves from negative effects by some form of hedging opportunities.

Moreover, in the political economic point of view, exchange rate movements facilitate the adjustment of the balance of payments in an event of external shocks, and thus, reduce the use of trade restrictions and capital movement controls to achieve equilibrium, and this in turn encourages international trade (Brada and Méndez, 1988).

4.4 The Effect Of Common Currency on Trade Flows

4.4.1 Introduction

Until recently, there was no literature regarding the impact of common currencies on trade, with the closest being the border effect literature. McCallum (1995) and Helliwell (1998) examined trade between two Canadian provinces and suggested that trade between them was about 10 – 20 times higher than between the provinces and the United States. Borders undoubtedly generate additional costs, which can be translated into price differences and can delineate different economic environments such as national tastes, market conditions, wages, transportation infrastructures etc. (Gopinath et al., 2009).

This huge border effect, particularly among countries which share the same language, similar cultural values and a free trade agreement that minimises trade barriers, suggested that the need to transact in multiple currencies, in the case of trade between provinces and states, might be playing an important role (Micco, Stein and Ordonez 2003). Although theoretical and econometric advancement in the gravity model has led to a huge part of the home bias being insignificant, the border effect remains substantial. See Nitsch (2000), Anderson and van Wincoop (2001) and Head and Mayer (2002).

As discussed in Section 4.3, the empirical literature has failed to find a positive relationship between exchange rate volatility and trade. The results of previous studies which examined this volatility relationship showed that it was either a negative relationship, (e.g. Brada and Mendez, 1988), statistically insignificant (e.g. Belanger et al., 1992) or weak (e.g. Frankel and Wei, 1993). This led to a debate regarding whether or not the trade effect of common currencies differs from the trade effects of exchange rate volatility. In order to ascertain the trade effect of adopting or joining a common currency area, it is necessary to examine the literature on the common currency's effect on trade. The most influential study to have analysed the effects of common currency on trade is that of Rose (2000). In his ground breaking analysis, he utilised the gravity equation to illustrate that trade between countries in a currency union is evidently larger than trade between other country pairs. His study led to a great deal of debate on the results obtained. These indicated that trade of countries within a currency union will increase up to 235% compared to other country pairs. This effect has since been labelled the 'Rose Effect' and has been heavily criticised. Section 4.5 discusses the Rose effect in detail and outlines the major criticisms.

4.5 The Rose Effect

Andrew Rose began the debate on the effect of common currencies on trade and found in his study (Rose, 2000), a significant result which stated that two countries with the same currency are likely to trade up to three times more than two countries with different currencies. In his analysis he isolated the trade effects of adopting a common currency from the trade effects of exchange rate volatility. Most importantly, Rose used bilateral exchange rate variability as one of his variables and, even if he had not used the currency union dummy, the study would still have been important because the latter variable explains bilateral trade and was highly significant statistically. This finding has been confirmed by Klein and Shambaugh (2006), thus sparking economists' interest in this area of research. Rose (2000) was viewed as a very important study in this field of research although it was ultimately subject to a great deal of criticism. Rose analysed the bilateral trade flows using the gravity model to determine the trade effects of common currencies and exchange rate uncertainty between 186 country pairs from 1970 to 1990 at 5 year intervals. He added dummy variables

to the traditional gravity model to capture other factors that could affect the volume of trade flows between the countries. Rose's gravity theory was based on the fact that two countries will trade more with each other if the combined national income between them is great and there is little distance between them. He also stated that countries are most likely to trade more with each other if they share a common language, common border, have or had a colonial relationship, used to be part of the same country and are members of the same free trade area. These dummy variables were all equal to 1 if they were shared by a country pair and 0 otherwise. Aside from the historical and cultural dummy variables added to his gravity equation, Rose also added two additional monetary variables which were viewed as the major feature of his model. The first variable to be included was aimed at measuring the exchange rate uncertainty between the country pairs. Exchange rate volatility is seen as a barrier to trade while stable exchange rates between countries' currencies is meant to have a positive effect on their bilateral trade flows and thus no negative coefficient for this added variable was expected. The inclusion of a variable to measure the effects of volatility was not initiated by Rose (2000). Many such variables have been used in analysing the trade effects of exchange rate volatility discussed in the previous section. The inclusion of the second variable of "*the currency union dummy*" in his gravity equation was a novelty in the gravity equation. This variable takes the value of 1 if a country pair belongs to the same currency union and 0 otherwise. The major finding in his analysis was to test whether being a member of the same currency union led to increased trade among its members; therefore, the coefficient of this second variable was expected to be positive. His results showed the expected positive signs for the normal gravity variables (GDP and GNP per capita) and for the historical and cultural dummy variables that he added into the equation of common border and language, colonial history and free trade area. The distance variable had the expected negative sign. Thus, the further away countries are from each other, the lower are their trade levels. The currency union dummy, which was of most concern to his research, was statistically significant and showed that countries sharing the same currency will trade up to 3 times more among themselves than they would with non-members using different currencies (Rose 2000:17). Adequate sensitivity checks were carried out on these results and he stated categorically that his results were robust to many situations,

including measure of distance, use of various other econometric methods, inclusion of omitted variables, adjusting the sample of countries, and the exchange rate volatility measure. He also added in many other factors and took simultaneity seriously. He noted in his article that the countries used in the analysis were deprived and/or small and therefore the results should not be taken literally.

On the other hand, the coefficient for the variable measuring exchange rate volatility was small but statistically significant, thus showing that the elimination of exchange rate uncertainty or its reduction to zero led to an increase in trade by about 13%. Rose (2000:17) explained that this result is of crucial importance because it brings to light the fact that a common currency is not comparable to a complete elimination of exchange rate volatility as alleged by previous research. He concluded by stating that the trade effects of common currencies and exchange rate volatility are economically distinguishable and the trade effects of joining or adopting a common currency are much larger than the effect of reducing or eliminating exchange rate uncertainty.

In summary, Rose's gravity equation consisted of the following variables

1. The dependent variable used was the log of the sum of trade flows between country pairs

2. Regressor 1 was a currency union dummy. This was equal to 1 for countries that shared a common currency and 0 otherwise

3. Regressor 2 was the monthly variability in the nominal exchange rate between the currencies of the country pairs

4. The other regressors are those used in most gravity models to explain the volume of trade flows. They include the log of the products of the GDP and GDP per capita as well as the measure of distance between the country pairs

5. Contiguity was set at 1 for countries which share a common border and 0 otherwise

6. Common Language was set at 1 for countries which share a common language and 0 otherwise

7. Common FTA was set at 1 if a country pair comprises members of the same FTA or 0 otherwise

8. Same Nation was set at 1 if one country in the pair is a dependency of the

other or if both countries are dependencies of the same country and 0 otherwise

9. Common Coloniser was set at 1 if both countries in a country pair are colonised by the same country after 1945 or 0 otherwise
10. Colonial Relationship was set at 1 if one country in the country pair has colonised the other or 0 otherwise.

There have been over 30 studies[51] which have analysed the common currency effect on trade after Rose (2000). Many of them have criticised the results obtained in Rose (2000) including Rose himself. In a bid to correct the mistakes which they claim Rose made in his analysis, they have come up with much reduced but positive trade effects of sharing the same currency. The main issues pointed out in the analysis were aggregation bias, non-random selection and simultaneity. These issues will be summarised individually.

4.5.1 Aggregation Bias

Aggregation bias occurs when there is an assumption that "the same treatment fits all". Generally speaking, a group of countries which adopt the same currency have varying experiences of their monetary integration. The countries may differ in size and wealth may be members of a multilateral currency union or overseas territories. In Rose's seminal paper, all countries that shared a common currency were grouped together regardless of these features. In Rose's defence, the currency union dummy variable added to the equation is meant to capture the trade effects of the single currency, while the historical, cultural and other factors which may affect trade are captured by the other independent variables. Despite this explanation, several authors still argue that using countries with different currency union arrangements leads to aggregation bias. Nitsch (2002) raised this concern stating that "combining different currency unions masks heterogeneous results". Levy–Yeyati (2001) attempted to correct for this bias by distinguishing between multilateral and unilateral currency unions. Unilateral currency unions occur when small, deprived countries adopt

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[51] For early criticism of the analysis of non- Eurozone countries refer to Rose and van Wincoop (2001), Rose and Engel (2002), Glick and Rose (2002), Nitsch (2002, 2005), Pakko and Wall (2001).

the currency of a richer "anchor country" (Rose, 2006). For example, El Salvador, Ecuador and a few smaller Caribbean countries use the US$ as their national currency while the South African Rand is used by Namibia, Swaziland and Lesotho. Multilateral Currency Unions exist when countries of equal size and wealth come together to use the same currency. Major examples of such currency unions are the CFA Franc Zone and the Eastern Caribbean Currency Union. The objective of the analysis was to highlight the fact that the currency union dummy variable added to the gravity equation in the study of Rose (2000) reflected omitted variables that were correlated with bilateral trade flows and as such were not captured by the other dummy variables. He achieved this using an augmented version of Rose's equation by dividing the currency unions into two groups of multilateral currency unions and all others. The result showed similar results to those of Rose (2000) for the latter while the trade enhancing effect for the former was reduced to 65%. See also Fatas and Rose (2002). Nitsch (2002) attempted to correct for errors made in Rose (2000) by exploring the trade effects of currency unions separately. He applied an augmented version of Rose's model to examine the intra-regional trade effects of the CFA Franc Zone (CFA) and the Eastern Caribbean Currency Union (ECCU). His results showed that members of the CFA zone trade more with each other (up to 55%) than non-members in Central and West Africa. In the case of the ECCU, the trade effect was not significantly different from zero. His results confirm that multilateral currency unions do actually boost trade among members but not by up to 300% as indicated by Rose. Another author who attempted to correct the aggregation bias was Klein (2002). His analysis was aimed at examining the dollarization effect on trade. He argued that the samples used by Rose (2000) were unsuccessful in the assessment of the effects of dollarization on trade and therefore could not have given accurate and robust results. He went further to distinguish between dollarization and a currency union, stating that the latter involves the creation of a central bank while the former entails countries adopting another country's currency. This occurs mostly when countries adopt the currency of their coloniser. His research was concentrated on the US and countries which adopted the US$ between 1974 and 1997. However, his results showed that countries which adopted the US$ did not trade more with the US. These results were was in contrast with Levy-Yayati's conclusion that showed a significant trade effect for countries in the second group of his study of the non-

multilateral currency unions. It should be noted that Levy-Yayati grouped both overseas territories and dollarized countries as non-multilateral currency unions and thus the large trade enhancing effect may be caused by the inclusion of the overseas territories. All the studies which have attempted to correct this bias (Levy-Yayati (2001), Klein (2002), Nitsch (2002), Melitz (2001) and Saiki (2002) have disaggregated the data and have used different countries and methodologies, with the addition of variables. The results obtained, although different, are all lower than those found by Rose (2000).

4.5.2 Selection Bias

A selection bias occurs in a currency union analysis when the features of member countries differ from those of the non-members. Most criticism of the use of gravity models when analysing the currency union effect on trade (Rose, 2000) is based on this bias. In his article, Persson (2001) explained that results can be biased if the member countries of currency unions are non-randomly selected for an analysis. He explained this situation using medical terms. When a medical experiment is carried out, there is usually a treatment group and a control group. A control group is used as a baseline measure; the patients in this group are indistinguishable from all other patients who are being examined, with the exception that they do not receive the treatment. The treatment group, on the other hand, contains the patients who are given the treatment or are manipulated. Using this context, Person explained that the currency union was the treatment; therefore, the treatment group comprised the Eurozone members. In order to test the effect of the currency union, it would be expected that the treatment group and control group are similar in all respects apart from the fact that the control group are not members of the currency union. He stated further that, if the two groups are not similar, then it would be difficult to tell if the difference between the two groups is a result of the treatment, which in this case is the currency union. This implies that a selection bias arises when analysing the trade effects of currency unions if the features of the countries in the treatment group (members of the currency union) are significantly different from the control group (non-members of the currency union).

Persson (2001) suggested that the bilateral trade of the currency union country pairs may be uncharacteristic and therefore should not be contrasted with the bilateral trade of other country pairs; instead, the comparison should be between country pairs. In order to deal with this bias, he contrasted the features of both groups using Rose's (2000) original dataset and found clear differences between the two groups. He then introduced the matching approach, which deals with the non -random selection bias without making assumptions about the functional form[52]. Using the matching approach, he selected country pairs which were directly comparable to the currency union country pairs, and discovered that the mean of the bilateral trade flows between the currency union country pairs was not significantly different from the mean of the trade flows between the other country pairs in his comparison group.

Kenen (2002), however, disagreed with the methods of Persson in selecting his comparison group and adopted a different approach. He explained that Persson's method failed to differentiate between the two kinds of currency unions[53] and therefore adopted a different method called the country based strategy which would account for the various country characteristics between the countries. His results were similar to that of Persson's. The mean of the bilateral trade flows between the currency union country pairs was not significantly different from the mean of the trade flows between the other country pairs that formed his comparison group. He then re-estimated Rose's gravity equation using his own country pairs and comparison group and found a significant currency union coefficient. In other words, his analysis confirmed both Persson's and Rose's results using his parametric test. He explained that the reasons for the inconsistent results can be attributed to the use of different datasets and strategies[54]. Alesina et al. (2002) also found a large and significant causal relationship between currency unions and trade even after allowing for reverse causality. Their argument was based on the fact that countries are more likely to adopt or share the same currency if they are (i) located close to each other or

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[52] Refer to Persson (2001) for the literature review of the methodology and its application with macroeconomic data.

[53] The first group consists of those countries that show a country's choice to join a currency union (e.g. Panama's decision to adopt the dollar) while the second group consist of countries that are by products of such decisions (e.g. Panama's currency unions with Bahamas and Barbados).

[54] Persson (2001) used the 'trade based strategy' while Kenen (2002) used the 'country based strategy'. See Kenen (2002) for a more detailed literature on the variations on the themes by both Rose (2000) and Persson (2001).

share the same border; (ii) have the same language; (iii) include a colony/coloniser; (iv) have lower per capita GDP; and (v) have a small population. For their analysis, they used an estimated 'propensity to form a currency union' variable as an instrumental variable for the currency union dummy variable, with their results showing larger estimates of the effect of currency union membership on trade than Rose (2000).

4.5.3 Simultaneity Bias

This is a distinct sort of endogeneity problem which occurs when one or more of the independent or explanatory variables are jointly determined with the dependent variable. This bias occurs when the estimation does not take into account the probability of a two-way casualty between the explanatory variables and the dependent variable. When examining the trade effects of currency unions, in terms of causality, there are two major probabilities apart from the fact that the volume of trade increases between countries when they share the same currency. Firstly, using the traditional Optimum Currency Area (OCA) approach, the decision to form a currency union is based on the fact that the selected countries already trade extensively among themselves or secondly, according to Yetman (2007), that the currency unions and the high level of trade are both caused by other factors which he identified as missing variables. See also Tenreyro (2001). Baldwin and Taglioni (2008) explained that large bilateral trade flows lead to the formation of a currency union rather than the other way around. Therefore, they stressed that the high estimates obtained by the 'Rose effect' reflect the trade effects of currency union formation rather than the impact of a currency union formation on trade among its members.

It is essential to leave this section of the literature with a proviso as it is clear from the studies that the evidence from non-European currency unions does not offer any beneficial information for the Eurozone. The results from the non–European currency unions are motivated by the currency unions used in Rose (2000). These non–European currency unions consist of deprived, small countries and the analysis is centred on these countries leaving rather than joining the currency unions. Baldwin (2006b) identified three kinds of currency

unions used in Rose's analysis with the intention of differentiating them from the Eurozone. They are

1) Hub-and-Spoke Currency Union arrangements which consist of small countries adopting the national currency of their dominant trading partner

2) Multilateral Currency Unions among small poor nations, such as the West African CFA.

3) Highly Idiosyncratic Unions involving a very local hegemony

4.6 Empirical Literature on the Euro's Trade Effects

4.6.1 Overview

An important subset of the empirical works on the relationship between currency unions and trade is referred to as the *Rose effect*. Rose (2000) discovered that countries participating in a currency union seemed to trade three times more than expected, even when the impact of exchange rate volatility is controlled for. The traditional OCA literature suggested that, unless certain conditions of price flexibility or labour mobility were met, countries subject to asymmetric shocks and cycles should avoid forming currency unions.

Studies by Frankel (1997) and Frankel and Rose (1998), however, suggested that the symmetry of cycles can be endogenous. These authors provided evidence, drawn from the experience of industrial countries, suggesting that increased trade integration leads to increased cycle correlation. If monetary unions lead to increased trade and increased trade intensity leads to higher correlation, then countries could meet the OCA criteria ex-post, even if they do not meet it ex-ante.

The impact of the euro on trade is a very significant issue, whether at a macroeconomic or microeconomic level, because the member countries and companies alike need to know whether or not deeper market integration is real. The introduction of the euro brings the promise of reduced transaction and trade costs between member countries and of price transparency promotion, thus

making the single market more efficient. With price transparency[55], consumers will be able to compare prices across member states (borders), which should lead to increased competition between firms and keep prices in the Eurozone lower and stable over a period of time.

It is a well-known fact that increased trade leads to available resources being more efficiently used, which, all things being equal, should lead to increased growth. However, Micco, Ordoñez and Stein (2003) stated that 'its significance exceeds the realm of trade'. Monetary unions can have important benefit, but they also impose important costs. In particular, by adopting a common currency, countries sacrifice their monetary independence. Unless the cycles of the member countries are highly correlated, this sacrifice may prove to be too costly. This cost is at the centre of the literature on Optimal Currency Areas (OCA), which began in the early 1960s with the work of Mundell (1961) and McKinnon (1963).

The impact of the Euro on trade is also important for the other European countries which have not joined the monetary union, e.g., UK, Sweden, and Denmark. The debate on whether or not they should join the new currency is ongoing and is in need of proper economic analysis to clarify the single currency's potential impact on many issues, which includes trade.

Although the results from Rose (2000) were robust and his evidence strongly suggests that countries in a currency union trade more among themselves than with non- members, they are not exactly applicable to the European Monetary Union. In his own words, he stated

"In 330 observations two countries trade and use the same currency.

Many (though not all) of the countries involved are small, poor or both, unlike

most of the EMU-11. Thus, any extrapolation of my results to EMU may be

inappropriate since most currency union observations are for countries unlike

those inside Euroland" (15). He went on further to state that although the

effects may be overstated for modern industrialised countries like those in EMU,

"Still, if my estimate of γ is over-stated by a factor of five, the growth of trade

inside EMU would still be large."..

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[55] There is much literature on price transparency and dispersion in the euro area, see Goldberg and Verboven,(2001 and 2004), Friberg and Matha (2004), European Commission (1990) among others.

By 2006, 7 years after the Euro was introduced and 5 years after notes and coins were circulated, there was enough available data to analyse the effects of the single currency on the trade patterns in Europe. It was found that bilateral trade among euro member countries increased significantly but the effect was much less than had been estimated by Rose on the larger dataset of smaller countries. Micco et al (2003) found in a dataset of European countries that trade between pairs of the first 12 EMU countries rose significantly between 1999 and 2002 by an estimated 15% beyond that which could be explained by growth and other factors. They also found no evidence to support the fact that the Euro has diverted trade of member countries away from the non-members. On the contrary, the Eurozone countries seem to have increased trade with their members as well as with non-members of the Eurozone. They also examined 22 industrial countries and the results for increased trade with member pairs were between 6%-26%. They used a difference in difference approach which resulted in findings of between 18%- 35% between 1992 and 2001. The variation in the figures depended on whether the country pair dummy variables were used or standard gravity variables were conditioned. There is a great deal of literature which argues that the common currencies (in this case the Euro) have led to an increase in trade within the currency area which therefore leads to higher incomes. In 2002, Bun and Klaassen (2002) used different gravity estimates and still arrived at the conclusion that the 'euro significantly increased trade with about 4% in the first year' and projected the long run effect to be close to 40%.

Flam and Nordström (2006) and Baldwin (2006) also both reached identical conclusions, that the value of trade flows between the members of the Eurozone increased by less than 10% since 1999 when compared to country pairs in the control group. Berger and Nitsch (2005), and De Nardis and Vicarelli (2003) reported similar results to Flam and Nordström (2006) whose result showed a trade effect of 26% during the periods 1995-1998 (pre- euro) to 2002-2005 (post- euro). Chintrakarn (2008), in a more recent study, estimated the bilateral trade effect between Eurozone countries to be between 9 and 14%.

Rose (2000)[56] and Glick and Rose (2002) both came to the conclusion that a single currency has a great impact on bilateral trade flows between the countries which use the currency. In their 2001 study, Rose and Wincoop estimated that the Euro would increase trade within the Eurozone by 50% and the study by Frankel and Rose (2002), which is based on the fact that trade is the key channel through which currency unions increase income growth, the found two main results. Firstly, membership in a currency union leads to a tripling of trade among the member countries and secondly 'a one percent increase in a country's overall trade increases income per capita by at least a one-third of a percent'. Based on his work, Rose assumed that the introduction of the euro could increase European income per capita between 15 and 20%. Recent evidence shows that the trade effects of the euro are statistically and economically significant but not as large as was estimated in Rose's literature. Some studies have resulted in even higher estimates regarding the positive impacts of the euro on trade. For example, Barr, Breedon and Miles (2003) estimated a 29% increase in trade among the Eurozone countries and Bun and Klaassen (2002) found that trade was increased by an initial 4% and estimated a long run increase of up to 40%. Please note that the survey of the relevant literature used is not comprehensive[57] but highlights and explores the major studies in the field.

In terms of analysing the euro's effect on trade flows, a study by Micco et al.(2003) is a seminal work that made use of the most effective existing data and econometrics at the time to examine this policy issue and is the first published study regarding the Eurozone's trade effect using similar techniques of Rose (2000). The analysis was centred on the time series dimension and, in order to answer the correct policy question, was focussed on investigating countries that had joined, rather than left, currency unions. By narrowing down the countries to those in EU membership, the authors were able to provide appropriate evidence for the non – Eurozone member countries that have the choice of whether or not to join the currency union. Although the time span investigated was short (1992-2002) they used different samples and

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[56] There have been a lot of studies that have criticised these findings based on the methodology used but still have not been able to solve the problem. See Persson (2001), Tenreyro (2001) and Nitch (2001)

[57] Baldwin (2006) provides a comprehensive review of literature and econometric methods used by authors in this field.

methodologies in their analysis and their estimates of the 'Rose Effect' ranged between 5 and 20%. This is much lower than that obtained in previous studies on non – European currency unions, although it is still statistically significant and economically important. The authors used two different country samples; the first consists of all the countries in the Direction of Trade Statistics (DOTS) dataset and the second sample consists of the EU15 countries. Although the first group has the benefit of a larger size, the key advantage of analysing the currency union's effect on trade using the EU15 states is that the countries are all geographically located close to each other, are homogenous and all belong to the same single market. They carried out the analysis using pair fixed effects for the EU15 sample and also using a difference- in -difference (DID) estimation strategy. This estimation strategy (which is a term used in medical sciences), divides the EU15 countries into two groups; the first group is regarded as the treatment group (Eurozone countries) while the second group is regarded as the control group (non-Eurozone countries). The gravity model was utilised to control for the differences between both groups while the DID estimate explains the changes in the bilateral trade flows in the treatment group relative to the changes in the control group. Thus, the aim of this strategy is to compare the changes before and after the phenomenon occurred in both groups. In order for the DID estimate to produce clean results, the control group must be very similar to the treatment group especially when dealing with unobservable factors. Baldwin (2006) stressed the importance of limiting the control group to EU countries stating that 'EU membership is a very intricate process which involves complex laws and regulations that impact on both intra-EU trade and trade with the EU countries and other countries. These laws and practices can sometimes be unobservable and therefore almost impossible to quantify when carrying out an econometric analysis'. MSO (2003) used a modified gravity model equation to answer the question of 'What are the effects of currency unions on countries that join them?'. It was a modified version of the standard gravity model similar to that used in Glick and Rose (2001), with a panel data approach which included country pair fixed effects. The reasons, according to Glick and Rose (2001), for using a panel data approach over the cross-sectional approach (used in Rose 2000), relate mainly to the fact that the policy question

is a time series question[58]. The country pair fixed effects included in the equation are to 'isolate the time series dimension of the EMU effect on trade, and leave out the cross-sectional variation'. As a result, the usual time-invariant variables which are known to enhance trade between countries and are regularly added to most gravity equations such as distance, contingency, common language etc., will be subsumed in the country pair fixed effects. The authors stressed the importance of including country pair fixed effects in the gravity equation, stating that 'employing the use of country pair fixed effects provides the cleanest benchmark against which to assess the impact of EMU on trade. Micco et al (2003) explained that a major condition for the creation of a currency union formation which was identified by the Optimal Currency Area theory states that "currency union areas are more beneficial the greater the extent of trade between the countries considering a monetary union". Therefore, if member states of a monetary union are selected on the basis of this criterion, then there would be more trade among members of a currency union. They suggested that country pair fixed effects rather than the traditional gravity variables should be included in the regression as a way to deal with this problem.

With the standard set, they introduced another variable of EMU 2 with the value of 1 when country pairs are both members of the Eurozone[59].

MSO were aware of the fact that adding country pair dummy variables could lead to endogeneity problems and thus they estimated the *Rose effect* with the traditional gravity variables as well as the country- pair fixed effects. The results of the former were higher (28%) although Baldwin (2006) explained that this figure should be ignored because it is biased upwards due to omitted variables and model misspecifications – just like Rose (2000). The analysis also checked for the possibility of trade diversion by introducing a dummy variable (EMU1) and found no evidence of trade diversion, which was also confirmed in Alho (2002). Many studies have followed this work using different methods and countries and have derived varying results. De Souza (2002) added the EU

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[58] The policy question of 'What is the trade effect of joining a currency union, is a time series issue as opposed to - ' How much more trade occurs between countries in a currency union than other countries?' which is a cross-sectional issue

[59] A list of variables used in this study can be seen in the next Chapter

trend[60] similar to the one added in MSO when estimating his gravity model for the EU15 countries. The results only showed evidence of an increase in trade when the *EUTrend* variable was removed. Piscitelli (2003), however, noted that the results from MSO depended on the data used and the length of time analysed. He stated that the *Rose effect* diminishes when the length of time used in MSO is taken back to 1980. He also pointed out that the source of the trade data[61] used has an effect on the results obtained. Bun and Klaasen (2004) and De Nardis and Vicarelli (2003) both used different methodologies with longer time periods than Micco et al., although they used the same static model (the fixed effects method) in the estimation of the euro effect on aggregate trade. Bun and Klaassen (2004) included country – pair specific time trends in their estimation and arrived at a 3% trade increase while De Souza (2002) failed to find any significant effect of the single currency on bilateral trade.

In Barr et al. (2003), the aim of the study was to examine whether the single currency had significant economic effects; this was carried out by comparing the Eurozone countries with the non-Eurozone countries focussing on the trade creation amongst the Eurozone countries. They used the instrumental variable approach to correct for the problems of reverse causality explaining that there is still a potential endogeneity problem even after allowing for fixed effects. When fixed effects are included in the gravity model, the variables which explain trade are usually dropped and the authors asserted that the endogeneity issue may occur if one of the variables that was removed foresees both the decision to join the currency union and larger trade flows after the creation of the currency union. They cited an example of this in their study, explaining that a change in the conditions or situation of a country may lead to an increase in trade with other Eurozone countries in the future, which will lead the country to join the currency union and gain the benefits of the change. When this occurs, higher trade flows between the country and other member countries will be observed shortly after the country's decision to join the currency union. Membership of the currency union or the decision to join in will take credit for the increase in trade flows even when fixed effects are allowed. This is where the

[60] In order to be sure that the increases in trade were attributed to the euro, MSO added a variable called the EUTREND. The aim was to capture the effects of the EU on trade as it evolves through time.
[61] He stated that OECD data used CIF methods while IMF trade data which was used by MSO used the FOB method.

inclusion of the instrumental variable is important – the ideology behind the instrumental variable is that it should be able to predict the decision to join a currency union but it should not be influenced by possible trade increases that occur after the currency union is formed. As such, any trade increases can be attributed to the membership in the currency union. They used a similar gravity equation to Rose (2000), analysing the trade effects between 1978 Q1 and 2002 Q1. The results, when fixed effects were included, showed the Rose effect to be about 27%. The second analysis saw the inclusion of the instrumental variables of price and output co- movement variables[62] but astonishingly the results were similar to the OLS regression[63]. This result was attributed to the fact that the endogeneity effect is not so large in the case of the Eurozone countries because they do not consist of high inflation countries or developing countries. Faruqee (2004) however found a 10% euro effect on aggregate trade for 22 industrial countries for the period 1992 – 2002. This study differs from the above mentioned as it utilises dynamic models rather than the static models used by most authors. The method of estimation used was the Panel Dynamic OLS (DOLS)[64] which also examined the effect of non-stationarity of variables on the estimates derived in the panel settings of gravity models. (Fidrmuc, 2009).The advantage of using the DOLs estimation is that, in the presence of non-stationary data and also simultaneity bias, this method gives reliable point estimates and was also used as a robustness check on the standard OLS estimates. De Nardis et al. (2008) also brought up to date the estimates reached in the previous study of De Nardis (2003) by applying a dynamic specification of the euro's trade effect using the gravity model. They used the system of GMM estimator which is a relatively new method and has rarely been applied in the estimation of the euro's effect on trade[65]. Their results showed an increase in trade flows of 4-5% and, although significantly less than some previous results, this still confirms the fact that the introduction of the euro had a positive impact on trade within the Eurozone.

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[62] These instrumental variables were discussed in more detail on page 582 of Barr, Breedon and Miles (2003)

[63] Tenreyro and Barro (2003) find a much larger Rose effect when they included instrumental variables in their analysis.

[64] The estimates from the DOLS estimation were generally lower than those when the standard OLS was used.

[65] See Fernandes (2006)

Bun and Klaassen (2007) argued that estimates[66] obtained regarding the euro's effect on trade was established based on the basic panel gravity models of trade. Their study aimed to prove that these estimates may be biased because '*the residuals from these models reveal upwards trends over time for the euro countries'*. Looking at previous literature on the euro's effect on trade, the lowest estimates obtained so far were from Micco et al. (2003) and Flam and Nordstrom (2003). Both studies used data for the periods between 1992 – 2002. These estimates become larger when the data used in the analysis is for longer periods. For example Barr et al. (2003) looked at the effect for the period 1978 – 2002 and obtained estimates of 29%, while Bun and Klaassen (2002) used data for 1965 – 2001 and arrived at estimates of 38%. Therefore, they added the time trend in the basic gravity equation in order to correct for this overestimation.

For easy comparability to results from current studies, the basic panel gravity model variables were utilised. Data was collected from 171 country pairs for the period 1967 – 2002. The dependent variable used in this analysis is the bilateral trade with GDP and GDP per capita as explanatory variables. In line with other gravity model equations, they include the euro dummy variable which takes the value of 1 where both countries in the pair are members of the Eurozone. A dummy variable for free trade areas was also included in the equation to take into consideration the increases in trade that result from FTA membership. Indeed, the time invariant trade determinants are also included and lastly a fixed time effect was used to control for the country pair trade determinants.

It is at this point that the equation is extended to incorporate the time trend which estimates the effect of all country-pair specific omitted trending variables. The euro's effect drops to 3% when the country-pair trends are included in the basic model. This shows the importance of including time trends[67] in the gravity model estimation and points out two important issues. Firstly, it proves that failing to include the trending variables as practiced in existing literature may have led to incorrect estimates of the euro effect and, secondly, that the extent of this bias is determined by the length of the sample. They

[66] Current analysis on the euro's effect on goods trade has shown positive results between 5% and 40%.

[67] Berger and Nitsch (2008) agree that with the inclusion of time trends in the gravity equation

therefore concluded that, with the inclusion of the country-pair time trends, both issues are avoided and the effect of the euro on trade will not be as large as previously analysed.

Although much of the literature on the euro's effect on trade has concluded that the introduction of the euro was alone responsible for an increase in the volume of trade between the Eurozone countries, Berger and Nitsch (2008) looked at the trade effects of the euro from a historical perspective. The study claimed that the introduction of the single currency is an extension of a succession of previous policy changes that have occurred over the last five decades which eventually led to economic integration among the countries that now make up the EMU. To justify their claim, they used a data set from 1948 - 2003, analysing 22 industrialised countries. They used MSO as a benchmark study and, after careful analysis, pointed out three main issues with the results that may need further study.

Firstly, they refer to MSO's standard cross-country regression equations (reported in their Table 1), where the results show that the estimated coefficient of the EU membership is only slightly higher than that of the Eurozone membership. The implication of this result is that the trade effect of the introduction of the euro is comparable to the trade effect of the creation of the single market and removal of trade barriers. This study takes into consideration the fact that the introduction of the euro has a smaller history compared to the huge amount of integration which had already been accomplished before the euro's introduction. As such, they found that the results are not valid and further research may be needed in this field. Secondly, they noted that intra Eurozone trade increased in 1998, which is one year before the euro was introduced and the exchange rates were irrevocably fixed[68]. The trade effect then rose steadily over the data period which implies that the intra- Eurozone trade might have been boosted by factors other than the euro. Lastly, referring to MSO's Table 7[69],

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[68] Refer to Table 2 in Micco et al. (2003) for the results. Berger and Nitsch (2005) pointed out that different dates have been used as the start of the introduction of the euro, each of which could be linked with a substantial increase in trade volumes. Examples include the signing of the Maastricht Treaty in February 1992, the fixing of the final date for the beginning of the currency union at the end of 1997, the actual start of the EMU on January 1, 1999, or the introduction of the euro as physical currency on 1st January, 2002.

[69] Which showed the trade effects of the euro on single countries or country groups.

the results are indicative of the fact that the Rose effect was largest for countries of the former Deutsche-Mark bloc. They also noted that in MSO's analysis, when the Deutsche-Mark bloc was removed from the sample, the Rose effect vanished. Berger and Nitsch found it puzzling that the euro's introduction had a positive effect on these countries and a negative effect on a country like Greece that experienced a much larger policy change with the introduction of the euro.

In a bid to correct these issues, they re-analysed the MSO dataset by extending the period to 2003 and with the inclusion of more recent trade data. The result obtained by extending the period showed a significant increase in the Rose Effect which was also confirmed by other authors including Berger and Nitsch (2005). They also examined the introduction of the euro as a 'continuation, or culmination, of a series of policy changes that have led over the last five decades to greater economic integration among the countries that now constitute the [Eurozone]".
The results from their dataset, which comprised 22 countries from 1948 to 2003, showed a slow increase in bilateral trade volumes amongst European countries. However, the effect of the introduction of the euro is negative once they control for this trend (EU Trend dummy). A major portion of this trend can be explained by measures of economic integration which were in place before the introduction of the euro. Although it is correct that the introduction of the euro is indeed imperative for the European integration process to move past the single market programme, Baldwin (2006) pointed out that the euro's effect on trade will only be more effectively understood when the dynamics of the European institutions are taken into consideration.

4.7   Empirical Literature on the Euro's Sectoral Trade Effects

Empirical investigations on the trade effect of the euro have testified to a significant trade effect. The results, however, do not in all cases support the hypothesis that creating a single currency leads to a decrease in, or the total removal of, transaction costs. Many authors have argued that the increase in trade in the Eurozone, among other factors, may not have been caused by the euro's introduction but by the fact that it was at the end of a long term process

of European integration with major events such as the introduction of the common market, the single market and the EMS playing very important roles in Europe's trade integration. Analysis of the euro's trade effect has been carried out mostly using aggregate data for total merchandise trade. Recently, however, the need to analyse the trade effect on specific industries, sectors or even products has become very important as the effect on total trade is not representative of all sectors. De Nardis et al. (2008) highlighted this importance stating that the analysis of sectoral trade effect sheds more light on those issues that cause the euro's influence on trade flows. The major issue with the use of sectoral data, however, is the unavailability of sectoral outputs which should be included in the gravity equation as explanatory variables. Failure to include these variables might bias the results because the GDP (and changes in GDP) is most likely correlated with the sector output and changes in sector outputs[70]. Most analyses on the trade effect of the euro using sectoral data still uses the GDP without any sectoral output as explanatory variables but point this out as a limitation to the study. When using sectoral trade data, it is possible to use the sectors gross value added or/and sectoral production figures. Such data, however, are very difficult to access for most sectors and when available are filled with measurement problems. Although most of the euro effect studies have been carried out at the aggregate level, both data samples have used panel data techniques as opposed to the pooled cross sectional data and the results for both aggregate and sectoral analysis have shown positively significant effects of the introduction of the euro on bilateral trade between the Eurozone countries.

The study by Flam and Nordstrom (2006) was aimed at estimating the trade effects caused by the introduction of the single currency in 1999 and was carried out as an extension to the study above by Micco et al. (2003). According to Baldwin (2006), this study was able to avoid the gold, silver and bronze errors of gravity model estimation. The study presented a few novelties which were aimed at fixing the typical econometric issues associated with the gravity equation[71].The dependent variable in their study was exports as opposed to bilateral trade used in MSO, which eliminates the silver medal mistake as

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[70] See De Nardis et al. (2008) and Baldwin (2005)

[71] Although the paper tackled the usual causes of bias in literature, it had a few of its own econometric flaws which are explained in detail in Baldwin et al. (2008).

recommended by Anderson (1979). They based their choice of dependent variable on the ability to '*separate euro effects on exports from euro to non-euro countries on the one hand, and exports from non-euro to euro countries on the other'.* They used a total of 20 countries in their dataset which included the first 10 Eurozone countries. Belgium and Luxemburg are treated as one country in trade statistics and Greece was not incorporated into the dataset because it only joined the single currency in 2001. The other 10 non-euro countries were Australia, Canada, Denmark, Japan, New Zealand, Norway, Sweden, Switzerland, United Kingdom and the United States between the years 1989 and 2002. The gravity model was estimated using OLS with country pair dummy variables that capture the factors which are unique to the country pair and constant over time. As usual, the standard dummy variables added to the gravity equation were subsumed in the bilateral fixed effects. The addition of country pair fixed effects eliminated the occurrence of the omitted variable and gold medal mistakes associated with the gravity model. The results for the aggregate trade (which had some econometric flaws, see Baldwin et al., 2008) showed that the euro led to a trade increase of 15% between the Eurozone countries during the period 1998-2002 compared to the target period of 1989-2002. They also noted an increase of 8 and 7.5% in exports from the Eurozone member countries to non-member countries and from non-member countries to Eurozone member countries respectively. When year effects were included, the euro member countries' exports almost doubled in comparison to the exports between euro member countries and non-member countries. They went on further to estimate the euro effects on sector exports using data from the one-digit SITC sector exports. They acknowledged the fact that, when using sectoral data in the gravity model, sector outputs need to be included as explanatory variables but, due to the fact that this information was not available for the chosen industry, they did not include these variables. This was viewed as one of the limitations of their study. However, bearing this in mind, the results obtained, which ranged between 7 – 50%, showed that significant effects of the single currency were more obvious in certain sectors where the goods are not homogenous and highly differentiated.

Baldwin et al. (2005) added to the existing literature in this field by using a sectoral dataset to analyse the 'insights from the gravity model theory'[72]. In their analysis, they used a model comparable to the one used in Rose (2000) but, when analysing sectoral data, included the value added per sector as well as the GDP of both exporter and importer as explanatory variables. They pointed out the significance of using sectoral variables as the GDP may not be an ideal variable in this circumstance. However, the benefit of using the GDP over the value added is that the dataset of the former will be complete whereas, with the latter, there will be missing observations. The dependent variable in their analysis was the sectoral bilateral imports data for the ISIC Rev. 3 2-digit and 3 digit manufacturing sectors of the EU15 countries plus Australia, Canada, the US, Japan and Norway for the period between 1988 - 2003. Other variables included in their analysis are distance, two Eurozone dummy variables of EMU1 which takes the value of 1 if one country in the pair is a member of the Eurozone and EMU2 which takes the value of 1 when both countries in the pair are members of the Eurozone and finally an EU dummy variable which is equal to 1 when the country pair are both members of the European Union. The model was estimated using the fixed-effect panel technique and the estimates show that the introduction of the euro led to a 70 – 112% increase in trade from the regression analysis pooled by both the country and industry and by 21-108% when the sector specific factors are taken into consideration. They noted that the extent of the 'euro effect' is determined by the variables used (GDP or sectoral output) and acknowledged the fact that both variables are unsatisfactory estimates for the country's import demand or export supply. The analysis also showed no indication of trade diversion when trade flows with non-Eurozone members were examined, while the trade creation tests showed that trade between outside countries and the Eurozone countries increased by approximately 27%.

Fernandes (2006) estimated the euro effect for 25 sectors[73] from ISIC Rev3 for 21 industrial countries for the sample period 1988 – 2003 using bilateral exports as the dependent variable. It was argued in the study that,

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[72] The study also develops an empirical model that analyses the euro effect on trade from estimates obtained from previous literature but for relevance just the sectoral estimates are discussed. For full discussion please refer to Baldwin et al. (2005).

[73] Flam and Nordstrom (2006) and Baldwin et al. (2005) have both analysed the euro effect by sector.

although many studies had in the past used static models in the euro effect estimation, it is incorrect to do so because trade in itself is a dynamic process and the use of static equations, particularly for the euro effect, will produce biased results. Fernandes (2006) utilised the system-GMM as the dynamic panel data model to analyse the euro effect on both aggregate and sectoral data. The result obtained from the aggregate intra-Eurozone was 2.88% which is considerably lower than estimates from earlier works while at the sector level the effect ranged between 7 and 22%. De Nardis et al. (2008) also used the system-GMM estimator to estimate the euro effect on sectoral data. In their study, the 25 ISIC 2 digit sectors for 13 exporting EU countries and 23 importing industrialised countries were analysed. The results show that the euro effect is not distributed evenly among the sectors with just 11 out of the total showing significant effects of the euro on export flows. This result is consistent with previous literature.

From the key literature highlighted above (for both aggregate and sectoral data), there are some major similarities in the gravity equations used by the different authors. It is easily noticeable that recent gravity model analyses of trade are estimated with the use of fixed effect panel data technique. The use of pooled cross sectional data in the estimation of gravity models was used in the past[74] but the results were regarded as being biased as they failed to properly control for heterogeneity among the countries (Cheng and Wall, 2005; Cheng and Tsai, 2008; Westerlund and Wilhelmsson, 2011). This led researchers favour the panel data technique because it controls for unobserved heterogeneity by introducing the fixed effects into the gravity equation[75]. De Souza (2002) explained that the fixed effects estimation reduces the chances of an upward estimation bias because it has the ability to control for the time-invariant factors like language, borders; cultural practices etc. (see also Egger, 2000).

Another advantage of using the panel data technique as opposed to the pooled cross sectional data is that it highlights the time dimension of trade in the basic gravity models when estimating trade flow determinants (De Nardis, De

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[74] After Glick and Rose (2001), most 'euro effect' studies were analysed using panel data techniques.
[75] Including the country pair fixed-effects model to the gravity equation ensures that the unobserved factors that explain trade volume between country pairs concurrently are taken into account.(Cheng and Wall, 2005).

Santis and Vicarelli (2008). Although gravity model estimations using the panel data approach are relatively simple[76], Westerlund and Wilhelmsson (2011) argued that it could also be challenging because the technique does not accommodate zero trade/missing observations between country pairs and secondly the model may be both biased and inefficient in the presence of heteroskedasticity. Regarding the issue of gravity model specification, Baltagi et al. (2003) introduced time, as well as importer and exporter country dummy variables, to control for the interaction effects in bilateral trade flows. This method was originally intended for static modelling but, as seen in recent literature, it has also been used in dynamic trade modelling (See Fernandes, 2006; Bun and Klaassen, 2006).

In addition, many studies have used the standard gravity model as the foundation and then augmented the model to suit the specific research question. The variables used have all consisted of the size of the country (GDP), geographical distance and including dummy variables of interest for RTAs, FTAs, EMU and EU. Other dummy variables included in most gravity model estimations are the other natural determinants of trade which have to be controlled for example, common language, common borders, colonial history, landlocked or island etc. In other cases, some studies have added measures of exchange rate volatility into the equation[77].

Another point noted with the studies is that they all examine the trade effect using developed countries and in some specific cases including just the Eurozone/EU/EU15 countries in the sample. The use of smaller underdeveloped countries as in Rose (2000) was pointed out as a weakness as the results could not be comparable to the Eurozone sample. The time span analysed however is heterogeneous. Some employed restricted time spans in order for their estimates to be comparable to Micco et al.'s (2003) seminal paper, while others analysed the euro effect for longer periods of time including time trends in the analysis. The dispute regarding whether or not to use short or long time spans in this analysis was ironed out by Berger and Nitsch (2005) when they argued that

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[76] The most widespread method used in the estimation of a panel data gravity model is carried out by taking the logarithms of the variables and estimating the results using the fixed effects Least Squares (LS).

[77] See De Nardis et al. (2003), Baldwin (2005), Fernandes (2006), Micco et al. (20030 and Flam and Nordstrom (2006).

the trade increases (coefficients of the euro dummy variable) in the European countries are highly dependent on the period studied. Their sample, which ranged from 1948 – 2003, showed a progressive increase in trade integration between the EU countries and this euro effect vanishes when the trend in trade integration is controlled for. Finally, the introduction of multilateral trade resistance into the gravity model has been included by all recent studies with some adding country pair fixed effects and others suggesting the use of country – group dummy variables. Anderson and van Wincoop (2003) suggested an improvement to the Anderson (1979) model which assumed product differentiation according to the country of origin. They came up with the addition of multilateral resistance terms for both the importer and the exporter that proxy for the presence of 'unobserved trade barriers'. In their model, Anderson and van Wincoop (2003) used distances, borders and income variables to obtain the multilateral trade resistance terms. This method is data and time and data consuming and as such has not been utilised by other studies. The more frequently used methods to include the multilateral trade resistance index to the gravity model are either by the addition of a remoteness variable or importer and exporter fixed effects with most of the euro effect studies favouring the latter.

4.8 Conclusion

The study of Rose (2000) led to extensive research in the Eurozone as trade increases among the members were viewed as one of the major benefits of its introduction. With most studies estimating the euro effect on aggregate trade, there is very little information of the effect on specific sectors/industries. The estimation of the euro effect on aggregate trade is of great importance but the results conceal vital information on individual sectors. It is therefore important to estimate this effect at the sector level for the highest possible disaggregation (Fernandes 2006). Regardless of the time span, variables, countries used or econometric specification of the euro effect on trade, there is enough evidence to prove that the euro has in fact boosted trade within the Eurozone countries.

The next chapter explains the methods used in this analysis to investigate the euro effect of trade in the transport equipment manufacturing sector. (ISIC Rev 3 No. 34-35).

CHAPTER 5

METHODOLOGY AND DATA

5.1 Introduction

Interregional trade is a very significant and controversial topic in international economics. After the breakdown of the Union of Soviet Socialist Republics, there was a reduction in customs duties globally and countries liberalized their trade regimes. The growing importance of bilateral trade has resulted in most countries seeking more efficient means of production to compete internationally. In order to achieve this most countries have tended towards regionalism. Over the last two decades, the world experienced the "strengthening and deepening of regional trade agreements as almost every country in the world has joined some kind of preferential trade agreements." (Kutlay, 2009).

However, with the creation of the European currency union in 1999, the effect of the single currency on trade has been widely studied. A majority of the research in this field has investigated the currency union effect on aggregate trade and this vast literature has contributed to the knowledge and theory of the currency union effect on trade while providing significant econometric advances in European trade literature.

This thesis however acknowledges the importance of aggregate trade analysis but asserts that the currency union effect on sectoral trade provides the basis for the re-examination of some of the ontological and epistemological assumptions of the EU trade research which are principally based on analysing trade on an aggregate basis. The euro effect on sectoral trade provides a much needed substitute to the main stream studies for a deeper understanding of the currency union effect.

Therefore, the motivation behind the choice of methodology is aimed at assessing the actual trade impact of the euro on an individual sector. The econometric model chosen for this analysis is the gravity equation, which has been used extensively to measure the impact of various policy variables such as trade (intra-regional and international), travel statistics, hospital patient treatment statistics, exchange rate effects, migration etc.

As was mentioned at the start of this thesis, the gravity model has its roots in Isaac Newton's Law of Gravity, which states that the attraction between two bodies is proportional to the product of their masses and inversely related to the distance between them. The model has been widely used as an empirical framework in the measurement and analysis of the trade effects of Regional Trade Agreements (RTAs) (Frankel and Wei, 1995; Frankel, Stein and Wei, 1995; Finger, Ng and Soloaga, 1998).

Vicarelli, De Santis and De Nardis (2008) highlighted the importance of analysing the euro's effect on a sectoral basis as opposed to its impact on total trade. They explained that analysing the impact on individual sectors helps to identify and evaluate the major trade determinants which aid the euro's effect on trade flows. Although their study analysed the impact of the euro on individual manufacturing sectors, the main aim of their analysis was to explore whether the effect of the introduction of the single currency varies across different industries. This study, however, is more specialised and will only examine the effect on the transport equipment manufacturing sector using different gravity model estimation formulations before comparing the results to those of the aforementioned studies.

The analysis which uses quantitative methodology with the use of secondary data will firstly focus on investigating whether there have been any increases in trade among the Eurozone members following the introduction of the single currency, secondly, whether the euro's introduction has led to trade diversion and thirdly, identifying the main factors affecting trade in this sector. There are many different events which would have affected bilateral trade flows in Europe such as the creation of the Single Market, but the impact of the euro's introduction will be singled out in order to assess its direct effects. One of the major reasons behind country's decision to join a currency union is to increase trade among the members. The trade intensity between countries depends

mainly on the explicit and implicit barriers which each country imposes on its partners. These barriers generally take the form of transport costs, tariffs and non-tariff restrictions. The declining cost of transport and communication which is associated with member countries in a currency union reduces the economic distance between communities, regardless of the country to which the communities belong. These cost reductions are likely to strengthen both domestic and economic linkages, which are necessary for the increased economic integration among the member countries.

The evidence described in Chapter 2 shows that, since the creation of the EEC in the later part of the 1950s, bilateral trade flows within the European Union countries have experienced significant growth. Nonetheless, it is important to look not only at the trade patterns of the Eurozone countries but also to identify the major causes of the increased trade flows. The determinants of the trade increases may include a decline in transport and transaction costs associated with the adoption of a single currency and/ or greater trade with neighbouring countries. It could also be due to globalisation, economic growth or the result of the European Union treaties. It is therefore necessary in this analysis to be able to control for as many of the natural trade determinants while attempting to examine the specific effect of the introduction of the euro on trade, taking into consideration the time and country specific effects. This can be achieved using the gravity model of trade.

The Eurozone countries' trade will be analysed and then compared to the control group of Denmark, Sweden and the UK. They are all part of the EU and have full access to the internal market of the European Union. Therefore, by using this group of countries as a benchmark, the effects of the general market integration in Europe across the sector being researched will be held constant. This chapter describes and justifies the research methodology used and also details the sources and nature of the data.

5.2   Methodology

5.2.1 Introduction

The gravity model of trade has been extensively used in the analysis of a variety of policies such as regional trade agreements, monetary and currency unions and border effects (Westerlund and Fredrik; Wilhelmsson, 2009). It has been used in the social sciences for a range of topics, including migration (Head and Ries, 1998; Epstein and Gang, 2006). The model has been used mostly in the analysis and explanation of bilateral trade flows among countries. Earlier studies had severely criticised its theoretical foundations, although there have now been many developments to the model and it now has a solid theoretical base.

The main reasons behind the choice of the gravity model are now detailed. Firstly, the model has been extensively used in previous studies to analyse and examine international and bilateral trade flows and trade patterns. It is also chosen for its empirical fit with the aim of this research and its ability to explain sectoral international trade patterns (Paas, 2000). Rose (2000), Feenstra (2002), Anderson and van Wincoop (2004), Evenett and Keller (1998), and Baldwin (2006) are among the major studies to not only have analysed international trade but also to have acknowledged the empirical validity of the gravity model. Secondly, it provides an acceptable theoretical framework for use in the chosen area of research. The validity of the theoretical underpinnings and background, as explained in the previous chapters, has been properly established following thorough analyses by Anderson (1979), Helpman and Krugman (1985), Bergstrand (1985), and Anderson and van Wincoop (2003).

5.3   Variables and Sources of Data

This section explains the variables used in the proposed gravity model as well as the sources of data, measurements and hypothesis.

5.3.1 Gravity Variables

Many variables have been used in the gravity equation and represent factors which are either trade enhancing or restricting between countries. As is evident from most of the literature, researchers have used the GDP of a country as a proxy for economic size while distance has been used to account for trade resistance between the trading partners. However, these two factors alone cannot be used to analyse trade flows between countries. In light of this, the basic gravity equation is extended and modified by the introduction of further explanatory variables which could have considerable effects on international bilateral trade flows. Martinez-Zarzoso and Márquez-Ramos (2008) explained that, when specifying the standard gravity equation, the bilateral trade between country pairs should be related to their respective incomes, distance between them, population and, most importantly, a set of dummy variables.

These additional factors range from natural forces to economic policy decisions. Examples of these include common language; common borders; common currency; membership of regional trade agreements; landlocked or island geography; colonial relationships; same country; national tariff rates, price indices; transparency of government economic policy; immigrant links and many more. At the time of their study, Oguledo and MacPhee (1994) identified 49 different explanatory variables used in the gravity model. In essence, many variables can be added to the gravity model, although it should be noted from the previous literature that there is no general agreement on the extra variables which should be included. In many cases, researchers have included variables which can be justified for use in the particular analysis being carried out and omit those variables that are not relevant to their study, thus potentially leading to estimation bias in the regression.

In their analysis of the bilateral trade flows between the EU, USA and Japan, as well as 57 of their most important trading partners for the years 1986-1997, Baltagi, Egger and Pfaffermayr (2003) argued that omitting variables which are related to the exporting and importing countries and the time variant effects can lead to a regression bias in the other variables used in the model. They therefore proposed that 'a full interaction effect design should be used in

the analysis of bilateral trade flows'. Their study further showed that the inclusion of all variables in a gravity model, which are related to the exporter, importer and changes in time, has significant results. However, it should be noted that, with the exception of GDP and distance, all other variables included in their analysis were in the form of dummy variables. They therefore used an error term to capture the extra effects which the unobserved variables could potentially have on the changes in trade flows.

In the analysis reported in the next chapter, only the frequently used variables which have been used in similar studies will be applied in order to avoid the regression bias associated with the inclusion of all trade enhancing/restricting factors[78]. The variables used in this analysis are detailed in Table 5.1 and subsequently explained in more detail.

Table 5.1 Summary of Variables used in the Model

Variable Name	Symbol	Notes
Bilateral Trade	lnX_{ij}	This is the sum of bilateral trade flows (exports and imports) between country pairs. This figure was computed as the **sum of the log of bilateral trade** between the countries.
Gross Domestic Product for Exporting Country	lnY_j	In Thousand US dollars
Gross Domestic Product for Importing Country	lnY_i	In Thousand US dollars
Distance	lnD_{ij}	Kilometres
Eurozone Membership	EMU1	Takes the value of 1 when both countries in the pair are members of the Eurozone and 0 otherwise
Trade Diversion	EUTD	Takes the value of 1 when just one country in the pair is a member of the Eurozone and 0 otherwise. The aim of this variable is to establish whether the euro has created net trade for the member countries or whether the increases in trade between the member countries came as a result of trade with non-members. If there is evidence of trade diversion, the coefficient of this variable is expected to be negative and significant

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[78]For a more detailed literature refer to Baltagi, B. H., Egger, P., and Pfaffermayr, M. (2003).

GDP Per Capita of Exporting country	lny_i	In Thousand US Dollars
GDP Per Capita of Importing Country	lny_j	In Thousand US Dollars
Common Language	$lang_{ij}$	Takes the value of 1 when both countries in the pair share a common language and 0 otherwise.
Common Border	$border_{ij}$	Takes the value of 1 when both countries in the pair share a common border and 0 otherwise.
Impact of European Union Membership over time.	R_t	This is a time trend.

The dependent variable is the sum of bilateral trade flows (exports and imports) between country pairs and is represented as lnX_{ij}. The decision to use total trade flow as the dependent variable in the analysis of bilateral trade flows has been a topic of debate among researchers, with some preferring the use of total imports, total exports or bilateral trade. The decision to use either uni-directional or bilateral trade flows in the gravity equation should be based on the theoretical foundations of the model, which favour the use of one-way export or import data. Nevertheless, due to data availability, the use of bilateral trade flows is acceptable (De Benedictis and Taglioni, 2011). The theoretical foundations of the gravity model also assert that it is a modified expenditure model and therefore the trade data used should not be deflated by price indices[79]. The trade flow values will be entered into the equation in nominal terms as explained in Chapter 3 where previous literature has justified the fact that trade flow values should be expressed in nominal terms (rather than in real terms) and with a standard numeraire. In this thesis, the common numeraire will be the US dollar.

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[79]Deflating trade flows using price indices should be avoided as the theoretical justifications of the model rules against this procedure and also due to the unavailability of the suitable deflators, empirical difficulties may arise if inappropriate deflators are used. For a detailed review of this, see De Benedictis and Taglioni (2011).

5.3.2   *Sources and Measurement of Data*

This section describes the sources and measurement of data and variables used in the estimations.

Dependent Variable

Trade Data

When using trade data, a choice must be made regarding whether to use Free on Board (FOB) or Cost, Insurance and Freight (CIF) data. Exports are essentially measured at FOB prices while imports are calculated at CIF prices[80]. The bilateral trade data is collected from the UN Comtrade Database (http://comtrade.un.org/) between 1990 and 2008 in million US Dollars for the vehicle manufacturing sector of the sample countries (ISIC Rev 3, 34 and 35). The trade data comprises both exports and imports from the EU15 countries for every reporting country and partner country[81]. The sum of the logs of bilateral imports and exports stated by countries (average of 4 data) is carried out in accordance with the correct specifications stated in Baldwin (2006) to avoid the silver medal error.

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[80] CIF values include the transaction value of the goods, the value of services performed to deliver goods to the border of the exporting country and the value of the services performed to deliver the goods from the border of the exporting country to the border of the importing country. FOB values include the transaction value of the goods and the value of services performed to deliver goods to the border of the exporting country.

[81]It should be noted that this thesis is focussed on the effect of the euro's introduction on 'trade values' and not on welfare effects. Also the analysis of the chosen sector is based on the manufacturing aspect of the sector and not the service aspect of the sector.

Independent Variables

Gross Domestic Product (GDP)

Nominal GDP in US dollars is used in this analysis and is taken from World Development Indicators from the World Bank database. The use of nominal income variables avoids the bronze medal error as stated by Baldwin (2006). WDI converts the dollar figures for GDP from domestic currencies using single year official exchange rates. GDP determines the level of demand and supply in the importing and exporting countries respectively and a positive sign is expected for this variable. Indeed, the GDP is included in the gravity equation as a proxy for the size of the country, although it should be noted that when carrying out sectoral/industry analysis it is preferable to use industry variables as a proxy for the industry/sector. Baldwin et al. (2005) expressed concern regarding this issue and duly noted that:

"When using sectoral trade data, however, the mapping between L [endowment of factors] and E [expenditure on imports] and GDPs is less clear. On the importer's side, one can think of using the corresponding sector's gross value added. However, the import/ demand for, say, chemicals arise from many sectors other than the chemicals sector. On the export side, one can think of using sectoral production as a proxy for the number of varieties, but sector production data is difficult to get for long time periods and a broad sample of countries. Moreover, such sectoral value added measures are typically fraught with many measurement problems". Baldwin et al (2005: p23)

Many authors have assumed that total GDP is a valid proxy for sectoral GDP. Examples include Rauch (1999) who analysed the effect of proximity and common language on various goods using the standard aggregate proxies, such as importer and exporter GDP for both countries[82]. In addition, Feenstra et al*.* (1998), Evenett and Keller (1998), Flam and Nordstrom (2006) and Portugal-Pérez (2008) have used aggregate size variables on sectoral trade flows in estimating the gravity equation.

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[82] The dependent variable in the study is total bilateral trade as opposed to imports or exports

GDP per Capita

This is calculated as nominal GDP divided by the population of the country. The GDP per capita data is collected from the World Development Indicators found on the World Bank database and is expressed in current US Dollars. The main justification for using this variable is that it is an indication of the country's level of development. The logic behind its significance is that the more developed a country becomes, the higher is the demand amongst consumers for foreign goods. Another justification for the use of this variable stems from the assumption that developed countries possess certain structures which aid trade, such as advanced transportation infrastructures. This variable has been used in the gravity model to predict whether countries with comparable levels of GDP per capita will trade more bilaterally than countries with different levels. In the gravity models, GDP per capita signifies the level of income and/or the purchasing power of both exporting and importing countries. In some recent applications of the gravity model, this variable has been omitted without definite reasons. However, it was noted by Bergstrand (1989) that the export of commodities between two or more countries is not only dependent on the income proxied by GDP but also on GDP per capita. In order to avoid possible specification issues, this variable is added to the gravity model.

Gravity model estimations which have used this variable include those of Sanso, Cuairan and Sanz (1993), Frankel and Wei (1998), Frankel, Stein and Wei (1995, 1998), Eichengreen and Irwin (1998), Baltagi et al. (2003), Sohn, (2005), Tang (2005), Carrere (2006) and Saker and Jayasinghe (2007) amongst others. The coefficient of this variable is expected to be positive.

Distance

There are many different ways in which previous studies have calculated geographical distance. Some of the methods used include shipping routes or differentiating between land and sea distances (Wang 1992, Bikker 1987). In this study, two different measures for the distance variable are utilised:
- The log of the distance between the capitals of both countries in kilometres.

- The log of the distance between the most populous cities in each country in kilometres.

The distance data used in this analysis is collected from GeoDist, the CEPII distance dataset (DIST_cepii.xls) and is calculated using the Great Circle Distance. This method uses the latitudes and longitudes of the most important city in terms of population or of its official capital. It has been suggested that this is an ideal way of estimating distances across different modes of transportation and works well in practice (Linnemann, 1966).

Common Border

Many studies have incorporated a dummy variable to identify countries which share a common border. Countries sharing a common border are more likely to be involved in trade than countries which do not and, as such, this variable is regarded as trade enhancing. The data on common borders is collected from the CIA World Fact Book website (https://www.cia.gov/cia/publications/factbook/).

Common Language

The evidence from studies of the gravity model in trade analysis affirms the proposition that two countries sharing the same language are more likely to have greater trade volumes. Head (2003), explained this point stating that:

'two countries that speak the same language will trade twice to three times as much as pairs that do not share a common language'. Head (2003 p.10)

This increase in trade between these countries could also be a result of the fact that they have shared some history as well as speaking the same language. For example, the countries may have shared colonial links. Colonial history is also a variable that has been included in the gravity equation and is viewed as a trade enhancing variable. Head (2003) explained that countries that share a common language do so as a result of shared history or colonial links in the past. He argued that the inclusion of colonial links between country pairs as

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a trade enhancing variable reduces the language effect slightly although it remains significant.

However, the two most commonly used language variables are included in this analysis. The first takes the value of 1 when the language spoken by both countries is the official language and 0 otherwise, while the second variable takes the value of 1 when the same language is spoken by at least 9% of the population in both countries. This data is collected from the CEPII website.

5.3.3 Countries in the Empirical Analysis

This study analyses a total of 15 countries (normally referred to as the EU15 countries). They are selected for this analysis because they are all members of the European Union and have all gone through the processes involved in the integration of Europe as members of the single market and are situated close to each other as in Micco et al'.s (2003) second country sample. Moreover, Baldwin (2006a) maintained that the control group should comprise only countries in the European Union because this will control and take into consideration the effects of the Single Market and the EU harmonisation of policies. In total, there are 91 country pairs from the sample.

5.3.4 Time Period

The data is collected for the period 1990 – 2008 (19years) with all the data being annual. The reasons for selecting this period are as follows:

1. Trade and economic data are available for the time period.
2. EU integration is a long process which started in the 1950s and has included a range of policies which have encouraged an increase in trade within the Union, e. g, the introduction of the Single Market. The time period will take all of these factors into consideration and control for them in the equations with the inclusion of the time-trend dummy variable. Thus the analysis would not attribute trade increases to the introduction of the euro when it could have been caused by the integration of the EU over time.

3. Lastly, the analysis is not solely focussed on investigating whether countries in a currency union trade more than others but also aims to analyse the currency union effect on trade. Using data that spans 19 years facilitates comparison of the euro's effect before and after its introduction.

5.4 Regression Method

5.4.1 Introduction

Previous chapters have explained the disadvantages of using cross-sectional data and show the preference for the use of a panel data approach. Unlike the cross-sectional data, the panel data methodology has the ability to control for unobserved individual heterogeneity between the country pairs. When these differences across the country pairs are not included in the regression but are somehow correlated with the independent variables, then the results obtained from the OLS regressions will be biased. In the proposed dataset for example, while the countries included are relatively comparable in terms of level of development and trade patterns, they also possess differences in their cultural, institutional and political frameworks. The use of cross-sectional methodologies will be unable to control for such heterogeneity, hence resulting in biased results. On the other hand, the use of the panel data methodology removes the effects of the omitted variables that are specific to the individual cross-sectional units and specific time period (Hsiao, 2003). This advantage is significant for this study as both structural and policy differences may have significant impacts on the trade flows between the country pairs.

Secondly, the use of panel data according to Baltagi (2001), is more beneficial in its ability to deliver more informative data, more variability and less collinearity among the variables. Thirdly, the panel data methodology can easily control for the effects that are not measurable in cross-sectional analysis. An example is a situation where countries in a country pair already trade more with each other or have had increasing trading relations in the past. Using the cross-sectional approach, the effect will be unobservable while this could be captured in the panel data approach by controlling for country-pair specific effects.

5.4.2 The Significance of Fixed Effects in the Gravity Model Estimation

The use of panel data methodology accounts for the unobservable cross-sectional specific effects via either the fixed or random effects estimation.[83] As mentioned in the previous section (Section 5.4) and detailed in Chapter 3, country pair effects that are omitted or not properly accounted for in the model can be controlled for by the fixed effects (FE) specification. (Dell'arricia, 1999).

In the FE framework, the import and export fixed effects were proposed by Matyas (1998) who includes two sets of dummy variables for each country, one as an exporter and the other as an importer. However, Egger and Pfaffermayr (2003) further proposed the inclusion of individual country pair fixed effects and time fixed effects to control for common shocks as a method to obtain unbiased results. The inclusion of the country-pair fixed effects is specifically important in the gravity model estimation as it highlights the issue of 'multilateral trade resistance[84]', which is part of the theoretical justification of the model. (Anderson and van Wincoop, 2003; Feenstra *et al,* 2001). Multilateral trade resistance was introduced by Anderson and van Wincoop (2003) who asserted that the analysis of trade flows using the gravity model should not only be determined by the economic mass and distance between country pairs but also by the bilateral to multilateral trade resistance. Bilateral trade resistance (BTR) can be defined as the size of the barriers of trade between country pairs while multilateral trade resistance (MTR) refers to the barriers each country faces in their trade with all their trading partners (including domestic trade).
The inclusion of multilateral trade resistance differentiates the new version of the gravity model, as developed by Anderson and van Wincoop (2003, 2004), from the traditional version used by earlier researchers such as Rose (2000). Christopher Adam, C and Cobham, D. (2007).

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[83] This section will deal with the fixed effect estimator as it is used in this analysis
[84] See Section 3.10

5.4.3 Gravity Models Specification

The first formulation, which is the baseline model, is estimated by means of Ordinary Least Squares (OLS) regression. This method allows for the use of pair- specific explanatory variables such as distance, border and language. The regression equation is specified as follows:

$$lnX_{ijt} = \beta_0 + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 lny_{it} + \beta_4 lny_{jt} + \beta_5 lndistance_{ijt} + \beta_6 border_{ijt} + \beta_7 language_{ijt} +$$
$$\vartheta EMU_{ijt} + \delta EUTD_{ijt} + \varepsilon_{ijt} \tag{5.1}$$

In this baseline model, bilateral trade X_{ijt} between a pair of countries i and j at time t is explained by the level of GDP in each country (lnY_{it}), as well as the GDP per capita (lny_{it}) and a set of variables which capture economic distance. Measures of both physical distance between the countries ($\beta_5 lndistance_{ijt}$) and language affinities between the countries ($\beta_7 language_{ijt}$) are employed, as well as a common border dummy variable ($\beta_6 border_{ijt}$)[85]. The language measures used are the official languages in both countries and the language spoken by at least 9% of the population in both countries, while the distance measures used are the physical distance between the countries and the distance between the most populous cities. However, these measures are included individually in the regression equations.

In order to test for the effect of a common currency, an EMU dummy variable EMU_{ijt} is added and takes the value of 1 if two countries belong to the Eurozone and 0 otherwise. For example, the pair of Spain-Austria is 1 after 1999 but the pair of Spain-UK is 0. This dummy variable captures the effect of integration in the Eurozone. To test trade for diversion a dummy variable $EUTD_{ijt}$ is added, taking the value of 1 when just one of the countries in any bilateral pair participates in the EMU. For example, this dummy variable is 0 for the pair of Spain-Austria but 1 for the pair of Spain-UK.

In the second model, panel data analysis with fixed effects is employed. As mentioned in the previous section, it is one of the methods used to control for

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[85] A 0 if no border/language is shared, and a 1 if two countries share a border/language.

the unobservable individual specific factors. This is the preferred method and will according to Micco et al (2003) answer the appropriate policy question of "What is the impact of a currency union on countries that adopt it?" Carrying out the analysis using cross-sectional techniques which do not have a time series dimension as such answers the wrong question of, "Do countries that share a common currency trade more than others that do not?" The former policy question is not only important to countries that are members of the currency union but also for other countries looking to become members. With this in mind and following Glick and Rose (2002), an augmented version of Equation 5.1 using panel data techniques and country pair fixed effects is used. The basis of this technique is to be able to separate the time series dimension of the 'euro effect'. However, it is known from previous studies that the inclusion of the fixed effect in the regression subsumes the time invariant country pair specific variables. This method according to Micco et al (2003) is the most suitable way to assess the euro effect on trade while also dealing with the possible endogeneity problems that arise from the Optimum Currency Area (OCA) theory which states that countries which trade extensively with each other are more likely to form a currency union. Although the panel data technique is the preferred method for the analysis of the 'euro effect', regression equations will also be run using the traditional gravity variables[86] in order to compare both results as suggested in Micco et al (2003). The general representation of the second model is given as –

$$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_{ij} + \mu_{ijt} \qquad (5.2)$$

In order to ascertain whether the fixed effects panel structure is preferred to the pooled model as in Equation 5.6, the Breusch and Pagan LM test will be applied and subsequently the Hausman test will be used to assess whether fixed or random pair effects should be assumed in this analysis. As the panels under consideration are macroeconomic with observations of 91 country pairs over 19 years, there are a few ways in which the panel model may suffer from some of the econometric problems associated with large datasets. Firstly, cross-sectional dependence is likely to occur as a result of the bilateral nature of the trade

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[86] Micco et al (2003) discovered that just using the traditional gravity variables as opposed to the inclusion of country pair dummy variables overstated the 'euro effect'.

values considered in the analysis. Secondly, common economic shocks are also likely to influence the relationships between the country pairs. In cases where the null hypothesis for cross-sectional dependence is rejected, it is then clear that there is evidence of dependence across the country pairs. There are several ways to address this problem. One method is the inclusion of year dummy variables into the model to account for common shocks. Another way is to use a set of recently developed estimation techniques for macroeconomic panels with large T (length of the time series) and small N (number of countries). They allow for heterogeneous slope coefficients across group members and are also concerned with correlation across panel members i.e., cross-sectional dependence. The Pesaran (2006) Common Correlated Effects Mean Group (CCEMG) estimator is quite general, as it allows for cross-sectional dependence and time-variant unobservables with heterogeneous impact across panel members. Thus, it not only addresses the issue of cross-sectional dependence but also accounts for any common shocks across the countries, which may have a differential impact.

Due to the fact that macro panel models also suffer from heteroscedasticity across panel units, a modified Wald test for group-wise heteroscedasticity will be applied in the fixed effects model. This Wald test has as a null hypothesis that the variances of all units are equal. Whilst there are no precise indications as to why, in some bilateral pairs, the residual variance would be much higher. However, in this sample, it could be due to the fact that trade values between some pairs are much larger than in others. It could also be that some pair-specific characteristics matter, regardless of whether they are observed or unobserved. However, this is taken into account by the fixed effects. The most general way to address this is to use the Poisson pseudo maximum likelihood (PPML) estimator. In fact, the seminal paper by Silva and Tenreyro (2006), which proposed the PPML estimator, was precisely meant to address the estimation problems of models which are log-linearised and then estimated with linear techniques such as OLS. The PPML takes account of the potential problems which arise when there is indeed heteroscedasticity in the formulation.

Another more standard method is to use Driscoll Kraay standard errors. This makes the inference robust to very general forms of spatial and temporal

dependence but leaves the point estimates unscathed and simply corrects the standard errors.

The third formulation follows the work of Feenstra (2002), which includes importer and exporter fixed effects[87] to proxy for the specific multilateral resistance term. Specifically, α_{ij} in equation (5.2), is substituted with α_i and α_j in (5.3). When carrying out the pair-wise fixed effect (Equation 5.2), all characteristics are assumed to be specific to both countries. For example, the Spain-Austria country pair has certain characteristics, as does the Italy-Sweden example. However, the importer and exporter fixed effects assumes that the characteristic is specific for each country acting once as an exporter and once as an importer. Thus, as in the example above, Spain will have two fixed effects. Micco et al (2003); Baltagi, Egger and Pfaffermayr (2003); Cheng and Wall (2005); Glick and Rose (2001); Ruiz and Vilarrubia (2008); Vicarelli and Benedictis (2004); Fidrmuc (2008) are examples of studies where this method has been used.

The model can be represented as:

$$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_i + \alpha_j + \mu_{ijt} \tag{5.3}$$

The panel model is further tested with the Pesaran (2006) Common Correlated Effects Mean Group estimator (CCEMG), which accounts for a common trend, and filters out all of the residual correlation from the model. Finally, the PPML estimator is applied to correct any heteroscedasticy problems which may result from the log-linearisation of the error term. The Wald test is then used to establish whether or not there are residual heteroscedasticy problems.

In the fourth model, the year dummy variables T_{t0} to T_{tN} are included in the regression equation with the purpose of controlling for common shocks following Egger and Pfaffermayr (2003). Ruiz, J. and Vilarrubia, J. (2007) argue

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[87] Mátyás (1998) proposed the use of this method stating that failure to take this into account could lead to misspecified estimates. Other studies that have used this method include those of Rose and van Wincoop (2001), Glick and Rose(2002), Ruiz and Vilarrubia (2007), Henderson and Millimet (2008)

that exclusion of year dummy variables in the estimation of a gravity model leads to potential bias of the results:

"estimated coefficients of explanatory variables that change over time are reasonably sensitive to the inclusion of country-year dummy variables, which leads to the possible bias caused by excluding these dummy variables in the gravity equation." Ruiz and Vilarrubia (2007:p 9)

The equation is represented as:

$$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \lambda_0 T_{to} + \dots + \lambda_N T_{tN} + \alpha_{ij} + \mu_{ijt} \quad (5.4)$$

One of the main points stressed by Bun and Klaassen (2007) is that there may be an upward trend in bilateral trade across countries over time. If trade has continuously increased, then not accounting for this would bias the results. The main difference between the time trend and the year dummy variables is the fact that the former takes into consideration the trade enhancing factors between the countries and prevents these from over-stating the euro effect. Examples are the effects of EU integration and existing trading relationships between country pairs prior to the introduction of the single currency. Bun and Klaassen (2007) actually reduce the impact of the single currency on trade with the inclusion of country pair-specific trends. As such, a time trend R_t is included and will be modelled as in Equation 5.5 below:

$$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \pi R_t + \alpha_{ij} + \mu_{ijt} \quad (5.5)$$

In order to account for the year-specific changes over time and the ability to detect the year-specific impact of the single currency, the year dummy variables T_{t0} to T_{tN} will be interacted with the EMU dummy variable, following Micco et al. (2003) with the view to addressing the following questions:

1. Is the increase in trade abrupt or gradual?
2. Does trade increase in anticipation of the formal creation of the EMU or is the impact obvious only after a time lag?
3. Is trade among EMU members still increasing vis-à-vis other country pairs or has the increase slowed down?

Therefore an alternative formulation of the gravity model is used in an attempt to address these questions. This method will show the evolution of the bilateral trade performance of the EMU country pairs through time, even before the formal creation of EMU. The main difference to the previous models is that the euro dummy variable is replaced with a variable comprising the interaction of the EMU variable with year and trend variables.

The model is formulated as follows:

$$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \lambda_0 T_{to} + \ldots + \lambda_N T_{tN} + \chi_0 T_{to} * EMU_{ijt} + \ldots + \chi_N T_{tN} * EMU_{ijt} + \alpha_{ij} + \mu_{ijt} \tag{5.6}$$

The reason for doing this is based on the argument that economic and monetary integration does not have an immediate impact on trade but only has an effect over time. Similarly, it has been argued that the effects of GDP growth do not translate one for one into more bilateral trade. Only over time does higher GDP imply more trade. This effect will be assessed by including the lag of GDP in each country (lnY_{it-1}).

The model is formulated as follows:

$$lX_{ijt} = \beta_1 lY_{it-1} + \beta_2 lY_{jt-1} + \beta_3 ly_{it-1} + \beta_4 ly_{jt-1} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_{ij} + \mu_{ijt} \tag{5.7}$$

Multicollinearity in a sample occurs when two or more of the explanatory variables are highly correlated and therefore have the ability to predict a large proportion of the variance of another independent variable. This undesirable situation in a statistical model can increase the standard errors of the coefficients. In order words, multicollinearity causes some of the explanatory variables to be statistically insignificant when they otherwise should be significant. It is an issue that is quite common when linear or generalised linear models are estimated. There are formal tests used for dealing with multicollinearity. Some studies such as that of O'Brien (2007), Robinson & Schumacker (2009), and Dormann et al (2013) have suggested the use of a formal detection-tolerance or the variance inflation factor (VIF) for multicollinearity. The former is simply the reciprocal of the latter. A tolerance of less than 0.20 or 0.10 and a resultant VIF of 5 or 10 and above indicates a

multicollinearity problem (See O'Brien 2007). The VIF and Tolerance are calculated as:

$$VIF = \frac{1}{1-R^2}$$
$$\&$$
$$TOL = 1 - R^2$$

Statistically, the Variance Inflation Factor (VIF) measures the degree of multicollinearity in an OLS regression equation by providing an index that measures the increase in the variance[88] of a regression coefficient that is caused by collinearity. Allison (2012) explains that the VIF approximates the "inflatedness" of the variance of a coefficient due to its linear dependence with the other variables. Numerous recommendations for the suitable levels of the Variance Inflation Factor (VIF) have been expressed in the literature with most recommending the value of 10 as the maximum acceptable level. (See Hair, Anderson, Tatham, & Black, 1995; Kennedy, 1992; Marquardt, 1970; Neter, Wasserman, & Kutner, 1989). However, this study will follow the recommendations by Rogerson (2001) and Pan & Jackson (2007) that suggested that the maximum levels of the Variance Inflation factor (VIF) should be 5 and 4 respectively.

5.5   *Hypotheses*

The hypothesis of this study concerns the relationship between the introduction of a single currency and the bilateral trade flows among the member countries. From the previous studies, the euro has led to trade increases in the analysis of both sectoral and aggregate data. Therefore, based on the hypothesis stated above and keeping in line with discussions in the previous chapters, the following research hypotheses are formulated:

1.   There is increased bilateral trade between countries that have higher GDPs. The regression coefficients β_1 and β_2 are expected to show a positive sign. The GDP is a proxy for the size of the country and therefore

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[88] The variance is the square of the estimates standard deviation

the greater is the country's GDP, the greater is the size and variety of its national output and exports.

2. There is increased bilateral trade between countries that have higher GDP per capita which proxies for the level of economic development. Kepaptsoglou et al. (2010) explained that, although two countries may have different populations and comparable GDP, their levels of economic development may be completely different. The coefficient for the $\beta_3 \ and \ \beta_4$ variable is expected to be positive.

3. Distance has a negative impact on bilateral trade flows: the greater is the distance between the country-pairs, the smaller is the projected level of bilateral trade flows between them. $lndistance_{ijt}$ is the geographical distance between countries i and j. It is used as a proxy for transportation and trading costs and is therefore expected to be negatively correlated with trade flows. The regression coefficient for the distance variable β_5 is therefore expected to be negative.

4. Having certain common characteristics between the country pairs influences trade flows. The dummy variables included in the equation above show that countries tend to trade more with other countries when they have common borders, are members of the same regional trade agreement or share the same language and are therefore expected to be positive.

Table 5.2 outlines the Aim, Research questions and hypothesis stated for this research.

Table 5.2 Summary of Aim, Research questions and Hypothesis of the Study

AIM	RESEARCH QUESTIONS	HYPOTHESIS
To investigate the euro effect on trade in the EU15 Transport Equipment Manufacturing Sector.	Has the introduction of the euro had a significant impact on the bilateral trade patterns in the EU15 countries in the chosen sector?	There is a significant increase in bilateral trade between countries that share a common currency.
	Has there been any evidence of trade diversion from non-member to member countries as a result of the introduction of the euro?	There is evidence of trade diversion from non-member to member countries of a currency union as a result of the introduction of the single currency.
	Apart from the euro, what are the other determinants of changes in bilateral trade in this sector?	1.There is increased trade between countries that have higher GDPs 2. Trade between countries reduces as the distance between the countries increases. (There is an inverse relationship between trade and distance). 3. Sharing common characteristics between country pairs leads to increased trade flows.

5.6   Conclusions

This chapter describes the research methodology to be used to investigate the euro effect on trade flows. Specifically, it has highlighted the methodological issues described in Chapter 3 and explained possible solutions to deal with these problems.

The specification of the traditional gravity model is introduced and then the benefits of using the panel data methodology to deal with heterogeneity, which is expected to be present in this analysis, are also highlighted. The significance of including fixed effects and the other econometric concerns are also presented. Lastly, the sources of data, variables used and a summary of the models to be estimated and reported in the next Chapter are explained in detail.

As discussed in the previous sections, there will be a total of seven regression equations used in this analysis which are extensions of the gravity model applied in recent studies to tackle the econometric issues associated with the use of the gravity model of trade. The empirical analysis will be based on these models, which are summarised further in the Table 5.3

Table 5.3 Summary of Models

5.1	$\beta_0 + \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \beta_5 distance_{ijt} + \beta_6 border_{ijt} + \beta_7 language_{ijt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \varepsilon_{ijt}$
5.2	$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_{ij} + \mu_{ijt}$
5.3	$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_i + \alpha_j + \mu_{ijt}$
5.4	$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \lambda_0 T_{to} + \ldots + \lambda_N T_{tN} + \alpha_{ij} + \mu_{ijt}$
5.5	$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \pi R_t + \alpha_{ij} + \mu_{ijt}$
5.6	$lX_{ijt} = \beta_1 lY_{it} + \beta_2 lY_{jt} + \beta_3 ly_{it} + \beta_4 ly_{jt} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \lambda_0 T_{to} + \ldots + \lambda_N T_{tN} + \chi_0 T_{to} * EMU_{ijt} + \ldots + \chi_N T_{tN} * EMU_{ijt} + \alpha_{ij} + \mu_{ijt}$
5.7	$lX_{ijt} = \beta_1 lY_{it-1} + \beta_2 lY_{jt-1} + \beta_3 ly_{it-1} + \beta_4 ly_{jt-1} + \vartheta EMU_{ijt} + \delta EUTD_{ijt} + \alpha_{ij} + \mu_{ijt}$

Table 5.4   Explanation of Terms used in the Regressions

Symbols	Meaning
β	The beta-coefficients are used for the standard gravity model variables. In the gravity model, one expects all betas to be positive and significant and, in the case of beta1 and beta2, they should be close to 1.
ϑ	The theta is the parameter used for the euro dummy variable. In the regression equations a positive ϑ would imply a positive effect as a result of the euro's introduction and vice versa
δ	The delta is used to denote the trade diversion variable. The delta could go in different directions e.g. positive if there has been more trade with non-Eurozone countries after the euro was introduced, and negative if it decreased trade with the non-Eurozone countries.
$a_{ij} + \mu_{ijt}$	These terms are included in all the equations from 6b-6g.The first part (a_{ij}) is the fixed effect & the second part (μ_{ijt}) is the residual. The former is specific to each country-pair and does not change over time. It indicates that there is something different in the pair Austria-Spain to the pair Austria-Italy, for example. The latter term is simply the residual of the regression equation, and should be independently and identically distributed across country pairs.
λ	The lambdas are the parameters on the year dummy variable. A significant lambda indicates that in this particular year there has been a common shock affecting all trade relations between all countries.
πR_t	This is the time trend dummy variable which was introduced by Bun and Klaassen (2007) By trending behaviour, it implies the possibility of the country pair's bilateral trade rising in the past and this should be taken into consideration as well. In 6e, the pi coefficient (π) measures the slope of the time trend R.
$T_{to} + ... + T_{tN}$	These are the year dummy variable included to assess the effects of common shocks; the lambda's (λ) as earlier explained measure the effect of a particular year on the bilateral trade values.
$\chi_0 T_{to} * EMU_{ijt} + ... + \chi_N T_{tN} * EMU_{ijt}$	The chi's are the coefficients on the euro-dummy variable interacted with the year-dummy variables. They measure the potential additional impact of the introduction of the euro together with the year-dummy variable. It could be that there are year-specific shocks and that these are particularly strong with the introduction of the euro. The chi-coefficients measure the impact for EMU countries beyond the impact of a common shock to ALL countries.

CHAPTER 6

ESTIMATION AND RESULTS

6.1   Introduction

From Chapter 3, it is clear that the gravity model of trade is a theoretically justified empirical tool used to analyse the effects of bilateral trade between countries and regions. Its use in the analysis of the 'euro's trade effect[89]' was reviewed in Chapter 4 with reference to the results of seminal studies in this area. The initial and full introduction of the euro as a single currency in Europe in 1999 and 2002 respectively prompted several studies undertaken to estimate its impact on bilateral trade in goods and services both at the aggregate and disaggregate levels. Overall, the results indicate an increase in bilateral trade flows ranging between 5% and 29%.

Some of the key studies include that of Micco et al (2003) who report an increase in trade of between 5% and 20%, Bun and Klaassen (2002) who identify a 38% increase in trade as a result of the euro's introduction, Flam and Nordstrom (2003) who report estimates of between 8% and 15% and Barr et al (2003) who estimate a 29% trade increase. These results suggest that the introduction of the euro has led to an increase in trade among the euro zone members. While most of the aforementioned studies have analysed the euro effect using total merchandise trade, this study extends the literature by analysing the effect on the Transport Equipment Manufacturing Sector in 12 countries of the Eurozone area within the European Union and 3 non-Eurozone countries that are still a part of the European Union. To this end, different econometric tests applied to aggregate trade in previous studies will be applied in the analysis taking into consideration the econometric advancements of the gravity model.

The remainder of this chapter is structured as follows. Section 6.2 summarises the research methodology proposed in Chapter 5 while section 6.3 estimates the 'euro effect' in the transport equipment manufacturing sector and

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[89] The 'euro's trade effect', specifically means the trade effect starting from the third stage of the Economic and Monetary Union(EMU).

reports the empirical findings. In Section 6.4, the results will be checked by including extensions to the empirical specification of the modified gravity model in order to test the robustness of the results. The chapter is concluded in Section 6.5.

6.2   Empirical Methods

The methodology used for this study as discussed in Chapter 5 is centred on the Gravity Model of Trade which is a standard specification in the empirical literature when analysing the determinants of bilateral trade among countries and regions. The estimation of the gravity model could produce biased results if the following econometric challenges are not dealt with:-

1. The exclusion of the multilateral trade resistance factors leads to omitted variable bias (Anderson and van Wincoop., 2003).

2. The existence of zero trade flows among the country pairs leads to a loss of information. This occurs because the log of zero is not feasible and therefore leads to biased estimates

3. The presence of heteroscedasticity in the data leads to unreliable estimates. (Silva and Tenreyro., 2006)

Finally, some major factors which affect trade are not reflected in the regressors and could also cause significant problems. These factors in most cases cannot be quantifiable but have to be controlled for in order to achieve correct estimates. Examples include technology and political factors which differ from country to country.

Most applications of the gravity model have their merits and demerits and no single approach is ultimately superior or outperforms the other. This is the main reason why the gravity model analysis must include varied estimation methods using the same dataset. In dealing with the estimation issues highlighted above, the issue of the zero trade flows will be ignored as it represents less than 10% of the total dataset. The other three issues will therefore be dealt with in the following ways. The omitted variable bias will be handled by using the fixed effects technique, the use of the panel data

estimation will deal with the issue of unobserved heterogeneity and finally the PPML estimator, although used to deal with zero trade flows, will be applied to solve the problem of heteroscedasticity in the trade dataset.

6.3   Specification and Results

In this section, the results of the baseline gravity model using the cross sectional methodology will be discussed first followed by the panel fixed effects models which include both the country pair and the importer and exporter fixed effects. Lastly, the single currency effect on trade will be tested.

6.3.1 Baseline Gravity Model

Initially, Pearson correlation coefficients were calculated to examine if there was a close co-movement of the economic cycles of the EU countries included in this sample. It was specifically computed to measure the relationship between the income and size variables used in the dataset (GDP and GDP per capita). Overall, the results in Table 6.1 show that there is a small negative correlation between GDP and GDP per capita and therefore the value of a country's GDP is not correlated with increases in the GDP per capita of the country. In order to account for the conditional effect on correlation between the variables the variance inflation factor (VIF) is computed. The rule of thumb states that a VIF higher than 5 is an indication of multicollinearity. Table 6.2 shows the highest VIF to be 1.08 and therefore this problem is not encountered.

Table 6.1 Pearson Correlation Coefficient

	GDP_i	GDP_j	GDPcap i
GDP_j	-0-04	1	0.1
GDP cap i	0.06	0.11	1
GDP cap j	0.01	0.36	0.11

Table 6.2.Collinearity Diagnostics: Variance Inflation Factor

Variable	SQRT VIF	VIF	Tolerance	R Squared
yi	1.01	1.00	0.9937	0.0063
yj	1.16	1.08	0.8645	0.1355
yci	1.02	1.01	0.9789	0.0211
ycj	1.15	1.07	0.8661	0.1339

Mean VIF   1.08

The results of the OLS regression using the traditional gravity variables (Equation 5.1) are reported in Tables 6.3 and 6.4 with the exclusion of the EMU and trade diversion dummy variables. In Table 6.3, the baseline gravity model is estimated by including the explanatory variables individually with the core variables to see their effect on the core variables. The first column shows the core variables without the inclusion of any of the traditional gravity variables. The Driscoll-Kraay standard errors for coefficients estimated by pooled OLS/WLS or fixed effects (within) regression were employed to deal with the problem of heteroscedasticity in this model. The issue of heteroscedasticity was dealt with in several ways in this analysis, firstly by adapting the specification to see whether some variables could be responsible (with the inclusion of dummy variables and trends). Secondly Driscoll Kraay standard errors was used in the baseline model and lastly, PPML was used in the panel model. In the panel model, the Wald test for groupwise heteroscedasticity in a fixed effects regression model showed that there is a presence of heteroscedasticity in the sample. The main advantage of using this method is its ability to control for an error structure that may be heteroscedastic, autocorrelated and possibly correlated between the groups (panels). Driscoll – Kraay standard errors are robust to very general forms of cross-sectional (spatial) and temporal dependence. (Hoechle, 2007).

The other columns show the gravity variables being added to the pooled model one by one and the results obtained are in line with the previous studies with all the standard variables having the expected signs and with their coefficients being similar to those of other gravity model studies. Both coefficients for importer and exporter GDP have high elasticities of approximately 3 which indicate their importance as determinants of bilateral

trade by indicating that on average a 1% increase/decrease in GDP leads to a 3% increase/decrease in the level of bilateral trade between the country pair. Also, the elasticities of trade with respect to distance point to the fact that on average, with all other variables held constant, a 1% increase in the geographical distance between a country pair leads to a fall in the level of bilateral trade of approximately 3% between them. These can be seen in the significant and negative coefficients obtained in Table 6.3 of between -2.8 and -2.5 notwithstanding the measure of distance used. GDP per capita on the other hand is only significant in the core variables model which suggests that the bilateral trade effects are absorbed by the gravity variables.

The common border dummy variable and the two measures of the language affinity variable are significant at the 0.01 level as expected in gravity model analysis. This coefficient for the common border variable showed a high elasticity of 3 which indicates that on average countries sharing a border are likely to trade 3 times more with each other than with other countries. The two language variables employed also had high elasticities of above 4 indicating that on average countries sharing the same language are likely to trade 4 times more with each other than with other countries. Both results are in line with the expected gravity model estimations.

Table 6.3 Baseline Gravity Model Estimates

Dependent Variable: Log of Bilateral Trade (lnX_{ij})	Model 1 core variables	Model 2 +common border	Model 3 +common language	Model 4 +common language 2	Model 5 +distance	Model 6 +distance (cap)
lnY_i	3.000***	2.826***	3.042***	3.093***	2.782***	2.761***
	(69.771)	(13.104)	(14.196)	(14.659)	(13.352)	(13.041)
lnY_j	2.914***	2.671***	2.948***	2.840***	2.645***	2.664***
	(60.557)	(10.422)	(11.351)	(11.667)	(11.529)	(11.221)
lny_i	1.146***	1.311	0.917	0.792	0.190	0.054
	(5.411)	(1.397)	(0.881)	(0.766)	(0.192)	(0.055)
lny_j	1.188***	1.101	0.826	0.788	0.229	-0.205
	(5.492)	(1.356)	(0.979)	(0.937)	(0.294)	(-0.251)
$border_{ij}$		3.251***				
		(4.325)				
$language_{ij}$			4.528***			
			(4.558)			
$language2_{ij}$				4.522***		
				(6.572)		
$lndistance_{ij}$					-2.807***	
					(-6.518)	
$lndistancecap_{ij}$						-2.543***
						(-5.666)
Number of observations	1,530	1,530	1,530	1,530	1,530	1,530
Adjusted R^2		0.754	0.741	0.758	0.785	0.775
F	11,637.480	67.698	74.354	80.661	81.600	69.466

Note: For a definition of the common language and distance measures, see main text. ***, ** or * indicate significance at 1%, 5% or 10% respectively. t-statistics are in parenthesis.

Table 6.4 Baseline Gravity Model Estimates with Multiple Variables

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
lnY_i	2.805***	2.746***	2.770***	2.869***	2.813***	2.839***	2.810***	2.745***	2.778***
	(13.501)	(12.996)	(13.125)	(13.617)	(13.014)	(13.292)	(13.308)	(12.637)	(13.022)
lnY_j	2.666***	2.619***	2.649***	2.666***	2.608***	2.650***	2.630***	2.563***	2.610***
	(11.018)	(10.551)	(10.832)	(11.257)	(10.770)	(11.166)	(10.915)	(10.491)	(10.872)
lny_i	0.273	0.360	0.320	0.206	0.340	0.254	0.256	0.394	0.294
	(0.275)	(0.382)	(0.342)	(0.208)	(0.361)	(0.271)	(0.258)	(0.420)	(0.314)
lny_j	0.253	0.161	0.008	0.229	0.205	0.008	0.302	0.284	0.064
	(0.311)	(0.197)	(0.010)	(0.282)	(0.251)	(0.009)	(0.371)	(0.346)	(0.076)
$border_{ij}$	0.319	0.908	1.165	-0.051	0.675	0.741	0.300	1.081	1.099
	(0.351)	(1.005)	(1.397)	(-0.059)	(0.746)	(0.907)	(0.331)	(1.204)	(1.338)
$language_{ij}$	1.201	2.003*	1.289						
	(1.071)	(1.812)	(1.205)						
$language2_{ij}$				2.080**	2.386**	2.167**			
				(2.314)	(2.386)	(2.268)			
$lndistance_{ij}$	-2.433***			-2.274***			-2.371***		
	(-3.725)			(-3.433)			(-3.614)		
$lndistancecap_{ij}$			-1.908***			-1.768***			-1.860***
			(-3.627)			(-3.243)			(-3.491)
Number of observations	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Adjusted R^2	0.787	0.779	0.782	0.792	0.783	0.787	0.788	0.779	0.784
F	60.484	51.657	56.896	65.168	56.439	61.366	63.951	54.776	60.107

Note: For a definition of the common language and distance measures, see main text. ***, ** or * indicate significance at 1%, 5% or 10% respectively. t-statistics are in parenthesis.

However in Table 6.4, a combination of the different measures of the standard gravity variables are added to the core variables. All the models in Table 6.4 represent a variation of Equation 5.1 and have the different measures of language and distance and the common border dummy variable included in the regression equation. The basis for omitting some variables in each model is to ensure that the results obtained are robust to the different variations of the language and distance measures utilised.

The results obtained are similar to the results in Table 6.3 with the GDP for both importer and exporter across all models being significant at the 0.01 level with elasticities of approximately 3. The GDP per capita on the other hand had positive but not significant values and this implies that the trade effects are absorbed by the gravity variables as in Table 6.3. The distance variable was negative and significant at the 1% level which is expected in gravity model analysis. The common language and common borders variables are also positive as expected even though not always significant in all the models. The coefficient on the variable for the common borders is averaged at 0.65. Since trade is specified in log form, the coefficient for the dummy variables are more effectively interpreted by taking the exponent value, thus estimating that trade will increase by 91% more for countries sharing the same border than for two other similar countries. The common language variables on the other hand have the expected signs and are significant at the 1% level. The results indicate that the baseline model estimates are robust to the different versions of the language and distance measures and agree with the hypotheses stated in Section 5.3.

In summary, the results achieved from the baseline gravity model estimation utilising the ordinary least squares regression method (OLS) are shown in Tables 6.3 and 6.4 reveal the following-
The coefficients for the economic size variables (GDP and GDP per capita) and the distance variable ($distance_{ijt}$) had the predicted signs affirming the gravity model intuition that bilateral trade is positively correlated with the economic size of the countries involved and negatively correlated by the distance between country pairs. The coefficient of determination (R^2) lies in the region of 74% - 79% and finally the F statistics are clearly significant which reflects the

explanatory power of the regressors in the tested equation and the joint significance of all variables in the model specification.

The estimates obtained from the GDP variables ($Y_i \ and \ Y_j$) are positive and significant and do not change over time, therefore advocating that bilateral trade flows are significantly determined by the sizes and income of the country pairs. On average from the tables above, a 1% change in GDP leads to a 3% change in the level of bilateral trade flows between the countries.

The distance variables are negative and significant which endorses the gravity model notion that countries trade flows between countries are reduced the further apart they are located and vice versa. The coefficients for the distance variable obtained from the tables above range between -1.7 and -2.8 and are highly significant at the 0.01 level indicating that a 1% increase in the distance between country pairs leads to a fall in bilateral trade between them.

The other trade enhancing variables which include the common border and common language dummy variables were significant, so confirming the results that countries which share the same border and speak the same language engage in more trade. The coefficient for the dummy variable for the common border was on average estimated to be 0.75 which indicates that countries sharing the same borders trade 2.1 times more than with other countries. The coefficient for the common language variable indicated that countries which speak the same language tend to trade 20 times more than they would with countries speaking other languages.

6.3.2 Panel Fixed Effects

The first two studies that employed the panel data technique are those of Ghosh (1976) and Matyas (1997). Contrary to the cross section regression equations previously used in the gravity model application, use of the panel data technique recognises that the main variables in the regression equations evolve through time and easily identifies the specific country and time effects. Most studies using the gravity model has turned to this model. Studies of Matyas (1998), Egger (2000), Rose and van Wincoop (2001), Brun et al (2002), Egger and Pfaffermayr (2003, 2004) are examples amongst others.

The Breusch and Pagan LM test and the Hausman tests are carried out to decipher whether or not the fixed effects model is more appropriate than the random effects model in the analysis. The null hypothesis for the Hausman test is that the two estimation methods (random and fixed effects) are both valid and that therefore they should yield coefficients that are "similar". The alternative hypothesis is that the fixed effects estimation is valid and the random effects estimation is not; if this is the case, then differences between the two sets of coefficients are expected. This is because the random effects estimator makes an assumption (the random effects are orthogonal to the regressors) that the fixed effects estimator does not. If this assumption is wrong, the random effects estimator will be inconsistent but the fixed effects estimator is unaffected. Hence, if the assumption is wrong, this will be reflected in a difference between the two set of coefficients. The larger is the difference (the less similar are the two sets of coefficients), the greater is the Hausman statistic.

A large and significant Hausman statistic means a large and significant difference and so the null hypothesis that the two methods are valid is rejected in favour of the alternative hypothesis that one is valid (fixed effects) and one is not (random effects). In this case, the Hausman statistic is very large, (test statistic 25.77, p-value 0.00) and therefore the random effects model is rejected. Box 6.1 shows the results of the two tests. The Breusch and Pagan LM test examines for random effects where the null hypothesis will be rejected when the variance of the residual is zero. The test results strongly rejects the use of random effects (test statistic 9315.47, p-value 0.00) and confirms the use of fixed effects in the estimation.

Box 6.1: Breusch and Pagan LM Test for Random Effects
Breusch and Pagan Lagrangian multiplier test for random effects
Null Hypothesis: var(μ_{ijt})=0
$\chi^2(1) = 9315.47$
Prob > $\chi^2(1) = 0.00$
 Therefore, reject the null hypothesis that the variance of the residual is zero. Hence, the use of random effects is rejected.

Hausman test for FE v RE

```
        ---- Coefficients ----
             (b)          (B)              (b-B)          sqrt (diag (V_b-V_B))
            fe_1         re_1           Difference       S.E.
--------------------------------------------------------------------------------
----
   yi      1.621205     2.703156       -1.081951         .8272084
   yj      4.670302     3.207425        1.462877         .7190491
   yci     .2712077    -.7483934        1.019601         .9479315
   ycj    -1.299781     .2387681       -1.53855          .8029722
--------------------------------------------------------------------------------
-------
   b = consistent under $H_o$ and $H_a$
   B = inconsistent under $H_a$, efficient under $H_o$

  Test:  $H_o$:  difference in coefficients not systematic
```
$\chi^2(4)$ = (b-B)'[(V_b-V_B)^(-1)](b-B)   = 25.77
Prob > $\chi^2(4) = 0.00$

➔The null hypothesis was rejected and hence difference in coefficients is systematic, meaning that the fixed effects is preferred

Further tests are carried out to check for possible problems with the panel model. Firstly, the test for the presence of cross section dependence in bilateral trade data which is caused by country-specific responses to common shocks amongst a group of countries (Chudik, Pesaran and Tosetti, 2011) will be carried out with the Pesaran (2004) CD test. Panel data models often presume that observations across individuals are independent as in the null hypothesis for this test. Table 6.8 strongly rejects the null of independence across country pairs in the baseline panel. It will therefore be important to consider common shocks and any other common influences across panel units.

Table 6.5 Pesaran CD Test for Cross-Sectional Dependence

CD-test	p-value	correlation
47.27	0.00	0.19

Note: t*he null hypothesis of the Pesaran CD test is cross-sectional independence.*

Secondly, the Wald test for group-wise heteroscedasticity is used to deal with possible problems of heteroscedasticity in simple fixed effects panel models. The null hypothesis states that the sigma (variance) of each panel unit is the same as the overall variance (sigma). In this case, there are 91 degrees of freedom, as we have 91 panel units, and it is clear from BOX 6.2 that the null is strongly rejected which indicates evidence of heteroscedasticity. The test statistic is very large and indicates strong differences in variance across panel units (p-value = 0.00).

Box 6.2   Modified Wald Test for Groupwise Heteroscedasticity in Fixed Effect Regression model

H0: sigma(i)^2 = sigma^2 for all i

chi2 (91) =   13997.68,

Prob>chi2 =   0.0000

$H_0: \sigma^2_i = \sigma^2$ **for all i**

$\chi^2(91) = 13997.68$

Prob > $\chi^2(91)$ = 0.00

reject the null hypothesis that variance is equal across units and hence there is a presence of heteroskedasticity in the sample.

Lastly, tests for stationarity of the residuals adapted to the panel context are carried out using the Maddala Wu (MW) and the Cross-sectionally Augmented Panel Root (CIPS) tests. The MW and CIPS test are both panel unit root tests. The difference between both is that the MW test does not account for cross-dependencies, whereas the CIPS test does by including a common factor.

Table 6.6 CIPS Panel Unit Root Test.

residual w/o fixed effect		residual including fixed effect	
without trend	with trend	without trend	with trend
0.69 (0.24)	0.50 (0.69)	0.61 (0.73)	1.62 (0.95)

Note: CIPS Z_t test statistic is reported with p-value in brackets. Test includes first lag and a single common unobserved factor.

Two types of residuals of the panel fixed effects model are modelled using the CIPS test. Firstly, the residual that does not include the fixed effect is tested and secondly, the fixed effects are completely excluded. In both cases, the CIPS test indicates that the residuals are not stationary, even in the case when the model has a trend included. The implication of non-stationarity in the residuals is that there is likely to be some evidence of trending behaviour that is not modelled. It could for example be the trend increase in trade flows over time. Hence, it seems that the present model is not sufficient to explain all trending behaviour. It is an open question of research regarding the additional steps that can be taken to model this trending behaviour. A time trend R_t would be modelled following Bun and Klaassen as in Equation 5.5.

The results achieved following the estimation of the gravity model using the panel data methodology with fixed effects are presented in Table 6.7. As with the previous tests, the estimations have significant values for the R^2 and F-statistics. Again only GDP for the exporting country (GDP_j) is highly significant showing elasticities of above 3 in all tests which indicate its importance as a determinant of trade flows between country pairs and can be interpreted to mean that on average, a 1% increase/decrease in GDP of the exporting country leads to a 3%increase/decrease in the level of bilateral trade between the country pairs. The size of the exporting country is more important than the size of the importing country when determining trade flows between countries. It was pointed out previously that the use of the fixed effects estimation subsumes the time invariant variables hence this is the reason that they are not included in these specifications. The coefficient values for the GDP per capita variables are positive although not significant. With the results obtained from the Pesaran

(2004) CD test[90] showing substantial evidence of cross-sectional correlation, the CCEMG estimates are reported in column 4 of Table 6.7. The results however revert to the previous outcome that the economic size of the countries is a determinant of bilateral trade between country pairs.

Table 6.7 Panel Estimates of the Gravity Model

Dependent Variable: Log of Bilateral Trade	Country Pair Fixed Effect	Exporter/Importer Fixed Effect	CCEMG	PPML
	(Model 1)	(Model 2)	(Model 3)	(Model 4)
lY_i	1.621	1.733	0.251	1.25***
	(1.455)	(0.931)	(0.070)	(11.706)
lY_j	4.670***	3.057***	5.262**	1.21***
	(3.749)	(7.849)	(2.113)	(9.823)
ly_i	0.271	0.312	1.934	0.054
	(0.211)	(0.173)	(0.551)	(1.072)
ly_j	-1.300	0.406	-2.615	0.060
	(-0.764)	(0.241)	(-1.183)	(1.452)
Number of observations	1,530	1,530	1,530	1,530
Adjusted R2		0.902		
F	139.715	.		

Note: country pair fixed effect not reported in column 1, exporter and importer fixed effects not reported in column 2[91]. ***, ** or * indicates significance at 1%, 5% or 10%. t-statistics are in parenthesis

6.3.3   The EMU Effect

In order to model the specific trade effects of the single currency, a euro dummy variable is added as in all previous studies to the regression equations which takes the value of 1 for each country pair that in a given year adopted the euro as the national currency. Given that the economic integration of the European Union has been on-going, a time trend that controls for the effect of

_____

[91] As there are 91 units in this panel (91 pairs of countries), the 91 fixed effects are estimates and are not reported for each unit. The coefficient reported is the intercept for each unit.

continued integration in bilateral trade is included in all the models. Trade gains between the euro zone members could also come at the expense of trade with non-members and could cause a shift in trade relations. In order to deal with this, a dummy variable is included in the regressions to model trade diversion.

The model is first tested with the simple pooled OLS again even though it will not be possible to interpret the EMU dummy in this case as the effect of the single currency over time. This question can be answered only with the panel models. Then the standard country-pair fixed effects and the exporter/importer fixed effects model are applied. Trade diversion in this case cannot be tested because it is a time-invariant characteristic for the country pairs. Added to the former panel are the year-specific dummy variables to model common shocks, and the application of the Mean Group estimator to model cross-section dependence. This model already includes a trend and therefore no further time trend is included here. Finally, the model with the PPML estimator is tested to account for the possible heteroscedasticity problems encountered before. The results for these six models are shown in Table 6.8.

Table 6.8 Gravity Models and EMU Dummy Variables

	Pooled Model (5.1)	Country Pair Fixed Effect (5.2)	Exporter/ Importer Pair Fixed Effect (5.3)	With Time Fixed Effects (year dummy) (5.4)	CCEMG (5.2)	PPML (5.2)
	(1)	(2a)	(2b)	(2c)	(3)	(4)
lY_i	3.016*	0.322	0.322	2.585	1.536	1.25***
	(13.032	(0.227)	(0.227)	(1.62)	(0.357)	(11.603)
lY_j	2.898*	3.582**	3.582**	3.06***	5.606*	1.21***
	(10.557	(2.444)	(2.444)	(15.56)	(1.782)	(9.838)
ly_i	1.673	0.734	0.734	4.74	2.825	0.063
	(1.306)	(0.400)	(0.400)	(1.57)	(0.644)	(1.190)
ly_j	1.658*	-0.865	-0.865	2.21	-1.675	0.071*
	(1.657)	(-0.526)	(-0.526)	(1.84)	(-0.604)	(1.659)
EMU_{ijt}	0.058	-0.026	-0.026	0.41**	-4.463	-0.011
	(0.166)	(-0.247)	(-0.247)	(1.95)	(-0.387)	(-0.674)
$EUTD_{ijt}$	0.538	.	.	-0.993		0.030
	(0.888)			(-1.83)		(1.090)
R_t	-0.059	0.052***	0.052***	-0.020	0.935***	

		(1.227)	(2.954)	(2.954)	(0.56)	(5.185)	
Dy1991					-.1200881		
					(0.62)		
Dy1992					.2164797		
					(1.36)		
Dy1993					-.3477527		
					(1.53)		
Dy1994					.0245567		
					(0.12)		
Dy1995					.3165306		
					(1.63)		
Dy1996					.4164783		
					(2.24)		
Dy1997					.214005		
					(1.24)		
Dy1998					.198292		
					(1.24)		
Dy1999					-.1188128		
					(0.85)		
Dy2000					-.5562782		
					(3.71)		
Dy2001					-.7516274		
					(5.05)		
Dy2002					-.7162187		
					(5.77)		
Dy2003					-.3545165		
					(3.15)		
Dy2004					.0654476		
					(0.76)		
Dy2005					.0671596		
					(0.82)		
Dy2006					.0766691		
					(1.11)		
Dy2007					.0655387		
					(1.24)		
Number of observations	1,530	1,530	1,530	1,530	1,530	1,530	
Adjusted R2	0.715	0.564	0.564	0.905			
F	82.843	105.172	105.172	.			

Note: the standard errors of the panel fixed effects models are based on robust Driscoll Kraay standard errors; ***, ** or * indicates significance at 1%, 5%, or 10%.

6.4   What does the Raw Trade Data Reveal?

Before reviewing the estimates obtained from Table 6.10 above, it is important to see if the indications of the euro effect on the data are clear from the raw trade data from the transport equipment manufacturing sector. For this purpose, bilateral trade will be categorized into five categories of bilateral trade between the EU 15 countries, the eurozone countries and between the Eurozone countries and Denmark plus Sweden and finally the United Kingdom. The aim of this is to identify the trend in trade between these country /region pairs. Figures 1-5 provide a description on the growth of trade in all five categories.

Figure 6.1: Intra Euro Zone Trade
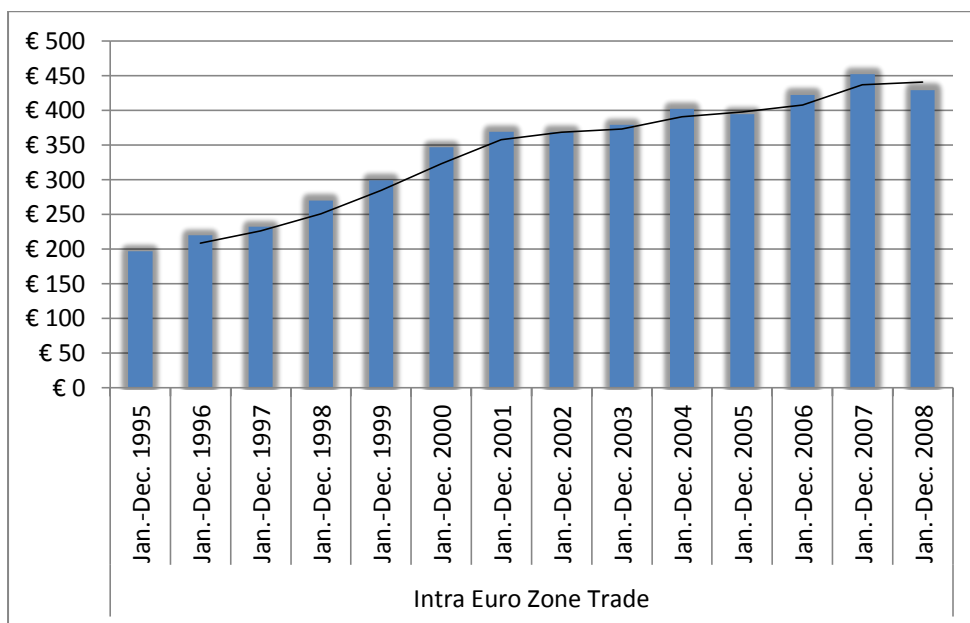
Source: Eurostat (Authors calculations)
(values in €billion)

Figure 6.2: Intra EU15 Trade
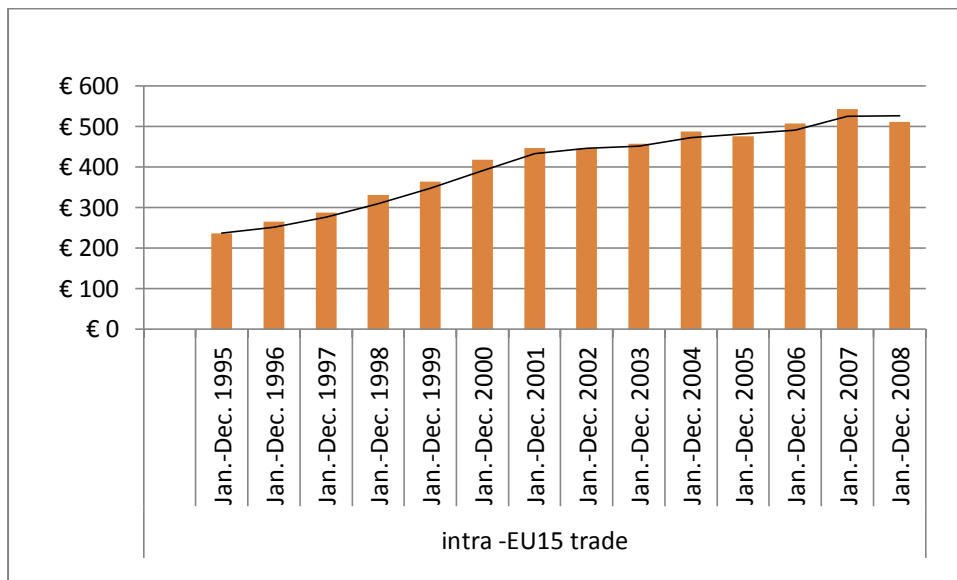
Source: Eurostat (Authors calculations)
(values in €billion)

Figure 6.3: Bilateral Trade between the EU12 and Denmark
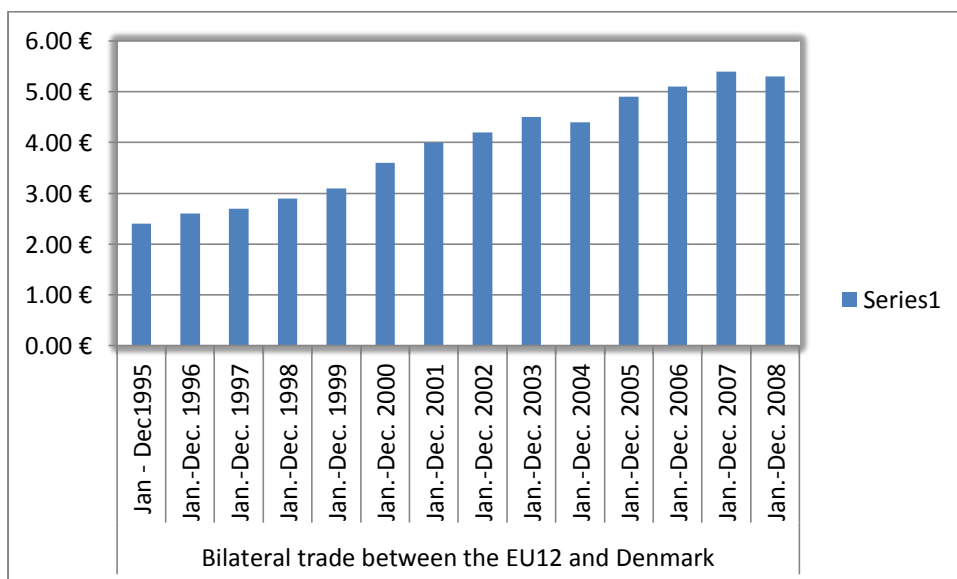
Source: Eurostat (Authors calculations)
(values in €billion)

Figure 6.4: Bilateral Trade between the EU12 and the United Kingdom
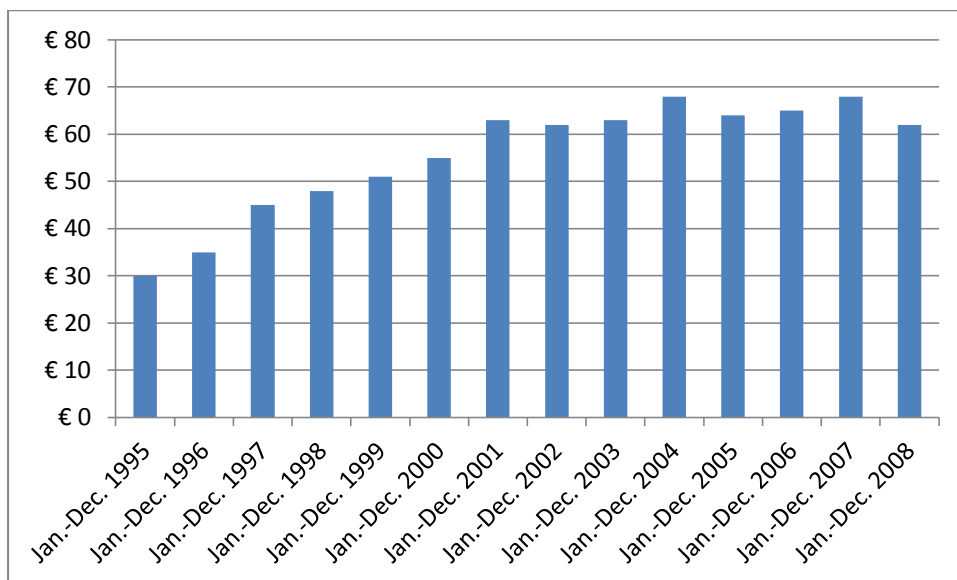
Source: Eurostat (Authors calculations)
(values in €billion)

Figure 6.5: Bilateral Trade Between the EU12 and Sweden
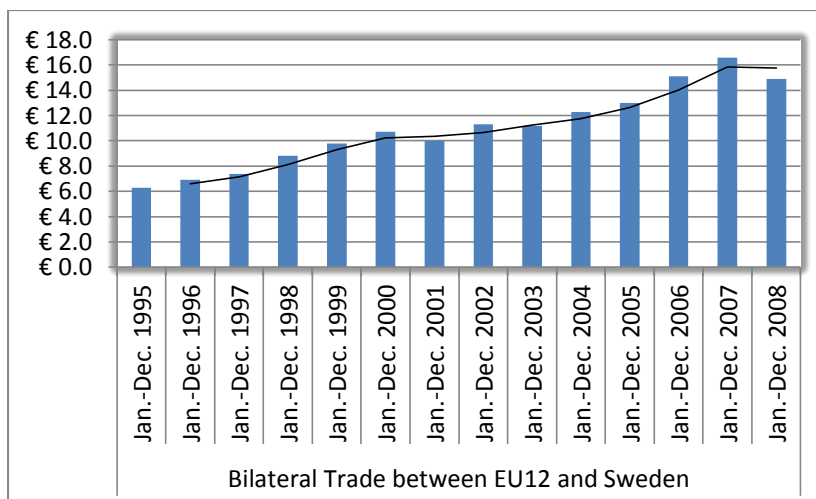
Source: Eurostat (Authors calculations)
(values in €billion)

Figure 6.6: Bilateral trade Performance
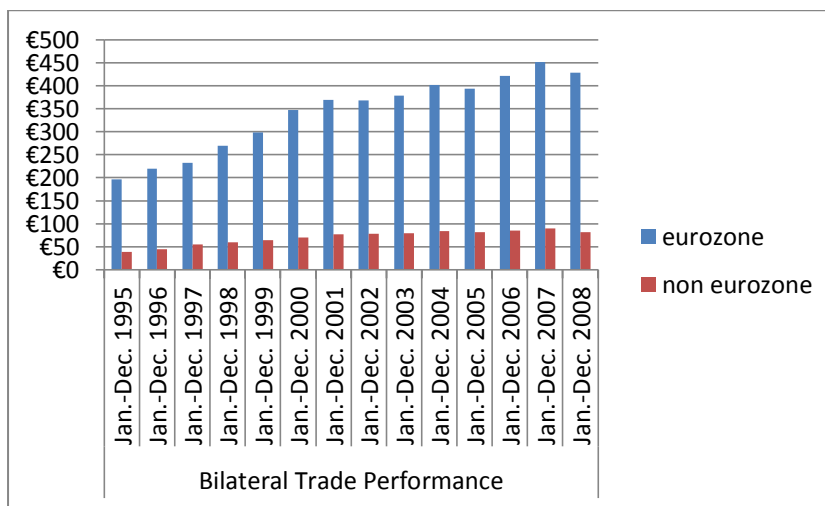
Source: Eurostat (Authors calculations)
(values in €billions)

The figures above show that there has been a gradual increase in bilateral trade flows in the transport manufacturing sector. Figures 6.1 and 6.2 which show the trade trend between the Eurozone countries and the EU15 countries both reveal that in 1998 there was a considerable increase in trade flows between the EU15 countries which continued till 2002 when there was a slight decline. This was also noted by Micco et al (2003) and was attributed to the anticipation of the single currency's introduction. The other categories which are represented in Figures 6.3-6.5 show the trade flows increasing at approximately the same rate up until 2000-2001 after which they rise considerably. Finally, Figure 6.6 shows the trade trend between the Eurozone countries and the Eurozone countries and the non-Eurozone countries. This figure shows that, even when trade flows between the Eurozone countries rises in 1998, trade rises between the euro zone and non-Eurozone countries remains gradual. At this point, the observed trade increases cannot be attributed to the single currency's introduction in 1999-2002 and this means that the trade effects of the euro will have to be ascertained by the estimation of the different variables that are considered to determine the volume of trade.

The results obtained from the augmented gravity model with currency union factors are shown in Table 6.8. The results for each of the different models in Table 6.8 also confirm the earlier findings for the baseline gravity model. The

R^2 and F-statistic for all the tests are significant while the coefficients for the core variables and the distance variable also show significant values. However, it is worth noting that across all tests the coefficients for GDP values for the exporting country (GDP_j) are more significant than the GDP value for the importing country GDP_i) which indicates that the former has more impact on bilateral trade than the latter. On average both importer and exporter GDP showed positive and significant coefficients which suggest that the trading partners incomes are strongly influences trade.

The simple pooled model would not show any significant increase in bilateral trade between the country-pairs belonging to the EMU or not. In this case, the estimate for ϑ would imply a tiny effect of just 6 per cent (Model 5.1). There is no evidence of trade diversion either.

When the panel data fixed effects estimations are employed, the coefficients for the income variables are both significant. From Table 6.8 above, although both domestic and foreign GDP are significant in all the FE tests, only the foreign output (Y_j) again significantly affects and determines bilateral trade. On average, the values show that larger countries are likely to trade 18 – 20 times more than other smaller countries. Even with a control for cross-section dependence with the Mean Group estimator, it is observed that only foreign output is relevant. This result suggests that the size of the exporting country is a greater determinant of trade than the size of the importing country.

The effects of the single currency on total bilateral trade volumes in the transport sector are seemingly limited and this can be seen from the negative coefficients on the ϑEMU dummy in the country pair and exporter/importer fixed effects models in Table 6.8. Note that, as explained above, trade diversion could not be tested for in these models. However, in both models, the time trend variable is highly significant at a 1% level (Models 2a and 2b)indicating that over time there may have been gradual increases in bilateral trade of about 5 per cent (1-exp[.052])each year that can be attributed to EU integration. The addition of a time trend in a regression model is often used to reveal the continuing rising/declining change of a variable over time. In this case it represents the continued increase in EU integration on bilateral trade volumes.

The parameter is simply the slope of the time trend which reflects the strength of this continued effect over time.

However, there is an interesting turn in the results when the year dummy variables are included in the panel model to capture common shocks, as in Micco et al. (2003), Flam and Nordström (2006) and Berger and Nitsch (2008). The results of this test show a positive effect of the introduction of the euro on bilateral trade between the eurozone countries. The size of the effect is also quite large at around 50 per cent (column 2c) for two countries sharing a common currency. The trend and year dummy variables were included separately because, apart from the trending behaviour caused by the EU integration, there is also a reason to believe that common shocks experienced by the country pairs (reflected by the year dummy variables) are important determinants of bilateral trade patterns across countries. There is some evidence of a high degree of trade diversion in this test, as the coefficient for this variable is negative and significant. The size of the effect indicates a fall of about 63 per cent in trade with the non-eurozone countries. The time dummy variables themselves also show an interesting pattern. During the late 1990s, the time dummy variables are nearly all positive, albeit just borderline significant. By contrast, all dummy variables (column 2c table 6.8) between 1999 and 2003 are significant and negative. It indicates a growingly strong reduction in bilateral trade over the years, from -11 to -50 per cent. This would be evidence of an important downward shift around the introduction of the euro. EU integration is suggested to have strong effects on both EMU and non-EMU members, particularly in the few years after its introduction. Hence, despite the gradual upward effect of EMU on bilateral trade in the transport sector, there has been a temporal decline for the first few years of the existence of the Eurozone. The PPML model does not recover any significant effect of EMU on bilateral trade either (nor for EMU members or non-EMU countries).

The results obtained with previous studies on the euro effect on trade in this sector vary due to the different specifications of the gravity model used. These have further corrected for some bias in the previous results relating to the dependent variable used, for the pool of countries included and for the number of years being considered. The summary of the analysis shows that the euro

effect on bilateral trade in the transport equipment manufacturing sector has been very limited. According to the estimates, a pro-trade impact of the euro is noticed when the year dummy variables were included and showed a huge 50% effect on trade flows. De Nardis et al (2008) and Fernandes (2006) both derived estimates that ranged between 27.1% and 23% respectively. In Flam and Nordstrom (2006) and in Baldwin et al (2005), however, the size of the Euro effect was much higher at 62% and 177% respectively. In a further study, Flam and Nordstrom (2007), come to the conclusion that the single currency affected trade flows in sectors with highly processed goods and those that specialise in semi-finished and finished products. Below is a table summarising the empirical studies of the euro effect on sectoral trade.

Table 6.9 Euro's Trade Effect using Sectoral Data

Authors	Econometric Methodology	Dependent Variable	Data	Results(transport equipment sector-aggregated)
Flam and Nordstrom (2006)	Fixed effect panel data technique	Bilateral Exports	14 European countries	+ Euro effect of 9.1%
Flam and Nordstrom (2006b)	Fixed effect panel data technique	Bilateral Exports	20 OECD countries	+ Euro effect of 62%
Baldwin et al(2005)	Fixed effect panel data technique	Bilateral Imports	18 OECD countries	+ Euro effect of 177%
Fernandes (2006)	System GMM estimator (panel data)	Bilateral exports	23 OECD countries	+ Euro effect of 15%
De Nardis et al (2008)	System GMM estimator (panel data)	Bilateral Exports	13 EU members and 10 OECD countries	+ Euro effect of 27.1%

Source: Authors Compilation

6.5   Robustness Checks

Robustness Checks are a standard application in empirical studies. Their aim is to examine the performance of the estimates from the main regression coefficients when the specification is altered either by adding or removing regressors. A result from this test where the changes to the coefficients are not significant indicates that they are 'robust'. (White, H., & Lu, X. (2010).

In Table 6.8, the estimates showed the importance of time evolution; therefore a simple robustness check where only the time trend is included without the euro variable is carried out. The simple reason behind omitting the variable was to check if the same result was obtained. The danger of including a dummy variable is always that it takes away special events in time that might have some logical explanation, so as a double check; the euro dummy is dropped to see if the results would still hold.

A summary of the estimates obtained in Table 6.10 reveal that all the estimations have significant R^2 and F-statistics. Also coefficients for the GDP and GDP per capita variables are positive which and are in line with the previous tests carried out.

The results in Table 6.10 also show that the time trend is positive (showing results of gradual trade increases of between 4% and 5%) in the fixed effects models highly significant at a 1% level in the country pair fixed effects model (column 2a). The result of the effect of the trend variable is similar to the effect in Table 6.8 which confirms the earlier result of a gradual increase in trade brought about by integration.

In the model with additional time fixed effects, the year dummy variables (not reported) show a similar pattern as in Table 6.8 - there is a pronounced downward shift in bilateral trade in the first years of existence of the Eurozone. This test further agrees with the results in Table 6.8 that the increases in trade in this sector are as a result of the integration rather than the introduction of the euro.

Table 6.10 Gravity Models With Time Trends.

	Pooled Model (5.1)	Country Pair Fixed Effect (5.2)	Exporter/Importer Pair Fixed Effect (5.3)	With Time Fixed Effects(Year Dummy) (5.4)	CCEMG (5.2)	PPML (5.2)
	(1)	(2a)	(2b)	(2c)	(3)	(4)
lY_i	3.024***	0.345	0.374	1.15	3.971	1.26***
	(13.181)	(0.245)	(0.255)	(0.78)	(0.958)	(11.622)
lY_j	2.915***	3.577**	3.051***	1.83	3.283	1.22***
	(10.539)	(2.443)	(7.751)	(1.16)	(1.141)	(9.763)
ly_i	1.452	0.688	0.595	2.52	4.352	0.066
	(1.144)	(0.382)	(0.315)	(1.36)	(1.138)	(1.077)
ly_j	1.381	-0.871	0.247	1.38	-0.252	0.068
	(1.424)	(-0.529)	(0.131)	(0.77)	(-0.096)	(1.442)
R_t	-0.044	0.051***	0.040	0.04	0.079	-1.681
	(-0.987)	(2.965)	(0.771)	(2.08)	(1.291)	(-0.808)
Number of observations	1,530	1,530	1,530	1,530	1,530	1,530
Adjusted R2	0.713	0.565	0.902	0.61		
F	109.297	125.550	83.67	52.16		

Note: ***, ** or * indicates significance at 1%, 5%, or 10%.

Given the results in Table 6.10 above, further robustness checks are carried out to include the addition of both a trend and the euro dummy interacted with time (each of the year dummy variables) to model the effects of gradual integration, following the study of Micco et al. (2003). Including further year dummy variables to model common shocks (equation 5.4) does not make sense in this case and therefore will not be included. Also the PPML and CCEMG are not reported in this case because both models cannot handle a large set of dummy variables and the parameter estimates of both models have become unstable in this case. The reason for this test is that there might be year-specific changes over time in the effect of the euro. For example, the recession in 2008 affected the transport equipment sector especially the motor vehicle manufacturers. Including only a simple year dummy variable would reveal just the effect of the common shocks in that year while including only the EMU dummy variable might suggest the change was due to the euro. Hence, to exclude the uncertainty of whether the change in trade was as a result of the euro in that particular year, the year and EMU dummy variables will be

interacted with the time dummy variables to analyse the changes in trade. In this test, the statistical significance of the EMU dummy variable (its absolute effect each year) is not the main focus but its evolution through time (the effect of TDE from year to year), paying particular attention to 1999 when the single currency was introduced. In order to ascertain if indeed the euro has had an effect on trade, a rise in the trade patterns (coefficient equivalent to the euro dummy variable) around the time of the introduction of the euro should be noticed. With the aim being to compare the euro effect across time, the country pairs will be constant throughout the sample; therefore Greece will be dropped from the dataset as it became a member of the eurozone only in 2001.

The summary of the results achieved from the estimation of equation 5.6 presented in Table 6.11 reveals that all the tests run have significant R^2 and F-statistics. As expected, the values of the coefficients for both GDP and GDP per capita indicate a positive effect on trade flows in this sector regardless of the estimation technique used.

The estimates show no specific time pattern of these dummy variables. Unlike the pattern found in Tables 6.8 column 2c for the panel model with fixed effects and year dummy variables, a particularly strong effect after 1999 as found in Micco et al (2003) was not observed. At most, the pooled model shows positive effects over time, except in the 1999-2003 periods. This could be read as evidence of the positive effect of economic integration. The panel model with country-pair effects shows significantly negative effects for a few years in the 1999-2003 periods but this is often a borderline case. Moreover, it is also the case for a few other years in the sample.

Table 6.11 Gravity Model - Time Trend and Euro Effect

	pool (5.1)	Country Pair Fixed Effect (5.2)	Exporter/ Importer Pair Fixed Effect (5.3)
	(1)	(2a)	(2b)
lY_i	3.246***	3.406*	3.535*
	(10.454)	(1.897)	(1.833)
lY_j	3.464***	2.096	3.588***
	(10.273)	(1.087)	(11.604)
ly_i	2.647	5.605**	5.533**
	(1.492)	(2.380)	(2.320)
ly_j	-0.429	1.509	-2.051
	(-0.339)	(0.664)	(-0.632)
R_t	-0.030	0.031	
	(-0.559)	(1.177)	
TDE_{1991}	0.149	-0.130	-0.128
	(0.871)	(-0.675)	(-0.608)
TDE_{1992}	-0.047	-0.126	-0.047
	(-0.200)	(-0.603)	(-0.185)
TDE_{1993}	-0.547**	-0.692***	-0.579**
	(-1.965)	(-3.660)	(-2.346)
TDE_{1994}	-0.082	-0.237	-0.139
	(-0.237)	(-1.083)	(-0.479)
TDE_{1995}	0.779**	0.107	0.381
	(2.364)	(0.486)	(0.888)
TDE_{1996}	0.861***	0.268	0.605
	(2.799)	(1.276)	(1.199)
TDE_{1997}	0.494	-0.054	0.363
	(1.573)	(-0.214)	(0.603)
TDE_{1998}	0.532*	0.040	0.584
	(1.872)	(0.186)	(0.807)
TDE_{1999}	0.610***	0.019	0.696
	(2.621)	(0.089)	(0.807)
TDE_{2000}	0.192	-0.311	0.451
	(0.807)	(-1.521)	(0.440)
TDE_{2001}	-0.097	-0.589**	0.233
	(-0.359)	(-2.550)	(0.213)
TDE_{2002}	-0.207	-0.516***	0.352
	(-0.986)	(-2.750)	(0.304)
TDE_{2003}	0.126	-0.181	0.713
	(0.667)	(-1.001)	(0.607)
TDE_{2004}	0.412***	0.175	1.073
	(2.990)	(1.403)	(0.921)
TDE_{2005}	0.449***	0.238**	1.202
	(3.556)	(2.153)	(0.977)
TDE_{2006}	0.191*	0.153	1.199

	(1.939)	(1.545)	(0.888)
TDE$_{2007}$	0.024	0.042	1.200
	(0.303)	(0.775)	(0.791)
Number of observations	913	913	913
Adjusted R2	0.743	0.609	0.931
F	78.983	75.836	.

Note: ***, ** or * indicates significance at 1%, 5%, or 10%. TDE is the time-trend dummy variable interacted with the euro dummy variable. t-statistics are in parenthesis.

Finally, the lagged effects of the GDP variables on bilateral trade are tested. If indeed the time trend is important to capture the gradual effects of integration, it is also possible that GDP/GDP (per capita) volumes only exert their multiplying effect on trade over time. Firstly, the baseline panel model for serial correlation is tested to check if such general time persistence is present. Table 6.12 reports the Wooldridge test for serial correlation in the idiosyncratic errors of a linear panel-data model. The null of the test is that there is not autocorrelation of the first degree. This null is strongly rejected. The test result does not necessarily imply lagged effects of GDP.

Table 6.12 Wooldridge Test for Autocorrelation in Panel Data

	test statistic	p-value
	F(1, 90) = 64.160	0.00

Note: null hypothesis has no first-order autocorrelation.

In Table 6.13, the effect of lagged income and size variables will be tested on all the models that have been used so far. Columns 1, 2a and 2b reveal the lagged effects of the GDP/GDP per capita variables without including the effects of the euro (Equation 5.1-5.3). In columns 3a and 3b, the lagged effect is tested with the inclusion of the euro dummy variable while columns 4a and 4b show the lagged effect of the GDP/GDP per capita variables on equation 5.6.
The summary of the results obtained following the estimation of equation 5.7 on the different tests is presented in Table 6.13. The results reveal that all the tests have significant R^2 and F-statistics. As expected, the values of the coefficients for

both GDP and GDP per capita indicate a positive effect on trade flows in this sector regardless of the estimation technique used.

The literature on gravity models so far has not paid much attention to this possibility. Therefore only the first lag is reported. Results show that the GDP/GDP (per capita) variables often turn out to be significant now as well as the lags. As there is a coefficient of the opposite sign on each of the lags, there is an indication that the trending behaviour in the trade series is still not well accounted for and the modelled series may be co-integrated. Bun and Klaassen (2002) and some studies in this field have analysed the gravity model in this way too, but going further into this test leads to more complicated and rigorous gravity model analysis that would certainly take the focus away from the objective of this research. An argument could be that the effect of a higher GDP is not felt immediately on trade volumes, as it takes time to trade. If this is the case, then the lags are showing the delay in the effect.

The main message of the models regarding the effect of the introduction of the single currency or the transitional effect of the euro does not change much with respect to the previous results. The estimates in columns (3a and 3b) confirm there is little impact of the euro dummy variable. By contrast, there is a gradual change over time, once the euro dummy is interacted with the time trend (TDE) in columns (4a and 4b).

Table 6.13   Lagged Effects of GDP/GDP per Capita on Trade

	Pool	Country Pair Fixed Effect	Exporter/Importer Pair Fixed Effect	pool (6a)	Exporter/Importer Pair Fixed Effect	Country Pair Fixed Effect	Exporter/Importer Pair Fixed Effect
	(1)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
lnY_i	3.650	4.274**	3.956**	5.795	5.125***	2.267	1.337
	(0.564)	(2.552)	(2.258)	(1.025)	(3.326)	(1.222)	(0.743)
lnY_j	-12.719*	2.463*	2.714	-7.520	5.330**	1.460	0.760
	(-1.846)	(1.909)	(1.007)	(-1.238)	(2.145)	(1.016)	(0.406)
lny_i	-5.348	-1.772	-1.617	-3.912	-2.254	0.077	0.545
	(-1.061)	(-1.089)	(-0.947)	(-0.893)	(-1.437)	(0.036)	(0.250)
lny_j	6.900	-0.008	-1.080	6.280	-2.667	1.568	-0.130
	(1.469)	(-0.007)	(-0.587)	(1.487)	(-1.546)	(1.225)	(-0.043)
lnY_{it-1}	-0.636	-6.385***	-5.733***	-2.778	-4.988***	-7.323***	-6.147***

	(-0.099)	(-3.837)	(-3.479)	(-0.495)	(-3.273)	(-3.261)	(-2.745)
lnY_{jt-1}	15.554**	-1.891	0.311	10.370*	-2.331	-0.057	2.811
	(2.252)	(-1.148)	(0.117)	(1.694)	(-0.947)	(-0.030)	(1.559)
lny_{it-1}	6.912	5.288***	4.833***	5.719	2.686	7.500***	6.564***
	(1.307)	(2.814)	(2.603)	(1.224)	(1.565)	(2.918)	(2.601)
lny_{jt-1}	-5.407	2.669	1.521	-4.544	2.729	0.600	-1.802
	(-1.141)	(1.309)	(0.716)	(-1.044)	(1.275)	(0.252)	(-1.148)
EMU_{ijt}				0.088	-0.030		
				(0.251)	(-0.208)		
$EUTD_{ijt}$				0.550	0.913		
				(0.912)	(1.517)		
R_t				-0.069	0.060		
				(-1.383)	(1.042)		
TDE_{1991}						0.047**	-1.295
						(2.156)	(-0.864)
TDE_{1992}						-0.002	-1.202
						(-0.011)	(-0.838)
TDE_{1993}						-0.559**	-1.725
						(-2.271)	(-1.242)
TDE_{1994}						-0.130	-1.263
						(-0.656)	(-0.903)
TDE_{1995}						0.256	-0.705
						(1.330)	(-0.562)
TDE_{1996}						0.395**	-0.489
						(2.007)	(-0.431)
TDE_{1997}						0.054	-0.757
						(0.276)	(-0.720)
TDE_{1998}						0.159	-0.517
						(0.905)	(-0.563)
TDE_{1999}						0.117	-0.402
						(0.631)	(-0.525)
TDE_{2000}						-0.234	-0.673
						(-1.229)	(-1.146)
TDE_{2001}						-0.560***	-0.933*
						(-2.855)	(-1.827)
TDE_{2002}						-0.492***	-0.810*
						(-3.064)	(-1.874)

TDE$_{2003}$						-0.195	-0.472
						(-1.066)	(-1.185)
TDE$_{2004}$						0.163	-0.065
						(1.412)	(-0.164)
TDE$_{2005}$						0.276**	0.075
						(2.379)	(0.223)
TDE$_{2006}$						0.036	-0.043
						(0.320)	(-0.182)
TDE$_{2007}$						0.076	0.085
						(1.059)	(0.965)
Number of observations	1,486	1,486	1,486	1,486	1,486	888	888
Adjusted R2	0.714	0.608	0.903	0.714	0.905	0.622	0.931
F	67.032	48.780	.	83.245	.	92.856	.

Adopting dynamic models or models that capture the gradual integration of the euro zone tends to find relatively smaller effects. The reason is that trade relations are indeed dynamic and, if they have been ongoing in the prospective of a stronger economic integration, then the eventual change of a single year as captured by the dummy variable may not show up as a relevant change. This is pictured in Figure 1a/b in Berger, H. and V. Nitsch (2005). It is also formally shown in Micco et al. (2003) and Bun and Klaasen (2002, 2006) where the overall effect of the euro becomes as small as 3%. It is therefore not surprising to see that, in the present analysis, the models that account for time trends together with year dummy variables do not find relevant euro effects. Also the countries included in the sample determine the euro effects; inclusion of more non-EMU countries makes the euro effect stronger as it gives a different benchmark (Fernandes A. (2006). A few studies have looked into more detail at individual sectors and points to be kept in mind when repeating the analysis at a sectoral level include the following:

(a) Shocks to specific sectors or firms can make the result unstable (the aggregation bias) (Flam and Nordstrom (2003).
(b) There is a question whether the scaling variable should be sectoral output or GDP. The former is not well measured and is probably not too relevant for some

goods but it is for others. The latter is measured in a more appropriate way but may be too wide. (Baldwin et al (2005).

The raw trade data in the figures above show increasing trade and growth in this sector. This growth can be seen in the statistics from the detailed enterprise statistics in Appendix 2 and the Index of Industrial Production. The latter index is used as a guide to measure the fluctuations in the industry or sector's value added at factor cost for a given reference period. This is carried out by measuring the changes in the sector's volume of output and activity at regular periods, e.g., monthly[92] thus representing the growth of the sector. The index also takes into account: gross production values, production volumes, turnover, work and raw material input. (Eurostat: Production Index). Changes in the production index for this sector in Western Europe happened at a faster speed than the industrial average between 1997 and 2007. During this period, the output for the sector rose by an average of 3.9 % per year compared with the total industrial average of 2.1 %. Annual growth rates for the sector surpassed those for the industrial economy in all the years between 1997 and 2007, with the exception of 2002 when there was a reduction in production for both the total industry and the transport equipment sector of 0.4 and 0.5% respectively. The growth in output in this sector was principally determined by the manufacture of motor vehicles, trailers and semi-trailers, where the production index increased by 4.4 % annually between 1997 and 2007. Figures 6.7 and 6.8 show the index of production for the manufacture of motor vehicles, trailers and semi-trailers and the manufacture of other transport equipment respectively.

Therefore, if there has actually been growth of trade in this sector in Western Europe (the raw data showed that there has been an increase in euro area trade in this sector), the possible determinants of this increase in intra eurozone trade need to be identified if it was not as a result of the introduction of the single currency. The two main factors apart from the European integration identified in the tests that could affect bilateral trade flows between the Western European

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[92] The monthly data needed for the calculation of the production index are not always available and in such cases alternative proxy values are used.

countries according to the gravity model literature are the economic size of a country and the geographic distance between countries. The term "gravity" is derived from Newton's law of gravity and states that exports are directly proportional to the exporting and importing countries' economic "mass" (GDP) and inversely proportional to the distance (geographical) between them. Therefore use of the gravity model is expected to show that larger country pairs will trade more but a reduction of trade flows will be observed due to higher transport costs when the countries are geographically more distant from each other.

Figure 6.7: Index of Production for the Manufacture of Motor Vehicles, Trailers and Semi-trailers
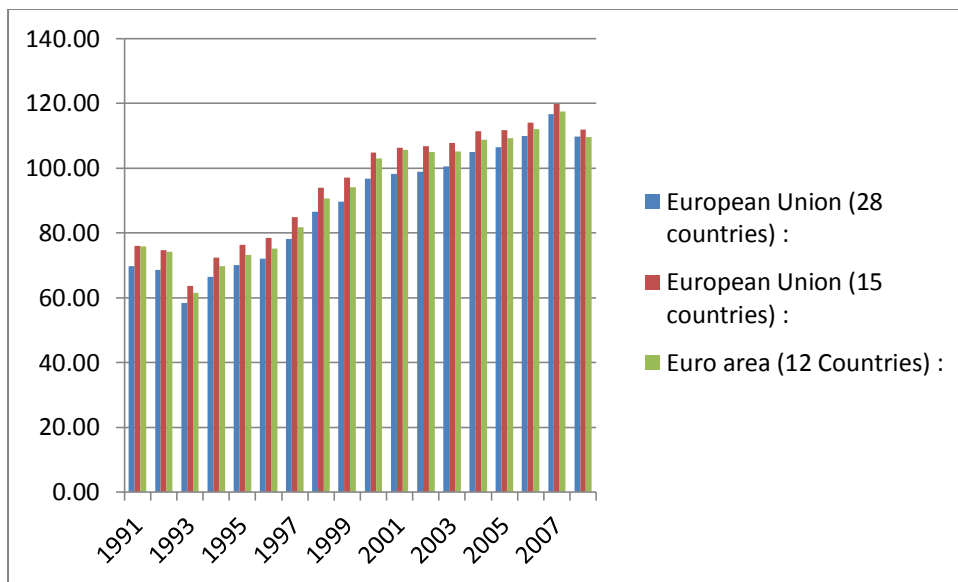
Source- Eurostat

Figure 6.8: Index of Production for the Manufacture of Other Transport Equipment
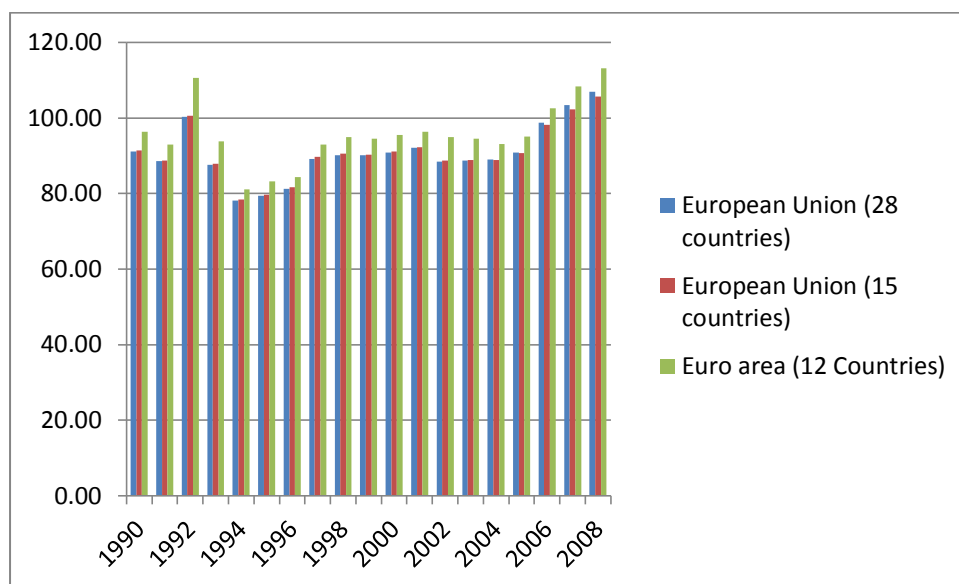
Source -Eurostat

GDP similarities between countries are regarded as a trade enhancing factor between them. Fundamental macroeconomic philosophy proposes that the imports of a country or region are linked to their national income. When analysing bilateral trade, the GDP levels of both countries should positively affect their total trade. New trade theory suggests that economies of scale are a significant factor when analysing bilateral trade and it is often proxied by the level of the country's GDP. (Helpman, 1981; Krugman, 1980). Linder (1961) explains the concept of "preference similarity" hypothesis from the demand side and states that it is more likely for countries with similar levels of GDP to trade more especially in the manufacturing sector. Other authors that agree with this argument are Helpman and Krugman (1985), Helpman (1988) and Hunter and Markusen (1988). Bergstrand (1990) also showed that 'the scope for bilateral trade is widened when there is no similarity between the economic sizes of the countries involved'.

The relationship between international bilateral trade flows and the levels of countries' GDP has been established in many empirical studies. From both theoretical and empirical studies, the overall interpretation is that the greater is the countries' level of GDP, the more is the bilateral trade which occurs between them. The results from the analysis in this study also agree with this theory as the coefficient for GDP was always positive and significant in all models.

Disdier and Head (2008) state that one of the most valid and established empirical results in international economics are that bilateral trade decreases with distance. Distance-based trade costs also increase the gains from currency unions because the geographical distance between the members make them "natural" trading partners. Luckily, there is no shortage of estimates of the effect of distance on trade flows. A large number of studies on the gravity model of trade have investigated the determinants of bilateral trade flows and they all consistently control for distance. Leamer (2006) states that the effect of distance on bilateral trade flows is "*conceivably the most vital discovery'* that has fully withstood the scrutiny of time and the onslaught of economic technique." Disdier and Head (2008) agree with this statement in their analysis of 1467 estimates of the distance effect. They found a mean elasticity of 0.9[93], which is indicative of the fact that bilateral trade is nearly inversely proportionate to distance. Marimoutou et al (2010) interestingly found that the distance variable could vary regarding the relationship between economic size and bilateral trade flows between countries. They assert that the distance effect on trade reduces depending on the size of the partners' GDP. They stated that, although the distance variable is negative, this 'influence can be offset by the size of the market'.

Although distance is seen to be a major factor in determining trade flows, globalization and technological developments have reduced the economic significance of geographical distance. (Buch et al (2003). According to the 1995 World Bank Report, reduced distance costs have led to an increase in gross trade which characterises the globalisation process.

Technological advancement is an important determinant of bilateral trade flows. Traditionally, economic theory suggests that a country's level of technology is an exogenous explanatory variable of international trade. This means that advancement in technology is an important factor which determines the export and import potentials of companies. Measuring technological advancement is difficult but a generally acceptable measure used is Research and Development (R&D) expenditure and patent applications. The European

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[93] This means that a 10% increase in distance between the trading partners will lead to a 9% reduction in bilateral trade flows between the countries.

Union was given an objective to devote 3% of GDP to research and development by the Lisbon strategy, with the aim of increasing the levels of investment and also encouraging competitiveness among the industries and companies. R&D is concentrated in very large industries with the manufacture of motor cars, trailers and semi-trailers in the top three sectors for R&D investment.

In summary, increased R&D investment is assumed to have a positive effect on trade flows because it leads to an increase in the variety and quality of products. However, this variable is rarely included in the gravity model in the explanation of international trade.

6.6   Discussion of Results

The aim of this chapter is to estimate and analyse the trade effects of the euro's introduction in the Transport Equipment Manufacturing Sector. This was successfully carried out with the use of different specifications of the gravity model. These were all major advancements of the gravity model and were taken into consideration in order to ensure that the analysis and the results thereof are not biased. This study is interested in applying the different methods in an attempt to understand the euro-effect in this specific sector and not to obtain a complete overview of all possible estimation techniques.

The section started with the results from the baseline model which is the pooled OLS technique that was used by Rose (2000). Any recent study would rarely apply this model, as it does not capture the relevant characteristics of country pairs, and so has no causal interpretation. It is normally used for comparison reasons. Anderson and van Wincoop (2003) criticised this method, stating its inability to take into account the fixed country-specific effects. The results using this model came up with the anticipated signs and high significance for the standard gravity variables used. GDP for both importing and exporting countries was shown to be a very important factor in explaining bilateral trade flows between countries. The GDP per capita variable was not always significant while the traditional gravity variables like common language and borders were all very significant and positive. The coefficient for the distance variable showed an expected negative effect to bilateral trade and these estimates were robust for

the use of various distance and language measures. Before the panel estimation was carried out, the Hausman and the Breusch and Pagan LM tests were applied to confirm that the fixed effects model was the appropriate method to use. Both tests strongly rejected the use of the Random Effects model and favoured the Fixed Effects model which is used in a majority of the related literature. The estimation of the Panel model without the inclusion of the euro dummy variable showed similar results to the former test carried out. They both arrived at the same conclusion that GDP is an important factor in explaining bilateral trade relations between countries.

The next section includes the introduction of the euro dummy variable to the regression. To undertake this, a variable was included in the regression equation which takes the value of 1 when both countries in the pair are members of the Eurozone with the aim of singling out the specific effect of the single currency. The results with the inclusion of the euro dummy variable also confirmed the same outcomes as the previous tests but in the panel models only the GDP_j variable (foreign output) affects bilateral trade positively.

The effect of the euro on the Transport Equipment Manufacturing Sector is limited showing a 6% increase when using the Pooled model. The fixed effects models (country pair and exporter and importer FE) however do not show any impact of the euro on trade as the coefficient remains negative. It is interesting to see that the studies which introduce dynamics into their panel usually achieve a very limited or negative euro effect. Fernandes (2008) applies a dynamic GMM panel estimator and Berger and Nitsch (2005) include a time trend. The consequence is that the euro effect is strongly reduced or even disappears completely. Micco et al. (2003) or Bun and Klaassen (2007), also find the introduction of dynamics reduces/erases the euro effect although their analysis was aggregated. A similar observation is apparent in the estimates of this project. The panel unit root tests carried out earlier in this chapter indicated trends in the residuals which are indicative of unmodelled dynamics. Taking that into account with time trends and year dummy variables is one possible way of explaining the negative effects achieved.

Finally, and as a possible additional explanation for the negative effect with the other estimation methods, in the start of this chapter, the Pesaran CD-test for cross-sectional dependence and the modified Wald test for heteroskedasticity were carried out. The former checks if there are unmodelled links between panel pairs while the latter investigates if there is variability of the different pairs. So far, to the best of the author's knowledge, there are no studies applying these tests in sector analysis[94]. It is therefore a possibility that the inclusion of these estimators led to negative effects of the euro in this sector. The more advanced is the econometric technique used, the more effectively it tackles some specification problems although different outcomes may be achieved. The choice of technique to use depends on the issue of interest. In that respect, there is no single right approach to identification as econometrics is not an exact science.

However, the time trend variable is significant in both models. This is indicative of the fact that there has been a gradual increase in bilateral trade of about 5% yearly. A time trend is added to a time series model to control for the effect of the continued impact over time of a certain variable that is otherwise hard to model. In this analysis, that is the continued integration of the European markets.

The year dummy variables on the other hand is normally included in a time series panel model because it captures the year-specific event that is common to a subset of the units of the panel model. These can be common shocks or developments that are specific to a given time unit. In columns 2a and 2b, the trend has a positive effect and a negative effect in column 2c (Table 6.8) when the year dummy is added. In the gravity model literature and also in the tests carried out in this analysis, there is an indication that there are common time effects which are not controlled for in the previous panel models that test gravity models. A significant trend has often been interpreted as evidence that integration has been ongoing and so eurozone integration reflects no more than a decade-long evolution but, once the year dummy variables are included, that

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[94] In studies using aggregate data is that the CCEMG estimator (the one tackling the cross-sectional part, as well as the dynamics of the specification) and the PPML estimator –(used to deal with the problem of heteroskedasticity, as well as the zero trade flows), tends to find negative effects of closer trade integration through the euro

trend disappears. In Micco et al. (2003) the year dummy variables have a distinguished volatile behaviour over time and this is also the case with this analysis. In contrast to Micco et al. (2003), the results here indicate a common upwards effect at the start of the sample but then significantly negative common developments after 1999. The interpretation could be that the trending behaviour is more effectively captured by the year dummy variables than by the time trend. A positive effect of the introduction of the single currency (50%) is found when the year dummy variables are included in the fixed effects regression. Looking back at the studies mentioned earlier that investigate the euro's effect on this sector, their common finding is that the euro has a positive effect in this sector. They all apply a panel fixed effects estimator on rather similar samples of EU or OECD countries over a sample period going typically from 1995 till 2005 more or less. When these authors apply year dummy variables and a time trend, their positive results are fully in line with the result obtained in this analysis for a strong positive effect. It is necessary to compare the 50% effect derived here to the estimates of Baldwin et al. (2005) (between 40 and 177%) or Flam and Nordstrom (2003)(between 7 and 50%).

The main reasons for the differences between the estimates obtained in this analysis and those of the two mentioned above is mainly due to the fact that they considered a much larger group of exporting countries while this analysis was focused on the EU15 countries. Another reason is the choice of the dependent variable used; Baldwin et al (2005) used bilateral imports as their dependent variable while Flam and Nordstrom used bilateral exports. It is also worth mentioning that the specification used by Flam and Nordstrom involved the inclusion of importer and exporter fixed effects. This was also used here but in their analysis this fixed effect was divided into two different dummy variables of intra-eurozone exports for the period 1999-2001 and for 2002-2005. De Nardis et al (2008) and Fernandes (2006) both report a much lower euro effect of 27.1% and 23% respectively for the same sector. The main reason was that they both used the bilateral exports as the dependent variable and both applied the system GMM dynamic panel data estimator[95].

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[95] The system GMM dynamic panel data estimator by Blundell and Bond is used to avoid inconsistency and biases in estimates and also it introduces controls for heterogeneity (De Nardis et al 2008)

The time dummy variables which are included in estimation are meant to show the yearly effects of the euro and specifically the year in which the euro effect applies and if it is increasing over time. According to Baldwin (2005) the exclusion of the time dummy variables in the gravity equation leads to a reference to the bronze medal error. Glick and Rose (2002) run their regression with and without the time dummy variables and find that the estimated coefficient on the currency union dummy variable is one standard deviation larger than it is with time dummy variables. Thus it is very important to include these dummy variables in order to correct this problem.

In conclusion, the Fixed Effects panel with year dummy variables indeed shows a positive euro effect. This effect becomes muted or even negative once dynamics or/and the cross-country behaviour of the panel are accounted for. The former point regards the introduction of lags or of a trend in the model. These are simplified ways to model the persistence in the series. As there is evidence of persistence (with the panel unit root test on residuals), this ought to be modelled somehow. Of course, either a trend or a lag is a very simplistic way of doing so but there is hardly anything more advanced that can be applied. The latter point on cross-sectional dependence is a bit more complicated. There is evidence that the panel-units are related to each other (the Pesaran CD test) and this is not so strange. These data are the trade flows between countries A and B so they must have some relation to the trade flow between countries B and C, etc. There is also evidence of heteroscedasticity of the panel units (with results obtained from the Wald test), implying that the trade flows over time have behaved in a way that makes them more variable as they increase. Again, that is not strange as the EU markets have become more integrated and trade flows have been increasing generally. The CCEMG estimator takes into account the panel interactions and this reduces the euro effect. This arises from the fact that the model accounts more effectively for the strong EU integration that already exists. If country-pairs are already closely integrated and closely co-moving, then there will be little additional effect of the euro as such. In this respect, the CCEMG acts as a much more advanced way of introducing a euro dummy variable. It is accounting for very much the same effect of continued EU integration that Berger and Nitsch (2005) argue to be so important. Hence, this is the link between the "CCEMG" and the "panel with a trend" and explains why

both find a muted effect. A similar explanation goes for the effect of heteroskedasticity. If this is picking up much of the trend rise in trade with EU integration, then the PPML estimator is bound to find a reduced effect as it takes account of the possibly increased volatility in trade flows.

6.7 Conclusion

Therefore, the bottom line result of the analysis carried out is that the euro effect is not significant in this sector once the trend in ongoing EU integration is accounted for. The gradual increases in trade in this sector are as a result of the effect of the integration rather than the euro's introduction per se. This was clear in the regression equations with the exception of the FE with year dummy variables and is also confirmed by the insignificant or even negative dummy effect in the other panel models. In other words, a simple panel FE would reveal a euro effect but the more advanced techniques that take account of the cross-sectional patterns and the rise in trade volumes, shows that this is an on-going result of closer EU integration. The euro is probably still a crucial next step but without any disruptive positive effects on trade in the transport sector as such.

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

7.1 Introduction

This thesis presents an extensive analysis on the impact of the adoption of the euro on trade flows in the transport equipment manufacturing sector in Western Europe (EU15 countries). This sector is made up of 2 subsectors of the manufacture of motor vehicles, trailers and semi-trailers and the manufacture of other transport equipment.

Regardless of the fact that many studies have analysed the euro effect on trade, there has so far been no extensive studies specifically analysing the effect of the euro on trade in this sector. Concentrating on the euro effect on aggregate trade assumes that the result is the same across the different industries when in fact the euro's creation might have affected different industries in different ways. Therefore, with the purpose of contributing to the existing literature and knowledge, this research has investigated the impact of the introduction of the euro on bilateral trade flows in the EU15 region.

In view of the fact that trade increases among the member countries of the European currency union was one of the driving forces towards its creation, a sound knowledge of its impact on trade flows is vital not only for the members but also for the non-members and for trade policies. The countries used in the analysis are all members of the European Union (EU) and as such have been involved in the process of Europe's integration.

In order to carry out the proposed investigation, the gravity model of trade was utilised. This model provides a manageable and theoretically justified method to estimate the euro effect. Rauch (1999) has asserted that 'the gravity model of trade is the most accepted and approved method and possibly the only empirical framework to effectively predict bilateral trade flows between countries'. The results achieved from the analysis provide evidence that the introduction of the single currency in Europe has had significant negative effects on bilateral trade. Although the evidence and raw data show that there have been trade increases

in this sector during the period analysed, the euro was not responsible for this as the coefficients of the EMU variable showed consistent negative values. These increases were however attributed to the European integration process as the coefficients for the trend variable showed a positive and significant effect which suggests a gradual yet steady increase in bilateral trade flows over the years analysed. With respect to trade diversion, which was the second objective of the analysis, the results of the FE test with year dummies provided evidence of trade diversion, suggesting that trade flows between member and non-member countries had fallen to about 60%.

The rest of the chapter is organised as follows:

Section 7.2 will summarise each chapter and highlight the main results while section 7.3 will outline the main limitations of the research and directions for further study and section 7.4 will report the conclusions.

7.2   Summary

The chapter by chapter summary of the thesis is as follows.

In Chapter 1, the introduction explained the inspiration for and significance of, the research. Owing to the Eurozone's economic importance to Europe and the rest of the world, it is important to investigate the pattern of trade flows among its members. It is not only important to analyse the aggregate trade effects of the single currency but also to examine whether the positive euro effect estimated using aggregate data also emerges in a sectoral analysis. In order to be as specific as possible, the focus is on the eurozone countries with Denmark, Sweden and the United Kingdom used as a control group over a long period of time (1990-2008).

The focus behind Chapter 2 is to explain the background and history of the creation of the European Monetary Union. This chapter started by explaining the theory of the Optimum Currency Area (OCA) and specifically analysing the suitability of the introduction of the single currency in Europe. This was done by using the traditional OCA criteria as well as pointing out the costs and benefits of the currency union

Chapter 3 examines the theoretical framework used in this thesis, namely, the Gravity Model of Trade. The chapter begins with a review of the theoretical justifications of this model in the analysis of bilateral trade flows. The major literature covering the model to estimate international trade flows was then investigated. The was initially pioneered by Tinbergen (1962) followed by Linnemann (1966) who both reported that the volume of trade flows between countries or regions is determined by three major criteria, namely, 1) the supply conditions in the exporting country; 2) the demand conditions in the importing country; and finally 3) trade enhancing and restricting factors between the origin and destination countries.

Chapter 4 presents an analysis of the euro effects on trade, focussing specifically on the previous empirical studies that have analysed this effect within the eurozone and also other studies that have analysed the sectoral effects of the euro. It is obvious from this chapter that extensive research has been undertaken into the analysis of a currency union's effect on bilateral trade flows. However literature exploring the case of the euro's effect on individual sectors has been limited. This strengthens the interest in reviewing the impact of the euro on trade in the transport equipment manufacturing sector.

Chapter 5 throws more light on the methodological approach used in the thesis. The analysis will be carried out using five different tests to examine the trade effects of the euro and two robustness tests. The tests are all advances from previous studies in this field aimed at reducing biases in the estimates. The countries used in the analysis are EU states and their bilateral trade data are analysed from 1990 – 2008. The justification of the use of the variables included in the gravity model and the sources of data are extensively addressed in this chapter.

In Chapter 6, the gravity model analysis is carried out and the results are discussed. The results show a limited euro effect as indicated by the EMU dummy variable coefficient for almost all the models in Table 6.10. However the trend variable (which introduces dynamics into the model) included in the regression analysis shows that there has been a gradual increase in trade flows of about 5% yearly over the period which necessarily cannot be attributed to the

euro but more to the process of continued European integration. The inclusion of the year dummy variables shows a 50% euro effect on trade over the period but also a decline in bilateral trade flows in the first few years after the euro's introduction. There is also evidence of trade diversion showing a reduction in trade of about 60% between eurozone members and non-members. This large effect was muted with the introduction of dynamics into the panel. The results obtained are not all in line with other empirical studies on the euro effect in this sector due to the difference in time spans, dependent variables and econometric techniques utilised. In conclusion, recent techniques that take account of the cross-sectional patterns in bilateral trade and the overall rise in trade volumes show that increased trade after the introduction of the euro in this sector is more a result of on-going closer EU integration than of the common currency per se. It is also worth noting whether EU integration would have been able to continue if it were not for the introduction of the euro.

7.3   Limitation of the Study and Further Research

There are several opportunities for further research that can be noted from the limitations of this study. They are summarised below;

In the 'euro effect' analysis, only the EU15 countries were included for the period 1990 - 2008. This has its advantages as all the countries involved are more homogeneous, geographically close and are all members of the single market. Also due to the fact that the countries share comparable experiences, it is unlikely that the estimates obtained will be affected by other factors that were not accurately accounted for. Even so, an analysis that includes a longer period and additional industrialised countries might have produced more accurate estimates[96].

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[96] This is especially true with the evidence of trade diversion obtained in the tests. Micco et al (2003) pointed out that the results using the developed country sample may be more reliable with regards to the inclusion of the trade diversion dummy variable. The reason is that in the EU sample, there are very few country pairs formed by non-EMU countries, and these are the pairs that are used as the benchmark for comparison.

Secondly, when analysing the euro effect on a sectoral level, it is important to introduce sector variables as the GDP may not be an ideal proxy for sectoral income. However due to a lack of and inconsistencies in the trade data in the chosen sector, these were not included and the results should be examined with that in mind. For further research it will be advisable to use sectoral value added variables as they become available as they are a more valid proxy for the income of the chosen sectors. The use of sectoral and firm level data would contribute to identifying the extra effects that may not be noticed when using aggregate variables.

The importance of trade in services is presently a central issue in the analysis of bilateral trade flows. This study has focused only on the euro effect of trade in the goods of the transport equipment manufacturing sector. Nevertheless, the effect of currency unions on trade in services should not be ignored in future research. An addition that would assist in analysing the transport sector would be a replication of the analysis for services in the sector. The transportation services sector is involved mainly in the provision of air, rail, truck, and waterborne transportation. Other services carried out in this sector also include transit and ground passenger and pipeline services. Finally, future studies should look to country specific sectoral research using the different tests carries out in this analysis.

There is still much research to be carried out in this field particularly when more sectoral trade data and statistical advancements become available. Nonetheless, this thesis has made a useful contribution to the study of sectoral trade effects of the euro. It has shown the importance of the individual sectors being analysed: the usual result obtained in aggregate trade effects is usually always a positive trade effect but this analysis shows the significance of sectoral studies as the euro may affect individual sectors differently.

7.4   Contributions of the Study

This thesis contributes to previous literature in the following ways. Firstly, the analysis of the euro effect on trade in particular sectors has received very

little attention, thereby creating a gap for future studies. The thesis contributes to knowledge in this field by analysing the euro effect on the transport equipment manufacturing sector in the EU15 countries. It is of vital importance that the overall positive euro effect on trade is not assumed to affect each sector equally.

It was with this view in mind that an extensive analysis which included several different gravity model estimations were carried out on a single sector in order to compare the euro effect using different econometric advancements in the gravity model. Also the inclusion of panel cointegration techniques that allow for cross sectional dependence among the panel units and the Wald test for heteroscedasticity were applied to the estimations which to the best of the author's knowledge has not been used in any published sectoral studies. The results showed that the single currency did not have significant effects on this sector rather; the gradual trade increases achieved were more as a result of the existing process of European integration. The implication of the results obtained from this sector shows that the trade effect of a currency union is comparable to the trade effect of the single market and removal of trade barriers. The analysis shows that the introduction of the euro is a continuation of a series of policy changes that have resulted in Europe becoming more integrated. It is therefore impossible to analyse the euro effect on trade without accounting for European integration. This provides valuable evidence for informing the ongoing debate of the single currency's trade effect on individual sectors.

7.5 Conclusion

This research is aimed at estimating the euro's effect on trade in the transport equipment manufacturing sector of the EU 15 countries. Basically, it investigates empirically the role that the euro has played in influencing trade flows in the European countries with the use of a framework underpinned by theory. This study has utilised the gravity model of international trade to provide a manageable and theoretically justified method to estimate the euro effect.

The potential for a more integrated market in Europe was undoubtedly the key reason for the creation of a currency union. Fifteen years on there is still a huge debate on the trade effects of the euro on its member countries. Has the euro actually increased trade flows as a result of the removal of transaction costs and exchange rate fluctuations? The question is of vital significance, not only for the euro zone member countries, but also for the non-members as they would use the answer to the question to understand whether or not they would benefit from joining the single currency. The debate is still intense today in some European countries such as Sweden and, particularly, in the UK. Proper economic investigations on the euro's effect on trade are extremely important to assist these countries in making correct decisions. Even today, over fifteen years after the euro's introduction, there are still unanswered questions with regards to the trade effect of the euro despite the large number of studies in this field.

In this thesis, the analysis carried out has been an attempt to provide some answers regarding the impact of EMU on trade in the transport equipment manufacturing sector, using a panel data set that includes the most recent information on bilateral trade for the EU15 countries for the period of 1990 – 2008 inclusive. Having controlled for many factors with the use of different fixed effects estimations, the results indicate that the euro has negative and significant effects on bilateral trade in this sector. Also the results show a high degree of trade diversion as a result of the euro indicating a fall of approximately 60% in trade over the period with non-member countries. However, the inclusion of the EU trend dummy variable which captures the effect of EU integration shows a gradual increase in trade flows between the eurozone members and this can also be seen in the raw trade data. This shows that there have been increases in trade flows in this sector within the euro zone countries but this cannot be attributed to the introduction of the single currency. The negative effects of the euro provide a support for the thesis that the trade increase within the euro zone shows a continuance of a long-run historical trend related to the broader set of EU's economic integration policies and institutional changes which is similar to the results and conclusions obtained in the studies of Berger and Nitsch (2008), and Lee (2012).

It is however important to note that this result relates only to the transport manufacturing sector and an analysis of different industries will be beneficial to identify the euro's effect as these results will vary across different sectors. The limited pro-trade effect of the euro weakens the case for euro membership for non- member countries which include UK, Denmark and Sweden. The results implies that the euro has not caused any significant trade increases in this sector and therefore the geographical location of the companies in the transport manufacturing sector does not necessarily have to be within the euro zone as the single currency had little impact on growth in the sector. Companies can locate their manufacturing plants anywhere in the European Union as the general process of EU integration and its benefits affected trade positively in this sector. However, the evidence of trade diversion[97] obtained in the FE with year dummy variables estimations strengthens the case for the British, Swedish and Danish membership in the eurozone as trade is being diverted from the non- members to the members. This implies a reduction in exports flows from the non- members and increased trade flows between the member states of the eurozone.

With the results obtained in this thesis, an obvious policy implication for countries looking to adopt the euro is that they should also be cautious regarding the potential for growth in intra-bloc trade in a particular sector, although they would continue to benefit from the on-going process of integration.

In conclusion, while the introduction of the euro might have been viewed as the next step towards a more integrated Europe and was vital in the continuation of the single market, the euro's impact on bilateral trade flows trade are difficult to examine and analyse without taking into account the process of the underlying European integration.

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[97] If the formation of a currency union diverts trade from a country outside the currency union to a country inside the currency union, this is trade diversion.

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APPENDIX 1

Empirical Literature on International Trade Modelling using the Gravity Model between 1999-2009

Year	Authors	Objective	Dataset	Dependent Variables	Explanatory Variables	Estimation Technique
2009	Baier and Bergstrand	Estimating the long-run treatment effects of Free Trade Areas (FTA) on members' bilateral International trade	Cross-Section, European Economic Community (EEC) and the Central American Common Market (CACM). 1960-2000. (total of 96 potential trading partners)	Bilateral trade Flows	GDP, distances, language, adjacency, FTA memberships	(Non-parametric) Matching econometrics
2009	Kepaptsoglou et al.	Analysis of the EMFTA trade agreement	Panel data, EU and Mediterranean countries, 1993-2007	Bilateral trade flows	Exports and imports, transportation costs, free trade agreements, tariffs	SURE with two way fixed and random effects.
2008	Lampe	Investigation of bilateral trade flows in Europe	1857–1875	Imports	National incomes of importer and exporter	OLS Core, OLS Extended, GLS Core, GLS Extended, PPML Core, PPML extended
2008	Boriss, Siliverstovs, Dieter and Schumacher	Comparison of the OLS approach applied to the log-linear form of the gravity model with the Poisson Quasi Maximum Likelihood (PQML) estimation procedure	1988-1990, 22 OECD countries	Bilateral trade flows	Distance, adjacency, membership in a preference area: EU. EFTA. FTA between USA and Canada, Asia-Pacific Economic Co-operation), ties by language, historical ties.	OLS, Poisson Quasi Maximum Likelihood (PQML

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory Variables	Estimation Techniques
2008	Soonchan, Park and Innwon	Estimation of the investment creation and diversion effects of RTAs	OECD's International Direct Investment Statistics covering from 24 OECD countries to 50 host countries for the period of 1982–99.	FDI	GDP in pairs, Skill, openness, reform, RTA/Insiders, RTA/Outsiders, RTA, (RTA/Insiders)·Reform, (RTA/Outsiders)·Reform, log of distance, common land border, common language, ex colony colonizer	OLS Fixed effects, Random Effects
2008	Henderson and Millimet	Estimation of gravity models-in levels and logs *via* nonparametric methods	132 non-industrial countries, 1948–1997	Bilateral trade flows	Distance, Currency Union, Common Language, Regional trade agreement, Adjacent, Number landlocked, Number of islands	Non-parametric models
2008	Bussière, Fidrmuc, and Schnatz	Analysis of the rapid trade integration that took place in the past decade between the CSEECs and the euro area	annual data from 1980 to 2003, 61 countries	Bilateral trade flows	Distance, territory, border, language, free trade arrangements: EU, NAFTA, MERCOSUR, CEFTA, ASEAN	OLS, fixed effects, random effects, dynamic OLS, fixed effects with regional specific time effects
2008	Grant and Lambert	Investigation of the trade flow effects of Regional Trade Agreements (RTAs)	1982–2002, AGR and NAGR commodities. The data set is derived from the United Nations Commodity Trade Statistics Database (COMTRADE)	Bilateral trade flows	GDP, Distance, Adjacency, Language, Landlocked, RTA	OLS fixed effects

Year	Author(s)	Objectives	Dataset	Dependent Variables	Explanatory Variables	Estimation Techniques
2007	Melitz	Examination of North – South Distance	157 Countries, 1970-1995, five year intervals	Bilateral trade flows	GDP, Distance, common border, difference North – South, common language, currency union, FTA, common country, ex-colony, common coloniser	OLS fixed effects
2007	Tzouvelekas	Development of a stochastic coefficient gravity model	1997, 15 EU countries.	Bilateral trade flows	GPD, distance, population	OLS, stochastic varying coefficient gravity model
2007	Sarkera and Jayasinghe	Analysis of regional trade agreements and trade in agri-food products	EU-15 from 1985 to 2000, 57 countries.	Bilateral trade flows	Distance, GPD, GPD per capita, EU (member of the EU), EUO(degree of openness of the EU members)	OLS
2007	Papazoglou	Analysis of Potential Trade Flows in Greece	Panel of cross-country data, 1993–2003, 26 countries: 14 EU members and the12 major trading partner countries.	Exports	GPD, population, distance, EU membership, common border, exports of intra-industry type	OLS
2007	Nowak-Lehmann et al.	Analysis of customs union between EU and Turkey	Panel data, Turkey and 10 EU countries, 1998-2002	Exports	GDP, GDP per capita, exchange rate, transport costs	OLS with fixed effects

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2007	Iwanow and Kirkpatrick	Investigation of trade facilitation, regulatory quality and export performance	Panel data, 78 countries, 2000-2004	Exports	GDP, GDP per capita, population, distance, remoteness, tariff, common language, colony(past/present), common border, FTA membership, trade facilitation, quality of regulation, infrastructure	GLS with fixed effects
2007	Bunt and Klaasen	Investigation of Euro Effects in trade	Panel data, EU-15, Norway, Switzerland, Canada, Japan, USA, 1967-2002	Bilateral trade flows	GDP, GDP per capita, FTA membership, Euro integration	OLS with fixed effects, DOLS
2007	Lee and Park	Investigation of optimised regional trade agreements for east Asia	Panel data, 50 countries, 1994-1999	Bilateral trade flows	GDP, GDP per capita, distance, country surface area, common border, common language, common coloniser, colony (past or present), participation in currency union, tariff, trade facilitation, FTA membership	OLS with fixed/random effects
2007	Kalirajan	Investigation of regional cooperation effects in trade	Panel data, Australia and IORARC members, 1992-1996 and 1999-2002	Exports	GDP, GDP per capita, population, distance, APEC membership	GLS

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2007	Abedini and Peridy	Analysis of the GAFTA agreement effects	Panel data - 15GAFTA countries, 8 GAFTA candidate countries, another 35 reference countries, 1985- 2000	Exports	GDP, distance, common language, multilateral trade resistance, information costs, common border, FTA participation (EU, NAFTA, GAFTA etc.)	Fixed effects, random effects, HTM, ABB
2007	Elliot	Analysis of trade flows in the Caribbean sea.	Panel data, Barbados, Jamaica, Trinidad and Tobago, 1968-2001 and 1969- 2003.	Imports and Exports	Population, distance, membership in CARICOM market union.	OLS
2006	Baier and Bergstrad	Examination of FTA effects	Panel data for years 1960,1965,…, 2000, 96 trading partners	Bilateral Flows	GDP, distance, common border, common language, FTA membership	OLS, fixed effects, two way Fixed effects and Random effects.
2006	Kang and Fratianni	Investigation of the effects of OECD membership and Religion in trade flows	Panel Data, OECD and non- OECD countries, 1980-2003	Exports	GDP, GDP per capita, region, common currency, distance, common border, common language, common coloniser, colonial relationship, OECD membership	OLS
2005	Kucera and Sarna	Evaluation of trade union rights and democracy effects in exports	Cross sectional, 162 countries, averages for period 1993-1999	Exports	GDP per capita, population, distance, country surface area, Common border, landlocked, island, FTA, exchange rate	OLS, TOBIT,WLS

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2006	Carrère	Investigation of the effects of regional trade agreements	Panel data, 130 countries, 1962-1996	Exports	GDP, GDP per capita, population, distance, shared borders, landlocked country, level of infrastructure, exchange rates, dummy variables for FTAs	OLS with two way random effects
2006	Antonucci and Manzocchi	Analysis of the special trade relation between EU and Turkey	Panel data, Turkey and trading partners, 1967-2001.	Exports	GDP, measure of similarity between countries, relative factor endowments, EU membership, evolving EU relationship, existence of RTAs, distance, border type (sea, land), specific features of trade partnerships	GLS with fixed effects
2005	Péridy	Investigation of EMFTA effects to trade	Panel Data, Mediterranean countries with 42 partners, 1975-2001	Exports	GDP, per capita GDP, country similarity in size, distance, border type, regional arrangement between EU and Mediterranean countries, language	OLS, Fixed effects, Random Effects
2005	Kandogan	Examination of the Natural Trade Partners Theory for the Euro-Mediterranean Region	Cross sectional, EU countries, 1999,2000	Imports	GDP, distance, per capita GDP, real exchange rates, foreign currency reserves, similarity in economic sizes, relative factor endowments	OLS with fixed effects

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2005	Tang	Analysis of regional trading arrangements for the NAFTA,ANZCER and ASEAN countries	Panel data, 21 NAFTA, ANZCER, ASEAN and non-member countries, 1989-2000	Exports	GDP, GDP per capita, distance, volatility of exchange rate, income similarity,developed (ing) country, NAFTA membership for both or one partner, ANZCER membership for both or one partner, ASEAN membership for both or one partner.	OLS, 2SLS
2005	Thorpe and Zhang	Investigation of the development of intra-industry trade (IIT)	Panel Data, East Asian Economies, 1970-1996	Index of intra industry trade (function of imports and exports)	GDP, differences in per capita income, distance, bilateral exchange rate, trade orientation, trade imbalance, economies of scale.	OLS
2005	Paas and Tafenau	Investigation of trade flows for countries involved in the EU eastwards enlargement process.	Panel Data, EU-25, 1993- 2002	Exports	Population, GDP, distance, EU-15 membership, post-socialist accession countries, land border existence, Baltic sea country, Central European country, Mediterranean country	OLS

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2005	Martinez, Zarzoso, Suarez and - Burguet	Investigation of the relationship between trade flows and transport cost	EU and five Latin America countries	Imports and Exports	GDP, GDP per capita, transportation cost as a function of weight to value ratio, distance, volume of imports or exports, landlocked country, language, transportation and port infrastructure characteristics.	OLS with Fixed Effects
2005	Sohn	Analysis of South Korea's trade flows	Cross sectional. Korea and 30 trading partners, 1995	Bilateral Trade Flows	GDP, GDP per capita, distance, trade complementarity, APEC membership	OLS
2005	Musila	Examination of the intensity of trade creation and diversion in COMESA, ECCAS and ECOWAS	Cross sectional data, 20 African countries, 1991-1998	Exports	GDP, population, distance, common border, common language, CFA Francophone zone, Intra COMESA, ECCAS, ECOWAS trade, Extra COMESA, ECCAS, ECOWAS exports and imports	OLS
2005	Augier et al.	Investigation of the impacts of rules-of-origin (ROO)	Cross sectional, 38 countries (EU and partners), total of 1992-1995	Exports	GDP, population, distance, FTA membership, EU membership, other country, common border, common language.	Fixed Effects
2004	Robers	Analysis of the proposed China - ASEAN FTA	Cross sectional, China and ASEAN Countries, 1996	Exports	GDP, GDP per capita, distance, FTA	OLS

Year	Author(s)	Objectives	Dataset	Dependent Variables	Explanatory variables	Estimation Techniques
2004	Longo and Senkat	Investigation of the expansion of Intra African trade	Panel data, 41 African and 15 industrial countries, 1988-1997	Exports	GDP, GDP per capita, country surface area, common border, distance, landlocked country, road length per capita, telephones per capita, internal political tension indicators, oil exporting, FTA participation	OLS, TOBIT
2004	Pelletiere and Reinert	Investigation of used automobile protection and trade	Panel data, US and 113 countries, 1998-2000	Exports	GDP, population, distance, left side driving pattern, protection measure, average tariffs for new and used cars, region	OLS
2004	Gopinath and Echeverria	Effects in the Foreign direct investment – trade relationship	Panel data, six countries, 1989-1998	Trade to FDI ratio	Panel data, six countries, 1989-1998	
2004	Egger	Estimation of regional trade bloc effects	Panel Data: OECD countries, 1986-1997	Exports	GDP, similarity, capital – labour ratio, high and low skilled labour ratio to transportation costs, exporter and importer viability of contracts, exporter and importer rule of law, EU, EFTA and NAFTA membership	Two way fixed effects - two way random effects

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2003	Wilson et al.	Investigation of trade facilitation and trade flows	Panel data, APEC countries, 1989-2000	Exports	GDP, GDP per capita, distance, NAFTA, ASEAN, LAIA membership, language (English, Spanish, Chinese), common border, tariff, port efficiency, customs environment, regulatory environment, e-business	OLS with two way fixed effects
2003	Kurihura	Impacts of trade flows by APEC	Panel data, 17 APEC countries (out of 21), 1980, 1985, 1990, 1995, 1998	Exports	Past exports, exchange rate, GDP, GDP per capita, distance, common language, common border, FTA, political union membership, colony - colonizer	OLS
2003	Filippini and Molini	Analysis of east Asian trade flows	Panel data, 11 EY countries, USA, Japan, China, 6 Asian and 6 Latin America countries, 1970-2000	Exports	Past exports, GDP, population, distance, technological differences, region	OLS with Fixed Effects
2003	Kangas and Niskanen	Trade in forest products in EU and Central and Eastern Europe	Cross sectional data, EU-15 and 10 accession countries, 1998	Exports	GDP, GDP per capita, distance, common border, flow between an EU and accession country	OLS
2003	Baltagi et al.	Development of a generalised trade flow model	Panel data, EU-15, USA, Japan, 1986-1997	Exports	GDP, GDP per capita, similarity in country size, distance	OLS with two way fixed effects
Year	Author	Objective	Dataset	Dependent	Explanatory Variable	Estimation

				Variable		**Technique**
2003	Fukao *et al*.	Analysis of trade effects under NAFTA	Panel data, NAFTA members, 1992-1998	Imports	GDP per capita, tariffs, total commodity exports, country specific factors	OLS with Fixed effects
2003	Micco, Stein and Ordonez	Estimate the early effect of the EMU on trade	Panel Data, Two samples -22 developed countries from 1992 - 2002 and the EU 15	Bilateral trade	GDP per capita, common border, distance, common language, EU, currency union, trade diversion and creation, island and landlocked dummy variables	OLS with Fixed Effects
2002	Glick and Rose	Investigation of currency union effects to trade	Panel data, 217 countries, 1948-1997	Exports	Currency union, distance, GDP, GDP per capita, common language, common border, FTA existence, country landlocked, number of islands, land areas, common colonizer, current colony, ever colony, same nation	OLS, GLS fixed effects, GLS random effects, between estimator
2002	Eger	Econometric view on the estimation of the gravity model	Panel data, OECD and 10 Central-Eastern Europe countries, 1986-1997	Exports	GDP, GDP per capita, similarity in country size, exporter and importer viability of contracts, exporter and importer rule of law, real exchange rate, distance, common border, common language	Fixed / random effects models

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2001	Soloaga and Winters	Analysis of regionalism and trade agreement effects in trade in the 1990s	Cross sectional, 58 countries, 1980-1996, analysis per year and averages	Imports and Exports	GDP, population, remoteness, distance, land area, common border, island, common language, trade agreement membership	Tobit, fixed effects.
2001	Sapir	Investigation of domino effects in Western Europe Regional Trade	Cross sectional, 16 Western European countries, annual data 1960-1992	Exports	GDPs, distance, common language, EU and EFTA membership	OLS
2001	Porojan	Investigation of the spatial effects in the gravity model	Cross sectional, EU-15 and 7 OECD countries, 1995	Imports and Exports	GDPs per capita, distance, EU and NAFTA membership, contiguity	OLS, spatial error, spatial lag, spatial error and lag
2001	Feenstra et al.	Evaluation of alternative theories of trade	Cross sectional, 110 countries, 1970, 1975, 1980, 1985, 1990	Exports	GDPs, distance, common border, common language, existence of FTA, remoteness	OLS
2001	Buch and Piazolo	Investigation of the impact of EU enlargement	Cross Section, 9 OECD and their partner countries,1998	Imports and Exports	GDPs per capita, distance, EU membership	OLS
2001	Nitsch	Investigation of natural border effect in trade in the EU	Panel data, EU-12 countries, 1979-1990	Exports	GDP, distance, common border, common language, country remoteness	OLS and Fixed Effects Model

Year	Author(s)	Objectives	Dataset	Dependent variables	Explanatory variables	Estimation Techniques
2001	Arghyriou	Investigation of effects on trade by Greece's participation in the EU	Panel data, Greece and major trade partners, Averages 1970-1980, 1981-199	Imports and Exports	GDP, Pre-Post integration period in the EU, exchange rate, monetary policy	OLS
2000	Rose	Analysis of common market effects on trade	Panel data, 186 countries, 1970, 1975, 1980, 1985, 1990	Exports	GDP, GDP per capita, distance, common border, common language, FTA, common nation, colony, common currency, bilateral exchange rate	OLS
1999	Breuss and Egger	Examination of East - West Europe trade potentials	Cross sectional data, old (24) OECD countries, averages of the period 1990-1994	Exports	GDPs per capita, population, distance, common language, EU12 and NAFTA memberships	OLS
1999	Endoh	Investigation of trade creation and diversion in the EEC, LAFTA and CMEA	Panel Data, EEC, LAFTA and CMEA members, 1960-1994	Exports	GDPs, population, distance, common language, intra member, inter-member trade and trade with non-members	OLS
1999	Kalirajan	Incorporation of stochastic aspects into the gravity model coefficients	Panel Data, Australia and Indian Ocean rim trading partners, 1990-1994	Exports	GDP, GDP per capita, distance	Stochastic Varying Coefficients model

Source: Kepaptsoglou et al., 2010

APPENDIX 2

Annual detailed enterprise statistics on the Transport Equipment Manufacturing Sector (TOTAL)

Number of enterprises

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	:	:	:	:	736	717	755	:	693	741	752	767	973	857
Denmark	796	776	744	753	642	645	583	538	519	501	508	502	541	542
Germany	:	:	:	:	3,426	3,431	3,403	3,914	3,504	3,763	3,713	3,660	3,746	3,729
Ireland	133	129	118	112	115	110	118	120	120	104	98	101	116	121
Greece	:	:	:	:	:	:	:	:	1,311	1,304	1,345	1,375	1,392	:
Spain	2,617	2,902	2,868	2,737	4,168	4,197	4,483	4,552	4,514	4,640	4,697	4,772	4,845	4,876
France	:	4,923	4,871	4,878	4,914	4,945	5,046	5,060	5,273	5,365	5,356	5,434	5,612	5,210
Italy	5,982	5,996	6,135	6,484	6,475	6,755	6,785	6,507	6,501	6,732	7,070	7,333	7,648	7,523
Luxembourg	16	13	12	12	12	13	12	12	12	12	12	12	12	14
Netherlands	2,000	1,895	1,975	2,700	2,500	2,265	2,465	2,370	2,105	2,400	2,450	2,200	2,530	2,579
Austria	280	297	323	311	283	264	369	333	377	386	388	401	448	430
Portugal	:	:	:	:	792	726	783	768	772	833	1,409	1,286	1,225	1,194
Finland	895	885	832	925	848	871	887	893	901	899	892	930	984	1,000
Sweden	1,552	1,562	1,874	1,930	1,955	2,058	2,128	2,224	2,448	2,529	2,604	2,699	2,757	2,841
United Kingdom	:	5,172	5,622	5,536	6,735	5,772	5,697	5,650	5,534	5,655	5,755	5,678	5,593	5,671

Turnover (EUR million)

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	16,458	16,550	15,606	16,922	18,258	18,587	21,498	:	18,351	20,263	20,597	21,016	21,304	20,303
Denmark	2,192	2,543	2,465	2,471	2,419	2,352	2,540	2,653	2,515	2,680	2,686	2,655	2,794	2,844
Germany	:	:	:	:	250,026	271,647	293,054	301,150	308,806	326,638	347,846	371,589	400,477	394,421
Ireland	577.3	678.0	830.3	916.1	963.3	1,084.0	1,056.9	1,017.7	1,045.5	995.4	1,101.9	1,201.1	1,359.3	1,230.7
Greece	:	:	:	:	:	:	:	:	1,355.6	1,394.3	1,291.9	1,229.0	1,465.8	:
Spain	34,598.5	38,151.9	42,631.7	47,713.2	53,622.5	59,539.3	55,850.9	57,390.1	62,073.1	65,393.7	65,352.5	71,064.8	75,794.8	70,943.1
France	:	103,526.3	114,345.5	128,276.6	197,672.0	163,199.0	176,983.7	237,497.0	240,909.9	162,799.6	166,006.4	147,629.9	155,062.5	152,007.1
Italy	41,966.1	48,462.1	54,579.2	55,514.3	54,417.9	64,624.5	63,835.2	62,569.6	62,101.5	65,422.0	68,168.6	78,703.7	88,570.8	87,074.9
Luxembourg	25.3	22.8	29.0	32.0	30.2	30.0	27.4	25.6	40.9	53.4	66.2	87.6	131.6	161.6
Netherlands	9,925.8	9,715.2	9,812.5	11,487.3	12,677.1	12,479.0	12,791.6	12,437.6	12,251.9	14,179.2	14,777.4	16,179.9	19,099.2	20,179.6
Austria	6,510.5	6,687.4	6,881.2	7,784.2	8,453.4	8,870.7	9,949.4	11,373.2	12,351.4	15,959.7	16,776.3	17,999.6	18,087.6	16,515.7
Portugal	:	:	:	:	5,726.8	5,765.7	5,655.7	5,502.5	5,363.2	5,111.0	5,065.7	5,036.6	:	5,706.4
Finland	2,033.7	2,594.7	2,506.5	2,669.7	2,646.9	2,744.7	3,367.6	3,298.5	3,156.7	2,456.1	2,985.9	3,366.0	3,808.9	3,896.1
Sweden	18,818.2	20,756.1	23,672.7	25,120.1	27,951.1	26,004.0	24,293.9	24,160.0	29,075.8	31,732.1	32,909.9	35,026.5	37,217.5	33,388.8
United Kingdom	:	64,186.5	88,783.4	92,516.3	95,582.8	100,685.4	98,120.3	99,041.7	91,865.2	98,323.0	97,336.0	101,324.3	109,521.0	98,436.0

Production Value (EUR million)

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	16,557.6	16,511.4	15,615.3	17,027.2	16,849.3	17,597.6	20,256.0	:	17,549.6	19,292.1	19,223.8	19,777.7	19,993.6	19,668.8
Denmark	2,364.4	2,415.3	2,549.2	2,518.9	2,273.2	2,396.3	2,560.3	2,491.4	2,291.1	2,470.1	2,652.4	2,598.1	2,734.1	2,738.1
Germany	:	:	:	:	218,771.9	236,658.3	256,637.0	259,714.6	264,844.1	277,838.2	294,140.0	315,820.5	346,877.1	338,777.1
Ireland	572.1	665.2	820.4	904.5	946.3	1,094.1	1,029.8	996.1	1,028.7	973.2	1,105.9	1,164.3	1,352.8	1,253.4
Greece	:	:	:	:	:	:	:	:	1,518.1	1,566.7	1,387.9	1,291.0	1,544.7	:
Spain	30,941.7	34,158.2	37,828.3	42,025.7	45,405.1	50,850.8	49,522.6	52,850.8	56,661.2	58,739.6	59,675.8	65,024.4	69,183.7	66,021.6
France	:	95,274.1	106,547.3	119,801.5	192,830.6	159,009.8	172,628.3	233,735.9	235,754.4	157,055.1	161,981.2	142,159.8	150,816.2	113,842.1
Italy	39,184.3	45,157.2	49,569.4	50,361.8	46,798.3	56,901.7	58,072.4	58,068.9	56,710.6	61,083.4	63,580.1	73,797.6	82,458.0	79,162.0
Luxembourg	24.5	23.3	29.6	32.6	30.2	30.5	27.4	25.7	41.7	54.6	65.8	91.3	136.1	168.9
Netherlands	9,290.6	8,706.4	9,348.5	11,239.5	11,714.0	12,136.1	12,076.0	11,901.2	11,577.3	13,500.5	13,399.2	15,011.4	18,247.4	19,457.5
Austria	5,841.4	5,996.2	6,406.5	7,309.3	7,924.9	8,432.9	9,811.0	11,480.6	12,231.0	15,827.9	16,614.6	17,761.0	17,837.3	16,655.0
Portugal	:	:	:	:	4,871.7	5,133.3	5,090.1	5,077.3	4,814.0	4,742.3	4,654.7	5,018.0	:	5,674.7
Finland	2,338.1	2,187.3	2,423.9	2,617.5	2,603.9	2,687.4	3,273.4	3,202.0	3,032.6	2,385.3	2,934.3	3,377.2	3,775.3	3,794.3
Sweden	16,393.8	18,166.3	19,316.1	20,228.7	22,336.9	26,008.0	24,152.0	23,724.6	28,090.8	30,713.7	31,811.6	32,861.8	35,555.5	33,542.6
United Kingdom	:	57,331.8	74,063.7	79,839.5	86,306.5	90,893.8	87,210.7	87,511.1	81,111.0	85,942.3	88,153.0	91,030.9	99,286.7	89,920.5

Value Added at Factor Cost (EUR million)

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	3,612.5	3,526.4	3,365.0	3,721.6	3,680.1	3,886.0	4,017.2	:	3,984.1	3,867.5	3,937.0	4,303.6	3,746.6	3,562.3
Denmark	852.0	695.1	875.2	841.1	815.1	772.7	803.2	752.1	722.0	702.2	754.5	720.4	724.7	808.1
Germany	:	:	:	:	59,010.5	57,191.6	67,009.5	64,565.8	70,882.6	70,152.4	71,760.3	78,671.6	84,270.9	73,335.6
Ireland	232.4	238.6	298.5	333.3	361.2	434.7	390.6	367.4	418.7	417.1	472.1	-78.6	500.3	434.9
Greece	:	:	:	:	:	:	:	:	646.2	640.5	567.9	673.1	837.9	:
Spain	7,659.9	8,432.2	9,344.6	9,673.7	10,121.4	10,211.0	9,469.4	10,528.7	11,661.8	11,685.6	11,504.3	12,406.8	12,861.6	12,448.6
France	:	19,591.2	21,668.4	24,240.9	25,486.3	26,258.3	26,200.8	26,872.0	27,073.0	26,623.0	28,387.2	26,958.8	29,326.6	26,288.9
Italy	11,112.3	11,358.6	13,139.8	12,426.0	11,148.0	12,184.1	11,596.7	10,837.4	11,236.0	12,239.9	12,754.9	15,390.7	15,735.9	15,373.6
Luxembourg	9.6	8.8	10.3	11.9	10.1	10.5	11.1	10.3	17.6	22.4	25.8	28.8	43.4	48.2
Netherlands	2,097.7	2,284.1	2,406.8	2,784.1	2,925.0	2,930.0	3,103.2	3,002.5	2,986.0	3,557.2	3,538.8	4,127.9	4,858.7	5,048.5
Austria	1,767.4	:	1,858.3	2,035.9	2,290.4	2,371.9	2,442.6	2,732.9	2,850.8	3,104.8	3,646.4	3,870.4	4,094.6	4,306.0
Portugal	:	:	:	:	1,110.3	1,255.5	1,123.9	1,086.5	984.1	1,017.8	991.5	996.7	:	1,109.2
Finland	771.4	781.8	802.6	838.7	782.8	755.1	944.7	1,027.3	986.9	786.7	879.3	928.6	881.3	1,006.1
Sweden	4,094.5	4,312.5	4,931.3	6,861.1	6,973.3	7,588.0	6,040.2	5,372.9	6,574.5	7,357.5	6,695.2	6,961.8	7,617.1	6,704.8
United Kingdom	:	17,986.6	23,132.7	24,764.7	27,374.2	25,828.3	27,632.1	25,898.8	23,613.6	24,977.8	24,645.4	25,309.0	27,589.2	26,198.6

Total Purchases of Goods and Services

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	12,894.2	13,000.1	12,250.7	13,289.2	14,554.2	15,093.2	17,314.9	:	14,511.5	16,390.6	16,617.7	16,898.1	17,620.7	16,717.8
Denmark	1,552.6	1,758.4	1,729.7	1,750.4	1,615.1	1,779.8	:	1,918.3	1,803.7	2,004.7	1,964.3	1,972.5	2,130.3	2,092.5
Germany	:	:	:	:	193,493.8	216,698.1	229,871.1	237,537.9	240,114.3	257,911.4	277,534.6	293,598.0	319,832.4	324,064.6
Ireland	363.2	443.1	549.1	589.8	609.3	686.7	647.3	617.7	626.8	586.9	652.4	753.3	874.1	839.0
Greece	:	:	:	:	:	:	:	:	960.5	991.8	858.4	670.9	762.5	:
Spain	27,574.3	30,455.4	34,492.4	39,302.3	44,565.0	50,638.7	47,040.3	48,465.0	51,829.5	55,107.3	55,418.5	60,487.7	64,908.4	60,844.5
France	:	83,586.3	92,001.2	103,591.0	172,711.3	138,116.9	152,280.7	212,535.6	213,489.2	136,582.0	139,941.1	121,801.1	127,618.8	126,087.0
Italy	32,991.8	37,133.7	41,303.4	44,635.1	42,708.6	51,864.8	53,014.9	53,013.5	51,593.3	55,294.6	57,151.6	66,741.9	75,345.0	75,800.3
Luxembourg	15.7	14.8	20.1	20.8	20.0	19.9	16.3	15.4	24.4	34.4	43.4	62.9	95.8	127.5
Netherlands	7,990.9	7,173.9	7,739.8	9,302.6	9,711.3	9,950.2	9,803.3	9,706.5	9,460.8	10,804.6	10,737.0	12,066.2	14,268.7	15,151.1
Austria	4,762.2	:	5,100.8	5,833.9	6,146.5	6,639.0	7,610.3	9,051.3	9,720.4	13,079.3	13,412.9	14,225.3	14,223.4	12,902.9
Portugal	:	:	:	:	4,693.6	4,531.6	4,553.9	4,489.9	4,300.6	4,152.5	4,197.5	4,152.8	:	4,704.7
Finland	1,580.2	1,486.1	1,668.2	1,851.2	1,903.6	2,026.1	2,449.4	2,309.8	2,194.8	1,717.2	2,164.1	2,504.6	3,034.7	2,941.3
Sweden	15,134.0	16,843.1	19,140.2	18,913.2	22,153.0	19,469.5	19,790.6	19,901.0	23,574.6	25,668.2	27,470.0	28,460.2	30,729.2	29,821.4
United Kingdom	:	45,459.5	63,289.2	67,190.4	68,353.1	75,181.2	70,931.7	71,698.7	67,373.8	72,112.2	72,861.3	76,246.3	82,691.2	73,330.9

Number of Persons Employed

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	61,894	62,285	61,954	62,776	63,162	64,504	65,469	:	59,043	57,499	56,841	56,486	54,397	52,789
Denmark	23,066	21,642	22,850	20,248	17,917	17,110	16,313	14,570	13,231	13,446	15,238	14,265	14,805	13,965
Germany	:	:	:	:	968,190	988,965	999,329	1,012,163	1,002,747	1,013,629	1,002,501	979,806	992,117	995,979
Ireland	7,457	7,475	7,509	7,554	7,982	7,896	8,295	8,053	7,931	7,362	7,226	7,660	7,590	6,961
Greece	:	:	:	:	:	:	:	:	15,772	17,302	16,620	16,835	16,477	:
Spain	191,171	195,120	204,094	207,104	212,879	217,367	216,571	220,804	221,512	220,756	216,214	216,238	214,913	:
France	:	417,939	401,996	393,537	396,929	401,033	414,155	410,951	427,249	427,258	420,136	416,094	403,077	:
Italy	292,830	300,690	293,845	293,968	275,528	270,587	269,728	262,739	256,471	263,520	264,905	274,522	283,250	285,726
Luxembourg	292	287	293	322	274	276	280	276	380	413	450	537	591	617
Netherlands	51,873	47,062	50,547	55,782	56,606	57,610	57,122	54,318	55,192	51,217	48,048	47,668	48,421	49,810
Austria	29,085	30,246	30,927	32,737	33,150	34,280	36,136	34,687	36,564	40,358	45,024	44,435	45,499	46,469
Portugal	:	:	:	:	37,841	39,771	34,875	35,988	34,168	32,792	33,744	32,895	:	35,369
Finland	18,749	18,755	17,980	18,671	18,876	19,764	20,452	20,562	19,776	17,718	17,595	17,436	18,620	20,006
Sweden	88,456	89,272	90,628	92,700	94,455	98,893	99,765	96,674	102,568	107,610	107,976	108,073	108,251	105,895
United Kingdom	:	406,265	414,591	426,471	401,014	404,243	389,577	383,961	370,367	356,649	343,432	325,652	323,654	:

Source – Eurostat (SBS)

APPENDIX 3

Major Steps towards the Introduction of the Euro, 1989-2014

February 1986
Signing of the Single European Act, advancing economic and political integration within the European Community.

April 1989
The Delors Report calls for Economic and Monetary Union (EMU) leading to a single European currency through three stages.

June 1989
The Madrid Summit of the European Council agrees that Stage 1 of EMU will start July 1, 1990. Stage 1 includes completing the internal market and removing all obstacles to financial integration.

October 1990
The Rome Summit of the European Council agrees that Stage 2 of EMU will begin January 1, 1994.

December1990
The Dublin Summit of the European Council marks the beginning of intergovernmental conferences on EMU and political union.

February 1992
Signing of the Maastricht Treaty to establish the European Union, the successor to the European Community.

June 1992
Danish voters narrowly reject the Maastricht Treaty.

September 1992
Currency crises force Britain and Italy to abandon the Exchange Rate Mechanism (ERM).

July 1993
Member states agree to widen the "narrow" band in the ERM from 2.25% to 15% around the central rates.

January 1994
Stage 2 of EMU starts. The European Monetary Institute comes into operation and begins the transition from co-ordination of national monetary policies to a common monetary policy. Economic convergence is strengthened through adherence to "convergence criteria" set out in the Maastricht Treaty.

May 1995

The European Commission adopts a Green Paper "On the Practical Arrangements for the Introduction of the Single Currency."(A green paper is a document intended to stimulate discussion and start a process of consultation).

December 1995

The Madrid Summit of the European Council reaffirms January 1, 1999 as the date for the irrevocable locking of exchange rates, thus for the introduction of the euro. The "euro" is officially adopted as the name for the new single currency.

May 1998

Special meeting of the European Council decides that 11 member states satisfy the conditions for adopting the single currency.

June 1998

The European Central Bank and the Euro system are set up.

January 1999

Stage 3 of EMU begins. The exchange rates of the 11 initial participating nations are irrevocably fixed and the euro begins to trade on financial markets.

January 2001

Greece adopts the euro.

January 2002

Euro notes and coins enter into circulation in all participating member states.

January 2007

Slovenia adopts the euro

January 2008

Cyprus and Malta adopt the euro

January 2009

Slovakia adopts the euro

January 2011

Estonia adopts the euro

January 2014

Latvia adopts the euro