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Empirical study on the Endogeneity of the OCA Criteria: A post EMU analysis

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

Abstract: Publicado em 1998, o estudo de Frankel & Rose na Endogeneidade dos Critérios das Áreas Monetárias Ótimas tem sido desde então um poderoso argumento em favor da Zona Euro. Os autores encontram uma correlação positiva entre a sincronização dos ciclos económicos e a intensidade do comércio, sugerindo que se um país se juntasse à Zona Euro, o consequente aumento do comércio com outros estados membros contribuiria para a o alinhamento dos ciclos económicos. Isto mitigaria a incidência de choques assimétricos, reduzindo a necessidade de uma política monetária independente. Este estudo replica a metodologia dos autores, com algumas adaptações, e faz uso de dados contemporâneos. Os resultados apoiam a hipótese da endogeneidade, e mostram que o Euro aumentou o comércio entre estados membros em cerca de 21% *ceteris paribus*. Estes resultados não são, no entanto, os mais precisos, devido a certas limitações da abordagem metodológica.

Palavras Chave: Ciclos Económicos; Integração Comercial; Zona Euro; Zonas Monetárias Óptimas

Classificação JEL: F14; F15; F45

Abstract: Published in 1998, Frankel & Rose's study on the Endogeneity of the Optimum Currency Area Criteria has since been an important argument in favour of the creation of the Economic and Monetary Union (EMU). They find, empirically, a positive correlation between business cycle synchronization and trade intensity, suggesting that if a country joined the EMU, the trade generating effects inherent to such a move would naturally contribute to the comovement of business cycles. This would mitigate the incidence of asymmetric shocks and reduce the need for an independent monetary policy. This study replicates their methodology, with some improvements and a contemporary dataset. The results support the endogeneity hypothesis, and show a positive trade generating effect of 21% for the EMU. These findings are, however, not the most accurate, due to certain limitations of the methodological approach.

Key Words: Economic Cycles; Euro Zone; Optimum Currency Area; Trade Integration

JEL Classification: F14; F15; F45

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Key Concepts:

Business Cycles: the downward or upward movement of GDP (or other measure of economic activity around its long-term growth trend.

Comovement: in the context of Business Cycle Synchronization, it is a synonym for **correlation**.

Demand Shock: an event that triggers a decrease (or increase) in the demand for a certain good (or goods) in an economy.

Idiosyncrasy: in a macroeconomic context, it means a peculiar or unusual feature of an economy, that distinguishes it from others.

Idiosyncratic Shock: synonymous with **asymmetric shock**; a demand or supply shock that affects two (or more) economies in different ways, *e.g.*, increases demand for cars in one and decreases it in another.

Intra-Industry Trade: the exchange of similar products belonging to the same industry.

Inter-Industry Trade: the exchange of products belonging to different industries; implies that the two countries (or regions) engaging in trade are better off specializing their production, along Ricardian lines.

Openness: the weight international trade has on the total product of an economy; how open an economy is to foreign trade.

Trade Intensity: in the context of this study, how much two countries trade with each other, taking their economic size into account.

Trade Barrier: synonymous with **Border Effect**; the effect a national border has on trade between two regions, after controlling for other factors.

Multilateral Resistance: an average border effect, encompassing the trade barriers with all trade partners of an economy.

Endogeneity: in econometrics, it refers to an explanatory variable that is correlated with the perturbation term, resulting in a biased point estimate for that variable and potentially compromising the overall consistency of the model; the opposite of exogeneity.

Dyadic Dataset: a dataset whose observations consist of a pair of elements; in the context of this study, each observation on the dataset corresponds to a pair of countries.

Abbreviations:

CU: Currency Union

ECB: European Central Bank

EMU: European Monetary Union

ERM: European Exchange Rate Mechanism

EU: European Union

FD: First Differences Model

FE: Fixed Effects Model

GMT: Gravity Model of Trade

OCA: Optimum Currency Area

Introduction

On the first day of January 1999, the Euro was officially launched. It was adopted by eleven out of the then fifteen EU members, with the United Kingdom, Denmark and Sweden retaining their national currencies, and Greece joining two years later, in 2001. At first the Euro existed merely as an electronic currency, being only used for banking operations, but, as the new coins and banknotes were printed, it gradually replaced the previous national currencies of member states. By 2002, it was the only currency in physical circulation accepted for official payments. Since then, the economic successes and failures of the Eurozone have been the subject of countless academic papers. This academic interest correlates positively with the importance such a topic has for the lives of millions of European citizens.

All the questions that can be asked about the Euro surround a fundamental one: Is the Eurozone, through its several iterations, an Optimum Currency Area (OCA)? This OCA concept, first outlined by Robert A. Mundell in 1961, has been influential in most academic contentions regarding Currency Unions (CU), since the transition from the Bretton Woods to the International Flexible Exchange Rate System, to the current Eurozone debates. Essentially, the OCA theory contends that, to benefit from the economic advantages a CU provides, candidates must exhibit suitable economic characteristics to mitigate the disadvantage of losing their independent monetary policies.

In 1998, Jeffrey A. Frankel and Andrew K. Rose put forth a fresh new perspective on the subject. They proposed that the criteria for CU membership are endogenous, *i.e.*, that if a country's candidacy did not fulfil all requirements, these would eventually be attained after the country joined the CU. The authors' reasoning was based on two assumptions: 1st) when two countries adopt the same currency, their trade relations grow; 2nd) this growth increases the symmetry of business cycles. In their 1998 study, they found empirical evidence for a positive and statistically significant correlation between trade intensity and business cycle symmetry: an increase in trade between two countries helps to synchronise economic activity between them, mitigating the effect of asymmetric demand shocks. The difficulty in addressing these shocks is the most important drawback of CU membership, due to the impossibility of having a different monetary policy for each member state.

Classical trade theory (*e.g.*, David Ricardo and Heckscher-Ohlin) would dictate that an increase in trade would result in increased sectorial specialization, and therefore, in more asymmetric shocks. But Frankel & Rose's (1998) findings support the idea that it is intra-industrial trade, not inter-industrial, that prevails among most trade ties. By the simple virtue of CU membership, increased intra-industrial trade would, over time, synchronize the business cycles of the candidate country with the other member states. This argument wraps up into a nice self-fulfilling prophecy: due to the endogeneity of the OCA criteria, entry into a CU is therefore justified *ex post*, rather than *ex ante*, as all previous literature defended.

To EU policymakers, this new take on the OCA theory gave scientific validity to the political end goal they had been striving for more than 40 years: the culmination of European economic integration into a monetary union, the Euro. Although some economists doubted that all member states exhibited suitable economic conditions for membership in the European Economic and Monetary Union (EMU), the hypothesis that these conditions could be attained after joining - and that the single currency would function better in the future, rather than in the immediate present – seemed to proselytise most sceptics.

The 2008 Financial Crisis, and the subsequent Great Recession, vindicated the most hardcore sceptics. The contrast of the recovery speed of member states was stark: while in 2010 the German Gross Domestic Product (GDP) went up by 4.1%, the worst was still to come for Greece, with its GDP plunging 9.1% the next year. With such asymmetric economic performance, a single monetary policy did not serve all members states well: the peripheric countries were forced to "tighten their belts" and engage in internal devaluation, as they did not have the option to devalue their own currency. The social and political strife that resulted from the harsh economic policies dictated by the European authorities took its tool in the minds of people from countries like Portugal, Greece, Italy and Spain. The 2010's saw a rise in Euroscepticism, both in public perception, as well as in political movements, with the most visible example being the Brexit campaign to withdraw the UK from the EU in 2016. But Euroscepticism is not limited to public discontent and political posturing. Prominent economists also speak out against the Euro, with Paul Krugman (2013, p. 439) calling the Eurozone "an economic trap".

As a master's student, my primary motivation for choosing this topic as my thesis subject was to better understand the academic positions for and against the Euro. This motivation was spurred by the unexpected result of the Brexit vote in 2016, as well as several ideological disagreements with friends. Asking if the Eurozone is an OCA in 2020 seems like a pointless question. If the business cycles of Germany and Greece are anything to go by, Frankel & Rose were completely wrong: not only they did not get more synchronized, but also the fact that Greeks could not decide their own monetary policy made their bad situation even worse. Of all the literature that I read to write this study, the endogeneity of the OCA criteria hypothesis seemed like the hardest one to believe, even more so after the Great Recession. Thus, I decided to re-do Frankel & Rose's original study, but with current data, to check if their conclusions hold up to the test of time.

Research Objectives

This study aims to replicate Frankel & Rose's (1998) methodology. The intent is not to adopt the most structurally sound model to produce results that consider the "big picture" of the relationship between business cycle synchronization and trade intensity. Instead, like Frankel & Rose, the aim is strictly empirical, with the goal of identifying the qualitative aspect of the relationship (signal). That is sufficient to draw a conclusion on what type of trade is more prevalent inside EMU: intra-industrial or inter-industrial. This study cannot offer an insight into the qualitative aspect of the relationship (*i.e.* how much do business cycles get synchronized when trade intensity goes up by, say, 1%).

Summing up, there are three objectives:

- To estimate the effect EMU has had on trade;
- To provide intuition to the relationship between trade intensity and business cycle synchronization;
- To compare the results with the surrounding academic literature.

With the benefit of hindsight, several methodological improvements are adopted. The dataset used is dyadic, with a span of twenty-five years, from 1990 to 2015, covering twenty-nine, mostly industrialized, countries.

This study is organized into the following sections: section 1 briefly explores the history of money and the concept of Optimum Currency Area; section 2 is dedicated to explaining the work of Frankel & Rose (1998): their Endogeneity Hypothesis and methodology; section 3 lists the most important methodological advances since Frankel & Rose (1998); section 4 presents a brief statistical description of the dataset used in this study; section 5 covers the methodology of this study; section 6 reports and discusses the results and finally the conclusions are presented in section 7.

1. Brief History of Money and of the Optimum Currency Area Theory

Membership in a Currency Union is one of the most complex and definitive decisions a country can ever take.

The term "Optimum Currency Area" was first coined by Robert Mundell in 1961. In his paper *A Theory of Optimum Currency Areas*, Mundell asks: "What is the appropriate domain of a currency area?". We can state it differently by asking: what is the size that optimizes the beneficial effects of a currency area? If pressed for a response, the reader might be tempted to say that the national level is the most adequate one, as that is the reality we have grown up in. Most countries in the world (with the notable exception of the Eurozone countries, as well as the CFA Franc and East Caribbean Currency Union countries, and some other very small countries) have a money of their own, and relinquishing control over it is generally seen as an unfavourable loss of national sovereignty.

Money, since the dawn of human society, has served three main purposes: a means of payment, a unit of account, and a store of value. Because of its universal acceptance (in the immediate geographical vicinity) people could trade much more easily, using money as an intermediary of exchanges rather than directly trading good-for-good. This would make value and price comparisons much simpler, as each good's value was first evaluated in relation to the currency (price), and then compared with other good's evaluations of their own (prices). It would also deal away with the inefficiency of direct trade. A person who wanted to trade apples for oranges had to find someone who was willing to sell the oranges he/she wanted, but also buy the apples he/she was offering. That is to say, the double coincidence of wants is a precondition for barter.

Money, both as minted coins and later as paper based promissory notes and banknotes, gave people an universally accepted mean of payment, in the sense that they could buy all the goods they could want, from whoever was selling them, using only money. On top of that, money's sole physical use was as a method of payment. This was another leap forward, compared to (at the time) existing commodity-based currencies such as salt and precious metals. These commodities were often used for other purposes, and not solely as currency, *e.g.* if you were a roman legionary in the time of Julius Caesar, you would literally salt your food with your hard-earned *salarium* (salary), as you would be payed in salt.

If money has revolutionized the way how humans exchange goods and services with one another, why restrict it to a single country? Why not let a single currency rule the world? To answer this question, we will explore an hypothetical scenario, drawn by Mundell (1961). Suppose that countries A and B are in a currency union and in macro-economic equilibrium. Also assume that labour mobility and wage flexibility are non-existent. An asymmetric shock shifts part of the demand for country B's goods to A's. The decreased demand will result in increased unemployment in B. In country A, the increased demand for its goods will shift its price upward, raising inflation. No worker from country B is able to move to country A to find a new job, and no worker from country A will accept lower wages to keep the inflation at bay.

Monetary policy would be the most useful tool to restore equilibrium. The alternative would be an internal system of payment transfers between country A and B, but, since such a system requires strong political integration (and will), it is not a very pragmatic solution. If country B had its own currency, independent of country A, it could devalue its own money and make its goods cheaper and more competitive in country A's markets. Meanwhile, country A could adopt a contractionary monetary policy, and prevent its internal prices from rising too much. This would result in increased demand for country B's goods, which would control the rise of unemployment, and in the reduction of the price of country A's goods (due to increased competition from B), containing inflation.

But countries A and B cannot conduct their own independent monetary policies. They are in a currency union (and have to share the same policy). To restore equilibrium to the economies of both countries, the central bank must pursue two different and mutually exclusive strategies: if it prioritises price stability, inflation in country A will be contained, but at the cost of increased unemployment in country B; if it pursues a full employment policy, the unemployment in country B will be controlled, but inflation in country A will rise even more. This is the dilemma of currency unions: they are desirable due to the reduction in information and transaction costs, making money more effective in its function, but impose a common monetary policy on its members, which at times can't attain a pareto efficient solution, *i.e.*, it can't improve the situation in one country without making the situation in another country worse. Because of this, the whole world is not an optimum currency area.

If we can't have one single world encompassing currency, how many should we have? One per country? One per regional district? One per city? Well, we can't have too many. To quote Mundell (1961, p. 662): "In a hypothetical world in which the number of currencies equalled the number of commodities, the usefulness of money in its roles of unit of account and medium of exchange would disappear, and trade might just as well be conducted in terms of pure barter". We don't want money to be ineffective in its functions, otherwise we wouldn't be using it. With this in mind, we can redefine the original question: what makes a currency area "optimal"? What is the ideal balance between the efficiency of money and macroeconomic equilibrium? McKinnon (1963) defines the optimum currency area (henceforth abbreviated as OCA) as an area where a single currency can best accomplish three often conflicting objectives: maintaining full employment; maintaining the stability of internal prices; and balancing international payments.

In the early 1960's, the time of Mundell's writing, some of the most important currencies in terms of world trade, like the British Pound, the French Franc, and German Mark, were all pegged to the US Dollar at arbitrarily set values. The dollar itself was pegged to the value of gold. Other smaller currencies were indirectly pegged to the USD as well, through the pound, the franc and the mark. This was known as the Bretton Woods System. Although it provided price stability, and countries had a limited control over their own monetary policy (they could devaluate it up to 10% against the dollar, unless the IMF allowed for more), each country still had its own currency, which meant that prices of foreign goods still had to be estimated with the help of exchange rates, and physical coins and banknotes still had to be converted for international payments.

Mundell's original 1961 paper was a response to Friedman (1953), who argued for a flexible exchange rate system as a means of overcoming the limitations of the Bretton Woods system. For Friedman, an international exchange rate system where every country allowed their currency's value to freely float on monetary markets was desirable, as that would make adjustments to economic shocks automatic. The central banks no longer needed to adjust the value of the currency to attain macroeconomic equilibrium, the adjustment would be determined by market forces. Recalling Mundell's scenario, if the countries A and B have monetary independence, instead of adopting a monetary policy to follow their own specific strategies, they instead accept the exchange rate that is determined by monetary market investors. If an asymmetric shock occurs, shifting the demand for the goods of country B to the goods of country A, investors lose trust in the value of country B's currency, and buy more currency from A. Country A's currency appreciates against country B's, and the rest follows from the previous example: macroeconomic equilibrium is restored.

The validity of Friedman's argument is taken as a given by Mundell. He does not dispute the idea that the value of a currency be determined in an international monetary market. His contention is at what level should currencies be allowed to float. While Friedman argued that every country should have its own currency and let it float, Mundell stated that currencies should float at the regional level instead. Without further context, the reader might mistakenly assume that Mundell is arguing here that every internal division of every single country should have its own currency, *e.g.*, every single state of the United States, or every single country inside the United Kingdom. He is not. For Mundell, a "region" is an economic area with characteristics that are suitable for a single currency to operate in. The United States, which is a country, would be considered a region by Mundell. But why does he do this? Why separate the country from the "region"? Because for him, the combination of countries that composed (then) Western Europe could also be a region. The label of "country" encompasses giants such as the USA and the (then) USSR, as well as Malta, Sri Lanka, Cyprus, etc. The economic conditions within these countries dictate different policies: while some should freely float their currencies (like the USA), others are too small to do that, and are better off pegging their currency or joining a CU with their closest neighbours. For Mundell what determines the desirability of a currency is not national identity, but economic feasibility.

So, what are the conditions that befit the "region" (or OCA) Mundell refers to? These are the most important four:

- Mobility of Factors
- Wage Flexibility
- Fiscal Integration
- Openness
- Business Cycle Synchronization

A high mobility of factors allows workers and capital to move from regions suffering an economic downturn into regions that are growing. This softens the effects of asymmetric demand shocks and reduces de burden of readjustment on the central bank. As Mundell (1961, p. 663) puts it: "…the world can be divided into regions within each of which there is factor mobility and between which there is factor immobility…". Labour mobility is especially important, as workers moving away from areas that lost demand and finding new jobs in others helps to control the unemployment rate. The less border and language barriers exist, the more mobile the workforce will be. Wage flexibility (see Friedman, 1953) also contributes to the mitigation of demand shocks, by shifting the burden of readjustment towards worker's wages. However, we should always be mindful of Keynes (1936): people are extremely unwilling to accept cuts to their nominal earnings (sticky wages), more so than their real earnings (money illusion).

Fiscal Integration (Kenen, 1969) differs from the previous two conditions in the sense that it is not an automatic stabilizer: it requires action on the part of political leaders to develop policies that correct macroeconomic imbalances, *i.e.*, transfer funds from regions that have increased demand to those that lost demand. The higher the fiscal integration, the more funds can be allocated, allowing for the correction of shocks of greater magnitude. However, depending on the prevailing attitude of politicians and the people in general, this can be a politically contentious issue at times.

McKinnon (1963) states that openness also plays a role in determining the domain of an OCA. Openness is a measure of how open to foreign trade a country (or region) is: the greater the weight of foreign trade on total GDP, the more open it is. In a big economy, where most of the goods needed by the people are domestically produced, the liquidity of money is safeguarded internally by pegging its value to the value of these goods (measured by the Consumer Price Index), and externally by allowing it to float. But, if most goods in an economy come from foreign trade, as is the case for many small economies, allowing the currency to float can be dangerous for internal price stability. It is much more helpful to peg the value of the domestic money to the value of those foreign goods, *i.e.*, to the currency of the most important trade partners. McKinnon (1963, p. 719) argues: “if we move across the spectrum from closed to open economies, flexible exchange rates become both less effective as a control device for external balance and more damaging to internal price-level stability”, and defends: “to maintain the liquidity value of individual currencies for small areas, a fixed exchange rate system is necessary”. The main giveaway of this is that the more two regions trade with each other, the better they are served by a single currency. In a line of thinking similar to Mundell, we can say: the world can be divided into regions within each of which there is significant trade and between which there are limited trade interactions.

Although not considered by Mundell, there is a consensus among more recent authors that business cycle synchronization is another crucial factor for the optimality of an OCA. The rationale is that if countries have similar business cycles, asymmetric (or idiosyncratic) demand shocks are less prevalent, and the need for independent monetary policies isn’t as great. If all countries in a CU are experiencing a recession, an expansionary monetary policy applied by the central bank will serve all countries well. The same is true if they are booming, and the central bank applies a contractionary monetary policy.

Determining if a country, group of countries, or other type of economic area exhibits the conditions described above, so as to be considered an OCA, is for Mundell an empirical question.

Table 1: Optimum Currency Area Theory

Optimum Currency Areas			
Objectives	Advantages	Disadvantages	Conditions/Criteria
• Maintain Full Employment • Maintain stability of Internal Prices • Maintain equilibrium in the Balance of Payments	Reduced information and transaction costs	Loss of individual monetary policy	• Mobility of Factors • Wage Flexibility • Fiscal Integration • Openness • Business Cycle Synchronization

2. The Endogeneity Hypothesis of the OCA Criteria

The Theory

Writing more than 35 years after Mundell's *A Theory of Optimum Currency Areas*, Jeffrey A. Frankel and Andrew K. Rose would put forth an argument that contested the assumption that, before joining a CU, countries had to exhibit suitable economic conditions to do so. Before Mundell, Meade (1957) had stated that the conditions for a common currency in Western Europe did not yet exist. Scitovsky (1958) argued otherwise, favouring a common currency because it would induce a greater degree of capital mobility, but stressed that steps still had to be taken to make labour more mobile and facilitate supranational employment policies. *The Endogeneity of the Optimum Currency Area Criteria*, published in 1998, broke away from this line of thinking. In it, Frankel & Rose (1997, p. 1) contend that "a naive examination of historical data gives a misleading picture of a country's suitability for entry into a CU, since the OCA criteria are *endogenous*".

This argument is essentially an application of the "Lucas Critique", as outlined in the 1976 paper *Econometric policy evaluation: A critique*, by Robert Lucas Jr.. In the mid 1970's, policy decisions were based on inferences withdrawn from large-scale macroeconomic models. These models were not structural, *i.e.*, policy invariant. They were based on the Keynesian macroeconomic approach, which lacked a dynamic foundation based on microeconomics (*i.e.* micro-foundations). As a result, whenever major policy changes occurred, which affected economic agents on a structural level, the model's assumptions would not necessarily be in line with reality. To compound the problem, the data used in those econometric models was highly aggregated. Aggregating data is the practice of grouping together a large number of observations into a single aggregated observation, to save digital storage space (which is at a premium today, and even more so in the 1970's). The properties of the aggregated observation would be averages of the properties of all the individual observations that composed it, losing valuable information specific to individual economic agents.

In Lucas own words (1976, p. 279): "Given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models.". From this we can understand that relations that appear to hold, such as the relation between unemployment and inflation (Phillips Curve), could change in response to changes in economic policy". The Lucas Critique therefore argues that it is naive to try to predict the effects of a change in economic policy entirely on the basis of relationships observed in historical data (especially highly aggregated data), because existing models were not structural, and could lead to misleading conclusions.

Frankel & Rose (1998) apply the Lucas critique to the late 1990's discussion on the upcoming European Monetary Union (EMU). On a separate (but interesting) note, academic interest in the OCA theory coincides with the discussion on the implementation of flexible exchange rates (before and during the downfall of the Bretton Woods system), and the creation of the Euro. In the 1970's and 1980's, contributions to the OCA theory were scarce. So, the conventional wisdom of the 1990's was the same of the 1960's: countries should join a CU only if they exhibited certain economic characteristics (that resembled Mundell's "region"): factor mobility; wage flexibility; fiscal integration; openness and business cycle correlation. Frankel & Rose's 1998 empirical analysis focusses on the relationship between the last two and finds a positive and economically significant relationship between the intensity of trade between two countries, and the synchronization of their business cycles. This gave empirical validity to the endogeneity argument of OCA criteria, that they previously put forth the year before (Frankel & Rose, 1997). The argument states that both of these criteria are endogenous: the correlation of business cycles is endogenous with respect to trade integration, while trade integration depends on policy, and gravity (as defined in the Gravity Model of Trade, to be explored later in this section).

The authors reason (Frankel & Rose, 1998, p. 22): "some countries may appear, on the basis of historical data, to be poor candidates for EMU entry. But EMU entry *per se*, for whatever reason, may provide a substantial impetus for trade expansion; this in turn may result in more highly correlated business cycles. That is, a country is more likely to satisfy the criteria for entry into a CU *ex post* rather than *ex ante*". Since the authors find empirical evidence to back up their words, in practice this means that if countries join EMU, regardless if they exhibit *ex ante* the necessary economic conditions, they will satisfy those conditions *ex post* by virtue of being a member of the EMU. After a country joins the EMU, increased trade with Eurozone members will, over time, contribute to the convergence of the business cycles. In turn, this will reduce the need for independent monetary policy to contain inflationary pressures and alleviate social problems, making the member countries more closely resemble an OCA.

If broken down, Frankel & Rose's endogeneity argument has two assumptions:

- 1st) countries that join a CU will experience growth in trade with other member states;
- 2nd) that growth in trade will be mostly intra-industrial (because of the positive relationship between trade and business cycle correlation) and will not result in an increase in sector specialization.

The first assumption seems, theoretically, uncontroversial: the use of the same currency by two countries makes trade easier due to reduced information and transaction costs, so they will trade more with each other. Andrew K. Rose (2000) affirms that this growth in trade could be as high as 300% Shortly after, Glick & Rose (2002) present a much smaller estimate, of around 50%. A more recent reassessment of this paper (Glick & Rose, 2016) reaches a similar estimate of 50%, but with an updated and more parsimonious methodology. However, no empirical consensus exists. We will explore some of the reasons as to why this is further in section 3.

The second assumption, unlike the first, does not enjoy a theoretical consensus because it directly contradicts classical economic theory: an increase in trade between two countries is expected to lead to greater specialization of their economies, in order to maximise their comparative advantages (Ricardo, 1817). This means that if demand shocks occur, it is more likely that they will be asymmetric than symmetric, increasing the need for independent monetary policy. From this divide, we can establish two camps: Frankel & Rose (1998) on one side defending the intra-industrial trade hypothesis (based mainly on their empirical findings), and Krugman & Veneables (1995) on the other, remaining loyal to classic economic theory. There are plenty of empirical studies to support both sides.

De Grauwe & Vanhaverbeke (1991) find that in Europe, asymmetric shocks tend to be more prevalent between the regions of a given country, than between countries themselves. This posits that the major obstacle preventing countries from uniting under a common currency can also be observed between the regions that compose them.

Bayoumi & Eichengreen (1993) analyse data on output and prices for 11 EEC member states to extract information on aggregate supply and demand shocks using a vector autoregression (VAR) decomposition. They find that shocks are more idiosyncratic across EEC countries than across United States regions, indicating that it would be more difficult to operate a monetary union in the EEC than in the US. However, a core of EEC countries (Germany, France, Belgium, the Netherlands and Luxemburg), experiences shocks of similar magnitude and cohesion as the US regions. The remaining EEC countries are in a "periphery" where the magnitude of shocks is considerably higher.

Clark & Wincoop (2001, p. 59) also document that "business cycles of U.S. Census regions are substantially more synchronized than those of European countries. Data from regions within European countries confirm a European border effect – within-country correlations are substantially larger than cross country correlations". This "Border Effect" means that it is significantly easier to trade inside a given country (between its regions), than internationally.

Despite this border effect being considerably stronger for Europe than for the US, Fatas (1997) finds that it has been on the decline. From 1966 to 1992, the correlation of incomes between countries in Europe has increased, while the correlation between regions within these countries has diminished. Fatas (1997, p. 749) explains: "These results are probably caused by the combination of two factors. First, European integration and increased trade is creating more cross-border links instead of favouring specialization at the country level. Second, additional coordination in economic policies is increasing cross country relations". Angeloni & Dedola's (1999) findings are also in line with Fatas, with intra-area correlations of output, stock market indices and aggregate prices having increased in the 1990's.

Bayoumi & Eichengreen (1997) operationalise the OCA theory by constructing an OCA index for European countries. Comparing the movements in the index from 1987 to 1995, and using Germany as the reference country, they identify three groups of countries: 1) converged countries – Austria, Belgium, Ireland, The Netherlands, and Switzerland; 2) converging countries: Italy, Greece, Portugal, Spain , and Sweden; 3) other countries – Denmark, Finland, France, Norway and the UK. They also find that the countries which had the greatest increase in bilateral trade have also experienced the greatest increase in their readiness for monetary integration. These results support Frankel and Rose's endogeneity of the OCA criteria hypothesis.

Hallet & Piscitelli (2000) study the effects of a single monetary policy when asymmetries exist. They find that monetary transmissions and private sector asset holdings, when significantly asymmetric, destabilise the business cycle in ways that cannot be corrected by deficit constrained fiscal policies.

Giovanni & Levchenko (2010), using a large cross-country industry-level panel dataset of manufacturing production and trade, find evidence that higher bilateral trade in an individual sector increases both the comovement within the sector between trading countries, as well as the comovement between that sector and the rest of the economy of the trading partner.

Calderon *et al.* (2007) distinguish the effect that trade intensity has on business cycle correlations between industrial and developing countries and find that this effect is substantially smaller for developing countries. The authors suggest that this divergence is explained by differences in the patterns of trade specialization between countries.

Giannone *et al.* (2008), writing almost a decade after the EMU came into effect, find that it has not affected the historical characteristics of member countries' business cycles and their cross-correlations.

Enders *et al.* (2013) also support this finding, claiming that there is little evidence that the EMU has systematically changed the European business cycle.

In contrast, Silvestre & Mendonça (2007) find a positive and statistically significant correlation between trade intensity and business cycle comovement. But, when dividing their sample by sub-periods, this relationship becomes insignificant after 1986. This happens despite the comovement between countries' incomes continuing to get more synchronised, suggesting that other forces beyond trade are contributing to the synchronization of business cycles.

Aguiar-Conraria & Soares (2011) study the comovement of business cycles of several members of the EU through wavelet analysis. The authors (2011, p. 19) defend that "Wavelet analysis is particularly well suited to study business cycles, because it estimates the spectrum as a function of time, revealing how the different periodic components of the time-series change over time.". They find that business cycle comovement is highly dependent on geographical adjacency. Germany and France form the "core" of the Eurozone's business cycle, being the most synchronized with all other members-states. Other countries gravitate around these two, with Spain and Austria's business cycles being synchronized with the European business cycle by virtue of being synchronized with the French and German business cycles, respectively. Portugal, Greece, Ireland, and Finland represent the "periphery": not showing any statistically significant correlation with the remainder of Euro-12's business cycles.

This distinction between core and periphery is also recognized by Caporale *et al.* (2015). The authors show that the relationships between trade intensity and output synchronization are positive and statistically significant for most European countries, but peripheral countries exhibit a declining effect over time, supporting the specialization model of Krugman (1993). This results in a divergence between core and periphery countries, and the authors call for change in the European Governance to preserve the future stability of the EMU.

Although finding a positive and significant correlation between trade and business cycle correlation, Frankel & Rose (1998) do not comment on the direction of causality between these two variables. They do not claim that it is increased trade that causes more synchronous business cycles, nor vice versa. They also do not comment on the possible simultaneity problem of both variables affecting each other.

The Praxis

Frankel & Rose's original 1998 methodology employed a Two Stage Linear Least Squares (2SLS) model, to study the correlation of trade intensity and business cycle comovement. This approach is preferred to a standard OLS, due to the endogeneity of trade intensity. The 2nd stage of their model was defined as:

$$Corr(v,s)_{i,j,t} = \alpha + \beta_1 Trade\ (w)_{i,j,t} + \varepsilon_{i,j,t}$$

where $Corr(v,s)$ denotes the comovement of business cycles and $Trade(w)$ the trade intensity.

Each observation in their dataset consisted of dyadic country pairs. Real GDP, total employment, the unemployment rate, and an industrial production index are used as variables of economic activity, to measure the symmetry of business cycles. Bilateral trade, weighted by total trade and total output, are used as variables for trade intensity, as specified by the following formulas:

$$wt_{ijt} = \frac{\left(X_{ijt} + M_{ijt}\right)}{X_{i.t} + X_{j.t} + M_{i.t} + M_{j.t}}$$

$$wy_{ijt} = \frac{\left(X_{ijt} + M_{ijt}\right)}{Y_{i.t} + Y_{j.t}}$$

where wt denotes the trade intensity, X the exports, M the imports, and Y the real GDP.

Capitalizing on the (then) relatively recent academic interest in the Gravity Model of Trade, Frankel & Rose adopt this model as the 1st stage of their 2SLS:

$$Trade(w)_{i,j,t} = \varphi\alpha + \varphi \log(Distance)_{i,j} + \varphi Adjacent_{i,j} + \varphi Language_{i,j} + \varepsilon_t$$

where distance, border, and common language are used as Instrumental Variables (IV's) to control the endogeneity of $Trade(w)$. The predicted values of $Trade(w)$ are then used to calculate wt_{ijt} or wy_{ijt} in the 2nd stage.

Today, the Gravity Model of Trade (henceforth abbreviated GMT) is one of the most used models in econometrics, with Krugman (1997, p. 42) calling it an example of "Social Physics". But, in the early to mid-1990's, the idea that gravity could explain the trade flows of the world's economies was one that most researchers did not took seriously. According to Head & Mayer (2014, p. 5) "one of the barriers to mainstream acceptance was the lingering perception that gravity equations were more physics analogy than economic analysis". Despite this, researchers "admitted" the importance of the GMT when they "realized there was a surprisingly large amount of missing trade, and admitted that gravity was one way to measure and explain it" (Head & Mayer, 2014 p. 5). This idea of missing trade was first introduced by Trefler (1995).

The GMT, like its physics counterpart, has rules for size and distance. A greater size means more trade, and a greater distance means less. More specifically:

- exports rise proportionately with the economic size of the destination; imports rise in proportion to the size of the economy of origin;
- a strong negative relationship exists between physical distance and trade.

Overall, the goal of Frankel & Rose is not to predict all the factors that affect business cycle synchronization. They were content with figuring out the sign of its relationship with trade intensity. They found this sign to be positive and statistically significant, and that was all they needed to support their endogeneity hypothesis. The meaning of this positive sign is that the type of trade more likely to be prevalent within the EMU is intra-industral, not inter-industrial, as classic theory would predict.

3. Advancements in Empirical Methodology

To recap, in section 1 we reviewed the history of the OCA concept, and in section 2 we learned about the Endogeneity Hypothesis and the methodology employed by Frankel & Rose (1998). In this section, we will explore the methodological advancements that came after their work. The first four subsections deal with advancements on the 1st stage (the gravity equation). As the EMU came into effect in 1999, most posterior studies have a heavy focus on estimating the trade generating effect of the Euro. Their results provide a valuable insight into the validity of the 1st assumption of the Endogeneity Hypothesis. On the other hand, few studies try to test the validity of the 2nd assumption. The final, fifth subsection covers this lack of advancements on the 2nd stage.

The Multilateral Resistance Problem (Anderson & Wincoop, 2003)

Multilateral Resistance is a term coined by Anderson & Wincoop (2003). To grasp this concept, the reader must also understand what a "Trade Barrier" is. In the context of the multilateral resistance problem, the term trade barrier is synonymous with “Border Effect”: the effect a national border has on trade, holding other factors such as gravity and CU constant. It stems from common sense that two regions within a country trade more with each other than two regions in different countries, *ceteris paribus*. The border effect measures just how much less regions between countries trade with each other (international trade) than regions within a country (intranational trade). Multilateral resistance is essentially a theoretical average border effect, encompassing the trade barriers with all trading partners of a given country.

Through the exploration of the micro-foundations of trade (beyond the scope of this study), Anderson & Wincoop (2003) find that, as multilateral resistance for a given country increases, the border effects for its current trading partners decrease, in relation to the border effects of non-trading partners. In proper English, this means that a country that doesn’t trade much (high multilateral resistance), is more likely to trade more with its existing (or preferred) trade partners than a simple estimation controlling for gravity would predict. This unpredicted “excess” trade results in a “lack” of predicted trade with partner countries with limited trade ties. Because of this, previous gravity equations (including Frankel & Rose’s) were flawed due to omitted variables that captured this multilateral resistance effect. Ignoring this problem is what Baldwin & Taglioni (2007) call the “Gold Medal Mistake” of GMT estimation.

There are two common ways to try and correct this mistake: one is the use of a Fixed Effects Model (FE), the other is the use of an OLS with Country Dummies.

A Fixed Effects Model (FE) helps to control the endogeneity of omitted variables, because it eliminates part of the error term. In this respect, it is similar to a First Differences Model (FD), where a first differences transformation deducts the value of the previous period to every actual value in a dataset. In practical terms, this results in the elimination of all non-varying elements in a dataset, including the error term. Only the idiosyncratic part of the error remains.

$$x^{FD} = x_t - x_{t-1}$$

In the FE model, all non-varying variables are eliminated, and variables with constant variation over time (*e.g.* a dummy for CU) are greatly distorted. But, instead of a first differences transformation, a fixed effects transformation is applied instead. This transformation subtracts the average of all actual values to each actual value. It is a more efficient method when the idiosyncratic error is serially uncorrelated.

$$x^{FE} = x - \bar{x}$$

Although both FE and FD models are effective at controlling endogeneity, the transformations they apply change the data considerably. Variables that are constant over time, *e.g.* dummy for common language, are eliminated. Variables that change at a constant rate over time are also greatly distorted. Take as an example the first differencing of a GMT with a dummy for membership in a CU. A country that never joins a CU will always have 0 as an actual value for this dummy. A country that has always been in a CU will also always have $1-1=0$. This dummy will only take the value 1 when a country joins a CU ($1-0=1$), or when it leaves ($0-1=-1$). So, the nature of our original question changes from a cross sectional, to a time series one: we are no longer asking "How much more do countries in a CU trade than those outside?", but rather "How much does joining a CU increase trade in the 1st year?". In the latter case, we can clearly identify if results are significant with the application of a test for non-linearities and structural breaks (the Chow test).

As to the FE model, the interpretation of its coefficients is the same as in OLS. But the data is still distorted by the fixed effects transformation. The alternative to the FE, in the context of the GMT, is employing Country Dummies in a standard OLS. Instead of eliminating the multilateral resistance effects from the estimation, the Country Dummies isolate them in a binary variable for each specific country.

Although both Fixed Effects and OLS with Country Dummies are effective at eliminating a substantial part of the multilateral resistance bias, their employment does not completely solve the problem. Both methods successfully control the time-invariant part of the bias, but, as Baldwin & Taglioni (2007) point out, multilateral resistance also changes over time. This time-variant part is captured by the perturbation term, so the results will still be biased, although not as much.

Baldwin and Taglioni (2007) as well as Head & Mayer (2014) propose the use of a Least Squares with time-varying country Dummy Variables Model (LSDV) as the definitive solution. This model is exemplified in Glick & Rose (2016):

$$ln(X_{ijt}) = \gamma CU_{ijt} + \beta Z_{ijt} + \{\lambda_{ijt}\} + \{\psi_{ijt}\} + \varepsilon_{ijt}$$

where X_{ijt} denotes the nominal value of bilateral exports from *i* to *j* at time *t*, CU_{ijt} is equal to 1 if countries *i* and *j* are in a CU, Z_{ijt} is a vector of controls (GDP, distance, common language, etc...), λ_{ijt} is a complete set of time-varying exporter dummy variables and ψ_{ijt} is a complete set of time-varying importer dummy variables. There is a dummy for each country in the dataset, in each given year. Plus, dummies also distinguish if the country is importer/exporter in each given dyad. In total, the number of dummies will be:

$$(Number\ of\ Countries * Number\ of\ Years) * 2$$

As the reader can imagine, in very large datasets the number of dummies can be astronomical. Nevertheless, this is the best method known so far that controls multilateral resistance effects in their entirety, being therefore indispensable. The inclusion of a yearly component into the dummies, besides isolating the time-varying multilateral resistance effect, also corrects the "Bronze Medal Mistake" (Baldwin & Taglioni, 2007): inappropriate deflation of nominal trade flows. Using a single deflator for all trade flows (*e.g.* the US price index) ignores global trends in the inflation rates of other currencies. A set of year dummies solves this problem more effectively by capturing the effects of inflation, for each year.

Measurement of Trade Intensity (Baldwin & Taglioni, 2007)

Recalling Frankel & Rose (1998), trade intensity is measured as an average of two one-way trade flows: exports from *i* to *j* (X_{ijt}) and exports from *j* to *i* (M_{ijt}):

$$wt_{ijt} = \frac{\left(X_{ijt} + M_{ijt}\right)}{X_{i.t} + X_{j.t} + M_{i.t} + M_{j.t}}$$

$$wy_{ijt} = \frac{\left(X_{ijt} + M_{ijt}\right)}{Y_{i.t} + Y_{j.t}}$$

Where wt_{ijt} represents two-way trade weighted by total trade, and wy_{ijt} represents two-way trade weighted by GDP. Since 1998, most researchers using the GMT no longer apply weights to trade intensity, instead adopting variables such as the product of the dyad's GDP, per capita GDP and Land Area as explanatory variables. The most common measure of trade intensity used is the logarithm of average two-way trade:

$$ln\left(\frac{\left(X_{ijt} + M_{ijt}\right)}{2}\right)$$

Although this was a very common approach to measuring trade intensity, Baldwin & Taglioni (2007) point out that most researchers commit the "Silver Medal Mistake": computing the log of trade intensity after computing the average. Basically, they mistake the log of the average for the average of the logs.

If the log of the average is calculated, instead of the average of the logs as it should be, serious problems can occur if trade is unbalanced. According to Baldwin & Taglioni (2007, p. 797) "…the error will not be too bad for nations that have bilaterally balanced trade – in which case is close to unity – but it can be truly horrendous for nations with very unbalanced trade. In the real world, bilaterally unbalanced trade is a huge issue, especially for North-South trade flows.". Mathematically, the sum of the logs is approximately the log of the sums, but the approximation gets worse as the two flows diverge. This will bias the results, resulting in an overestimated effect of a CU on trade. This bias is more severe in panel datasets.

Essentially, the averaging should be done after taking the logs:

$$\frac{log\, X_{ijt} + log\, M_{ijt}}{2}$$

It is reasonable to think that CIS (Cost, Insurance and Freight) import data is preferable over FOB (Free on Board) export data, because countries pay more attention to imports rather than exports when inspecting accounts, to avoid tariff fraud. But, since 1993, trade data is gathered from VAT (Value Added Tax) statistics for most European countries. Exporters are thus incentivized through VAT rebates to announce exports properly (and disguise imports). No consensus on the decision between the use of FOB or CIF data exists.

The Small Datasets Problem (Rose, 2017)

When estimating the effect EMU has on trade, Glick & Rose (2016) reach an estimate of about 50%, but they note that across other studies this estimation varies significantly. In a meta-analysis of the literature, Rose (2017) posits that most other researchers seem to reach a much smaller estimate, closer to 10%. Some even obtain negative estimates. The author points out that there are two interesting correlations:

- the more years in a dataset, the higher the estimate;
- the more countries in a dataset, the higher the estimate.

The first had already been pointed out by Frankel (2010). The second is mostly due to omitted multilateral resistance effects. Most studies have less than 30 countries in their sample, the majority being rich and industrial ones. Rose (2016, p. 3) writes: "Dropping small and poor countries leads to biased estimates of these effects if small and poor countries have systematically different 'trade resistance', or if the trade resistance of large countries is reflected in trade with smaller countries. Intuitively, the fact that Germany exports to small countries like Fiji is important in understanding German export prowess, but this information is lost if Fiji isn't included in the sample of data.".

Simply put, Rose warns that if the effect EMU has on trade is to be estimated accurately, then a large dataset spanning a long-time frame and, most importantly, including as many countries as possible, should be employed. As multilateral resistance is a function of all bilateral trade barriers, there is no reason to omit countries from the dataset, as small or unimportant they may be. In fact, if this is done, the heterogeneity in multilateral resistance effects between big and small countries, and between developed and developing ones is lost, resulting in less accurate results. Rose (2016, p. 3) concludes: "As multilateral trade resistance is a function of all bilateral trade barriers, all trade partners should be included for the most accurate estimates".

Disaggregating CU's (Eicher & Henn, 2011)

Eicher & Henn (2011) emphasize the importance of disaggregating individual CU's when studying their effects on trade. The intuition for this is quite straightforward: not all CU's are the same. The EMU is not comparable to the East Caribbean Currency Union or the CFA Franc (the only 2 other formal currency unions in existence) because EMU countries are larger, richer, and the ECB pursues inflation targeting (Rose, 2016). In contrast, the East Caribbean Currency Union pegs its currency to the dollar, while the CFA Franc pegs it to the euro. Grouping them together into a single dummy variable will therefore lead to misleading results about the EMU's effect on trade.

Glick & Rose (2016) show this by calculating 3 different regressions of the GMT: one where CU's are all aggregated, one where EMU is separated from all other CU's, and one where all CU's are disaggregated. In the first scenario, the point estimate is 0.63, while in the second it is 0.41 for EMU. This result does not change in the third scenario, implying that entry into the EMU expands trade by $(e^{0.41} - 1) \approx 51\%$. This trade generating effect is larger for other currency unions in the second (0.75) and third scenarios, except for the East Caribbean Currency Union.

The 2nd Stage

The 2nd stage of Frankel & Rose's (1998) estimations has not received nearly as much attention as the 1st stage has, despite the authors calling for more research into omitted variables. To the best of this student's knowledge very few studies attempt to replicate their methodology.

The only study found was Silvestre & Mendoça (2007). It has some differences, mainly the way how trade intensity is calculated and the number of detrending filters applied, but the goal was equally limited: identify the signal of the relationship between trade and business cycle correlation. The authors state (2007, p. 6): "Obviously, many other factors beyond bilateral trade intensity play a role in cycles synchronization and in shock incidence or transmission, but the objective of this analysis is only to evaluate the trade effect and not trying to find all explanatory variables for business cycle correlation. In fact, though the statistical significance of the model, it has reduced explanatory power and R^2 of the regressions are very low".

Let's recall the assumptions of the Endogeneity Hypothesis: 1st) countries that join a CU will experience growth in trade with other member states; 2nd) that growth in trade will be mostly intra-industrial (because of the positive relationship between trade and business cycle correlation) and will not result in an increase in sector specialization. Both assumptions match perfectly with the 1st and 2nd stages of Frankel & Rose's (1998) 2SLS model. Just as the 2nd stage equation depends on the 1st, the 2nd assumption depends on the 1st as well. If membership in a CU doesn't result in increased trade, it is pointless to assume (for the endogeneity argument) that trade is positively correlated with business cycle synchronization, as membership in CU would make no difference in the rate of synchronization. Maybe the attention of researchers simply went in the direction of the first assumption, as we cannot build the rest of the argument if that one fails to hold.

Another possible explanation for this apparent lack of interest is the limited value of this approach, in terms of knowledge gained. The empirical intuition for the relationship between business cycle correlation and trade, although very interesting, only accounts for the qualitative aspect (sign) of the relationship. It says nothing about the quantitative, *i.e.*, how much an increase in trade correlates with business cycle synchronization. To find unbiased estimates of this quantitative aspect, there would be a need for a structurally sound model explaining most of the variation in business cycle correlations.

One final possibility is that researchers attempted to adopted more "complete" methodologies, with proper micro-foundations. Frankel & Rose (1998, p. 6) admit that "Ideally, we would use a general equilibrium model of international trade to derive testable hypothesis. ... Creating such a model from scratch is beyond the limited scope of this (chiefly empirical) paper.". Such a model, although requiring some more effort, would provide much more useful information, such as the quantitative aspect of the trade – business cycle synchronization relationship.

4. Descriptive Statistics

The dataset employed in this study consists of dyadic panel data, and was manually compiled by the student. Trade data is retrieved from IMF's *Direction of Trade Statistics*. GDP and industrial production data are retrieved from IMF's *International Financial Statistics*. Data for employment and unemployment are retrieved from OECD's *Main Economic Indicators*.

The dataset ranges from 1990 to 2015, and encompasses 29 countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Republic of Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

Table 2: Descriptive Statistics

VARIABLES	(1) N	(2) mean
landborder	21,112	0.0764
seaborder	21,112	0.00360
border	21,112	0.0800
language	21,112	0.0665
lanl_n	5	616.6
isld_n	5	167.4
eu90	11	147.5
eu99	14	147.1
eu08	19	358.3
eu15	19	358.3
euro99	10	150.2
euro08	11	152.4
euro15	12	217.7
nafta90	2	133.5
nafta99	3	180
nafta08	3	180
nafta15	3	180
efta90	5	145.2
efta99	2	144
efta08	2	144
efta15	2	144

Source: Own computations.

From table 2, basic statistics about the countries that compose the dataset can be observed. The total number of observations amounts to 21 112: 29 countries times 28 trading partners equals 812 country-pairs; 812 dyads times 26 years equals 21 112 observations. Of these, 7.64% represent country-pairs that share a land border, and 0,36% represent country-pairs that share a sea border. This sea border refers to countries that, although not physically connected to each other by landmass, are nonetheless close in geographic terms (*e.g.* Australia and New Zealand) or connected by man-made tunnels/bridges (e.g. France and UK; Denmark and Sweden). The variable *border* is simply the sum of *landborder* with *seaborder*. About 8% of all the dyads represent geographically adjacent trading partners, and 6.65% represent countries with the same official language. Of these 29 countries, 5 are land-locked (*i.e.*, are completely surrounded by other countries and therefore have no access to the sea) and another 5 are islands.

The remaining variables are dummies for membership in EU, Eurozone, NAFTA and EFTA, in the years 1990, 1999, 2008 and 2015. It can be observed that the weight of countries belonging to trade blocks other than EU is relatively small: at their height, only 5 countries compose EFTA and 3 compose NAFTA. Nonetheless, in a universe of 29 countries, the weight of these trade agreements is too large to be ignored, especially when EU countries amount to about $1/3^{rd}$ of the dataset in 1990 (11), and $2/3^{rds}$ in 2015. All countries with membership in the Eurozone are EU members, but not all EU members use the Euro. Of the 14 EU member states in the sample, only 10 adopted the Euro in 1999. Although many countries joined the EU in later years (with the 2004 and 2007 enlargements being the most significant), only 2 more adopted the Euro as of 2015. This means that, roughly, only half of the EU members use the Euro in the last period of the dataset.

The following figures present an overview of the correlations of economic activity. Figures 1 through 3 show real Gross Domestic Product correlation, 4 through 6 Industrial Production correlation, 7 through 9 Employment correlation, and 10 through 12 Unemployment correlation. The data used in all these figures has been detrended with the Hodrick-Prescott Filter.

Figure 1: Box plot of GDP correlations for non-EU country pairs

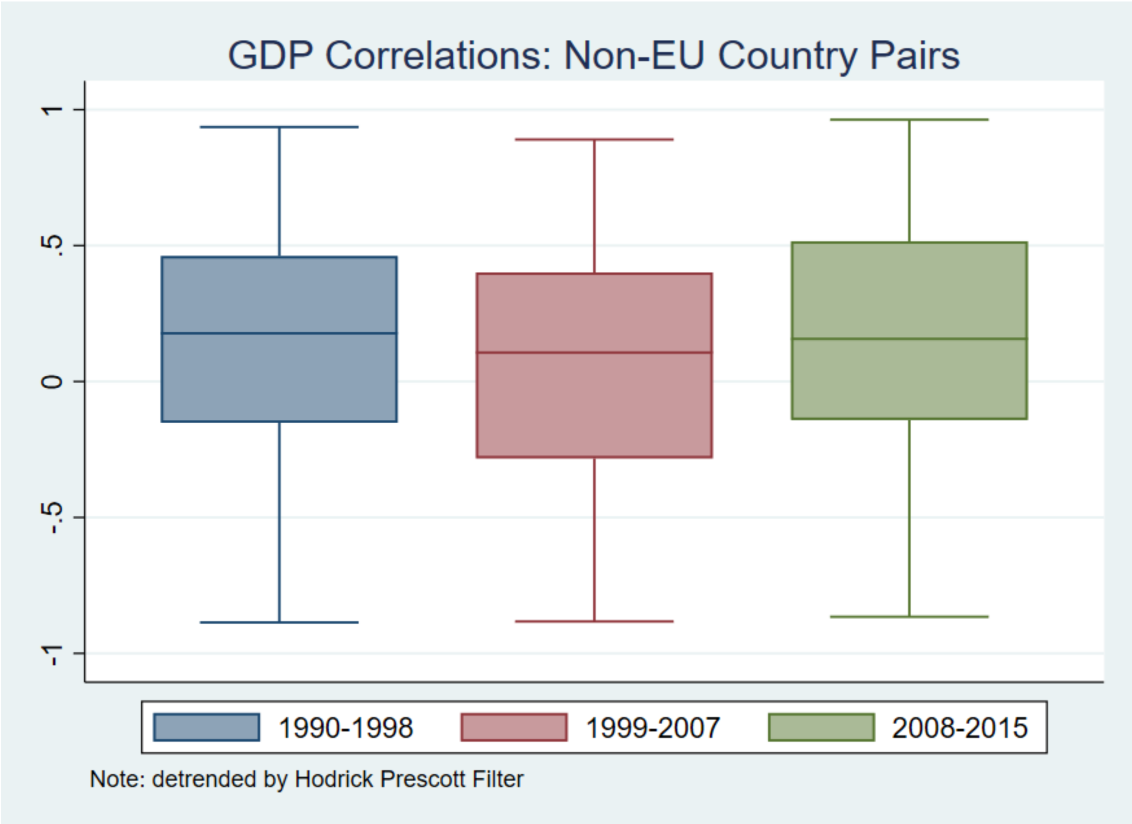


Figure 2: Box plot of GDP correlations for EU country pairs

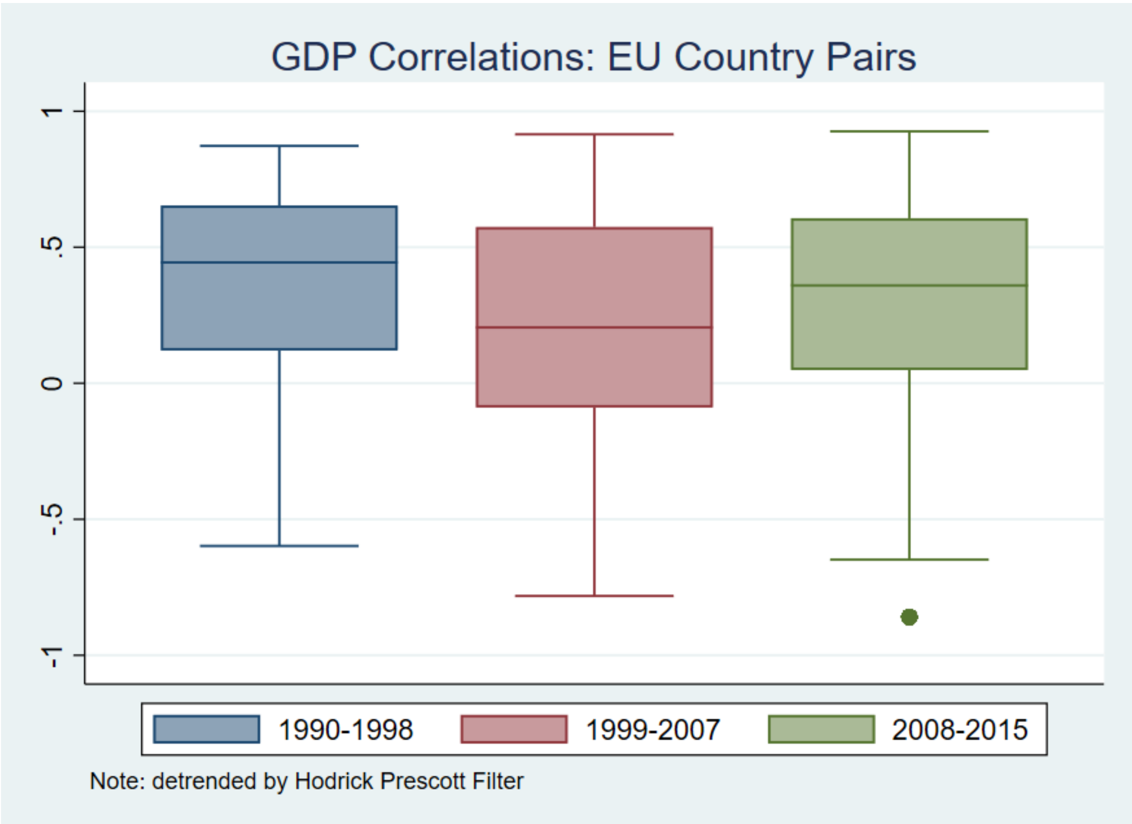


Figure 3: Box plot of GDP correlations for Euro country pairs

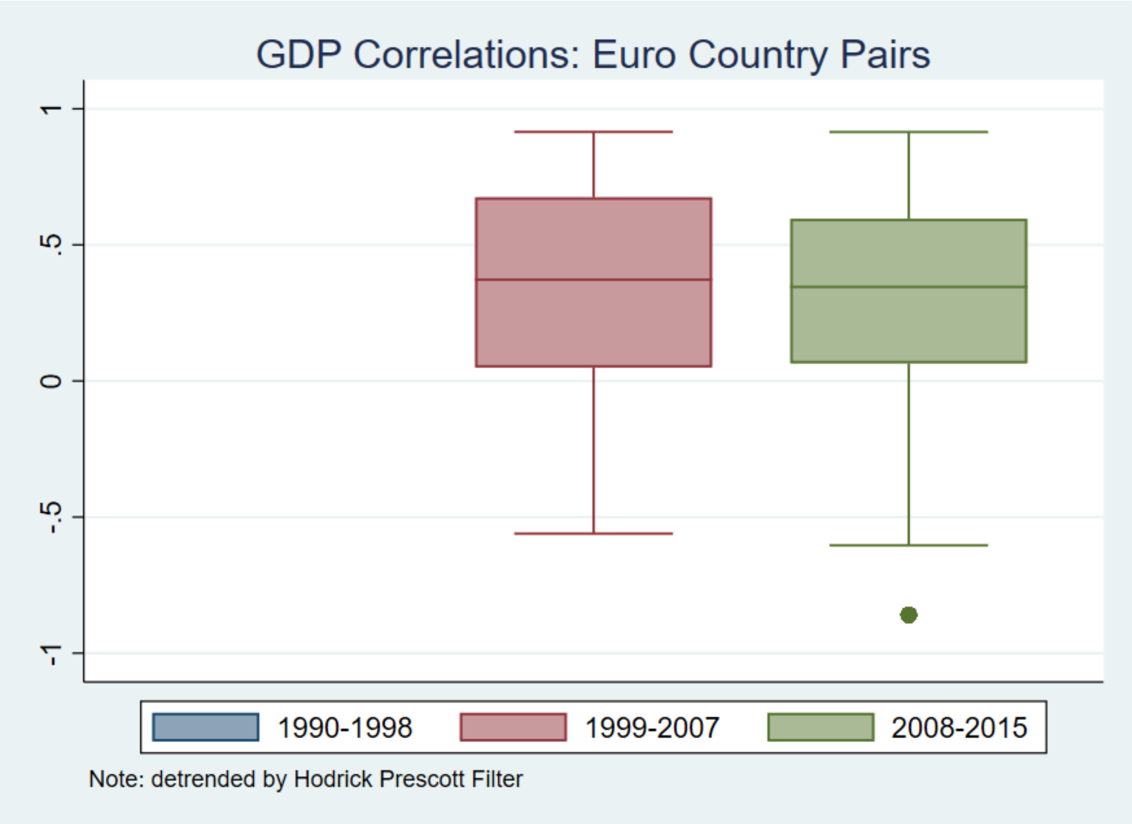


Figure 4: Box plot of IPI correlations for non-EU country pairs

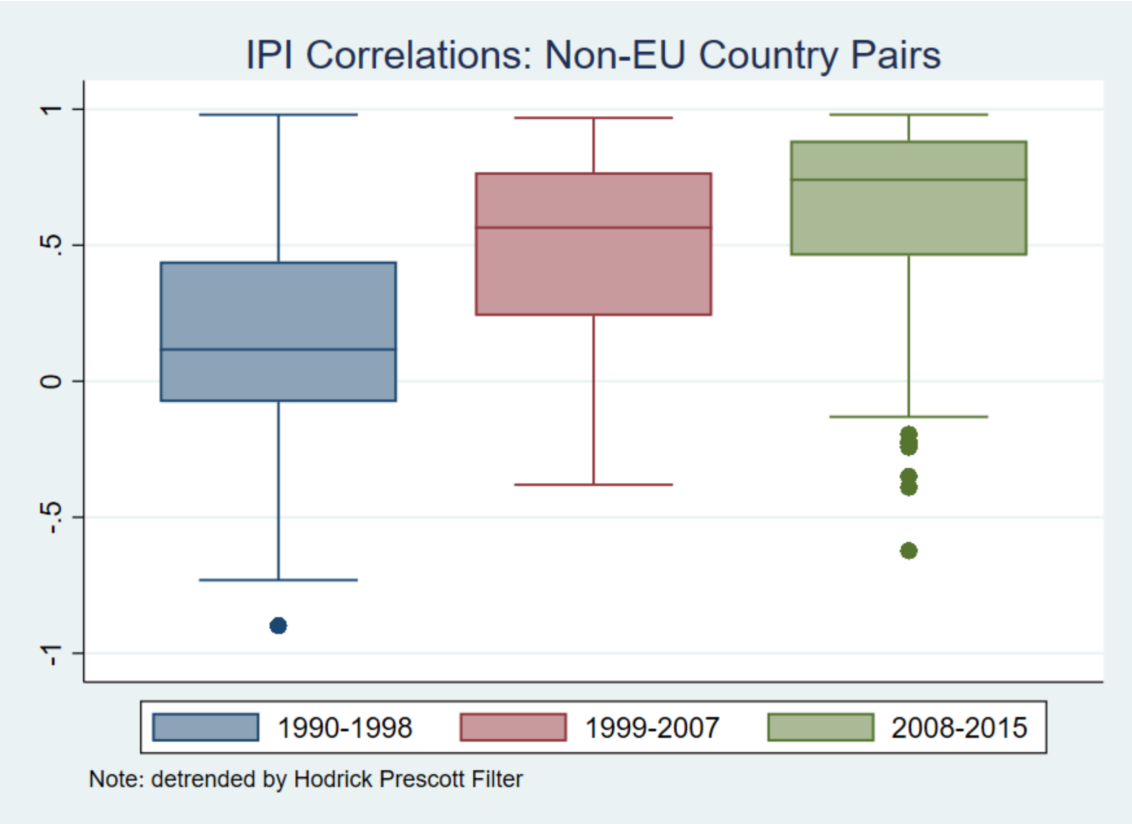


Figure 5: Box plot of IPI correlations for EU country pairs

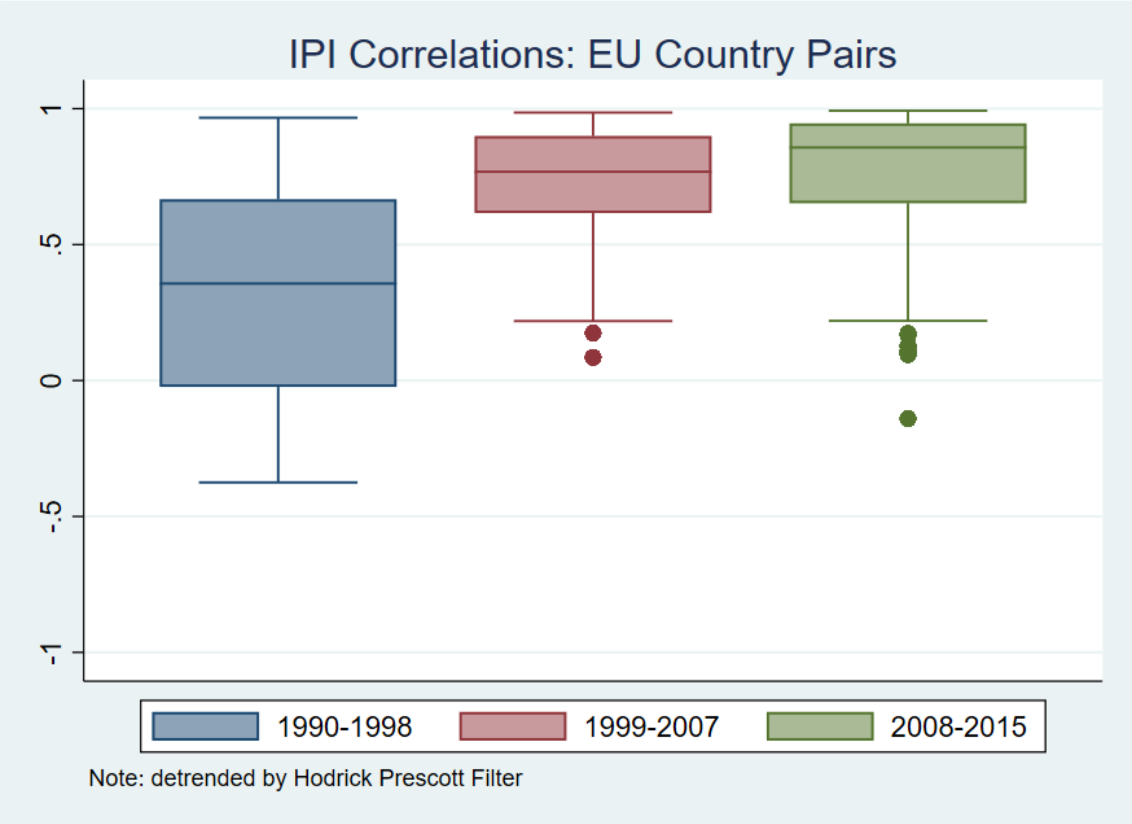


Figure 6: Box plot of IPI correlations for Euro country pairs

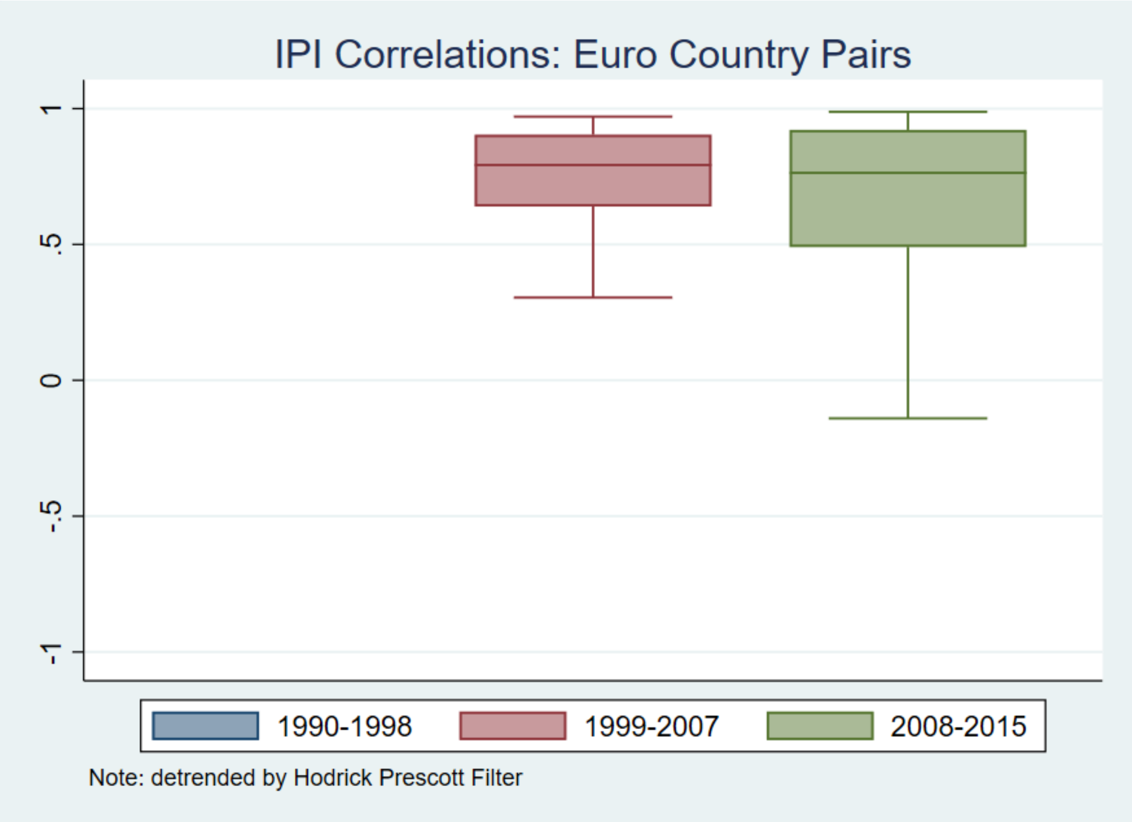


Figure 7: Box plot of Total Employment correlations for non-EU country pairs

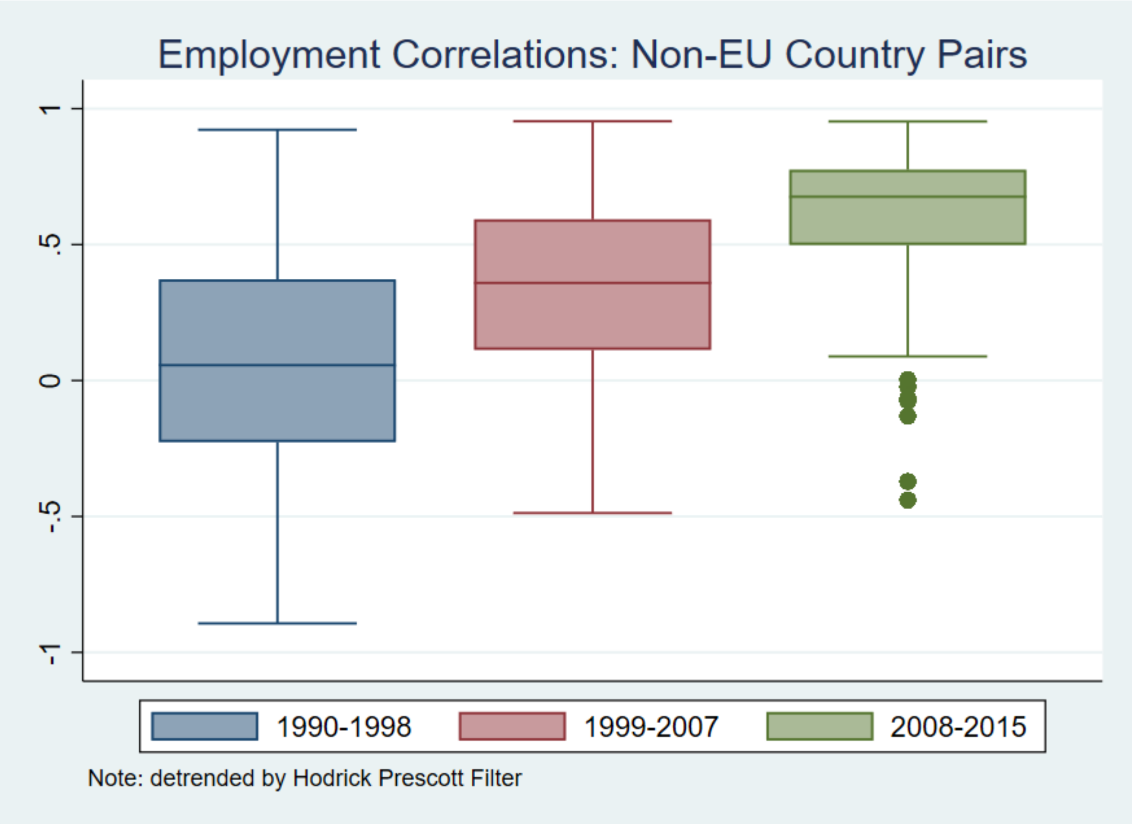


Figure 8: Box plot of Total Employment correlations for EU country pairs

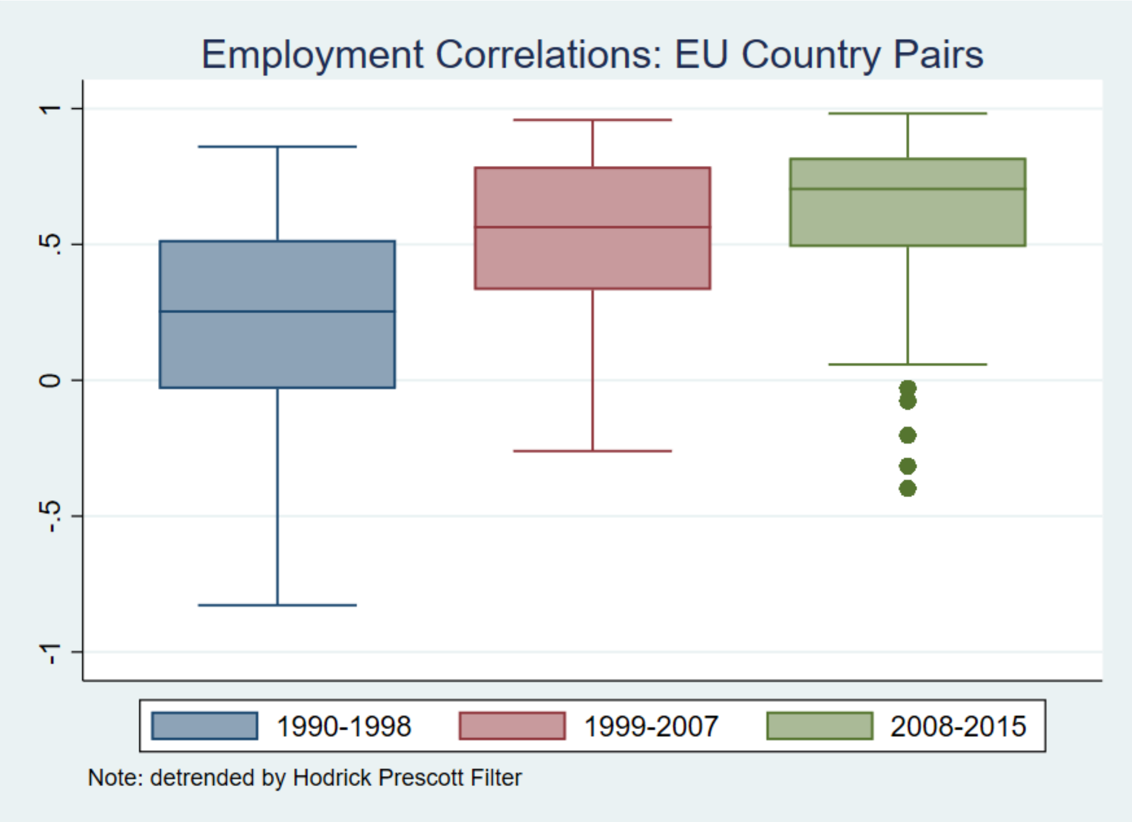


Figure 9: Box plot of Total Employment correlations for Euro country pairs

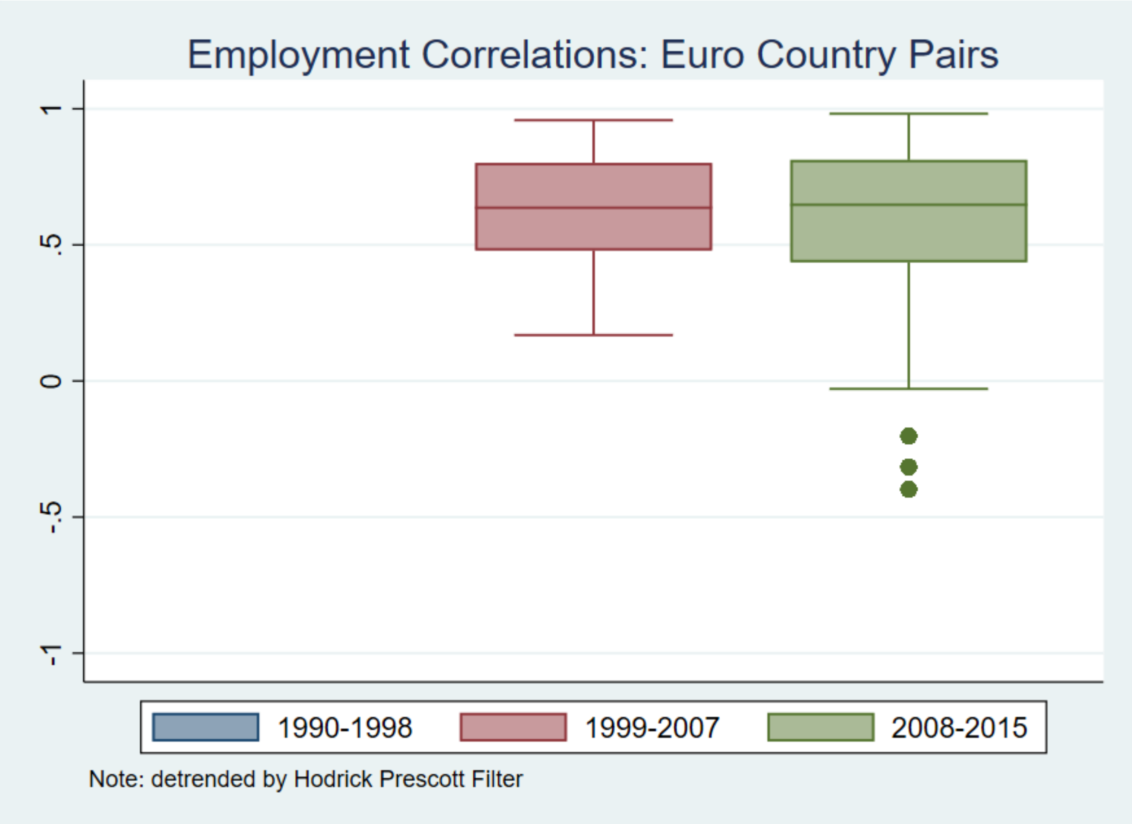


Figure 10: Box plot of Unemployment Rate correlations for non-EU country pairs

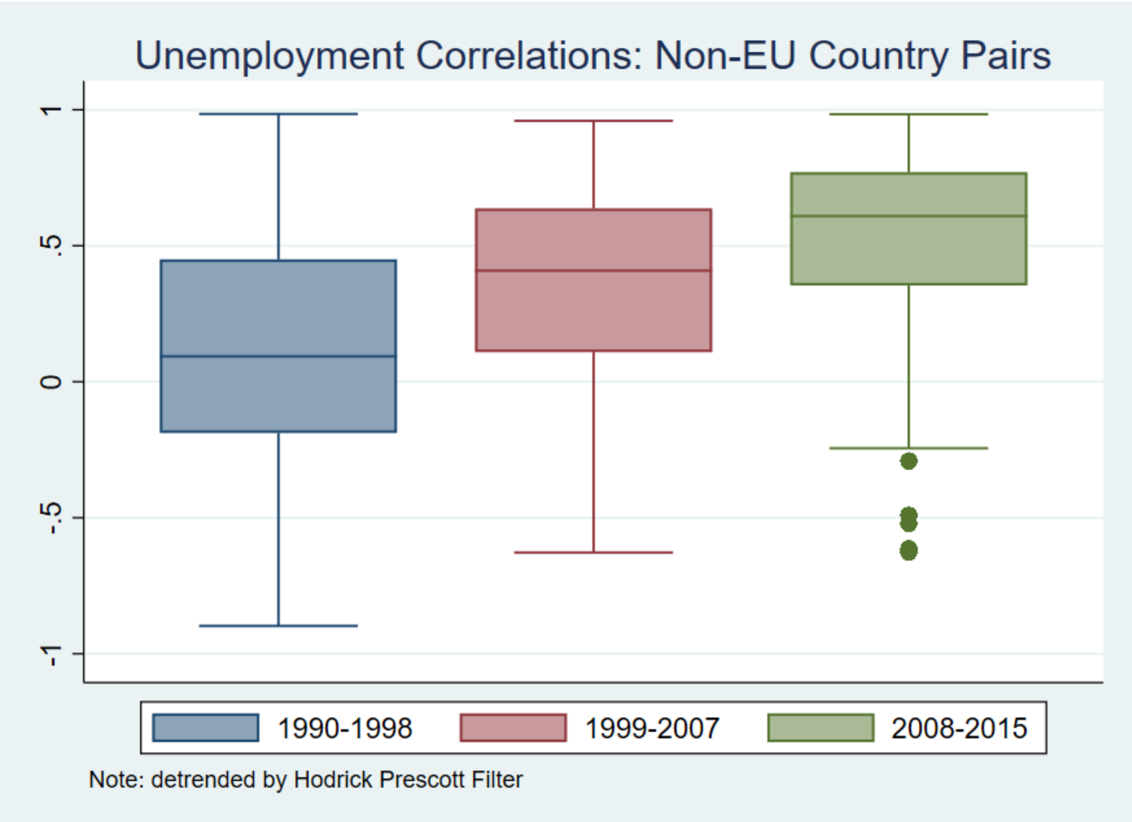


Figure 11: Box plot of Unemployment Rate correlations for EU country pairs

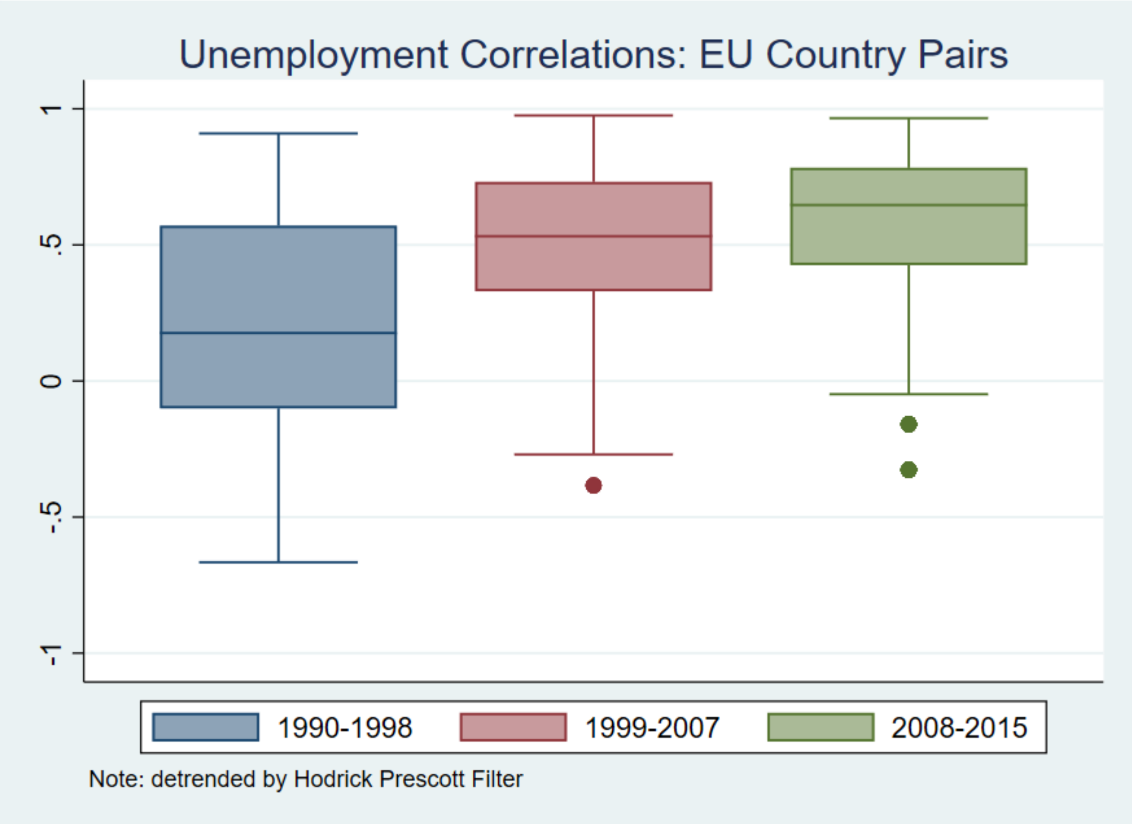
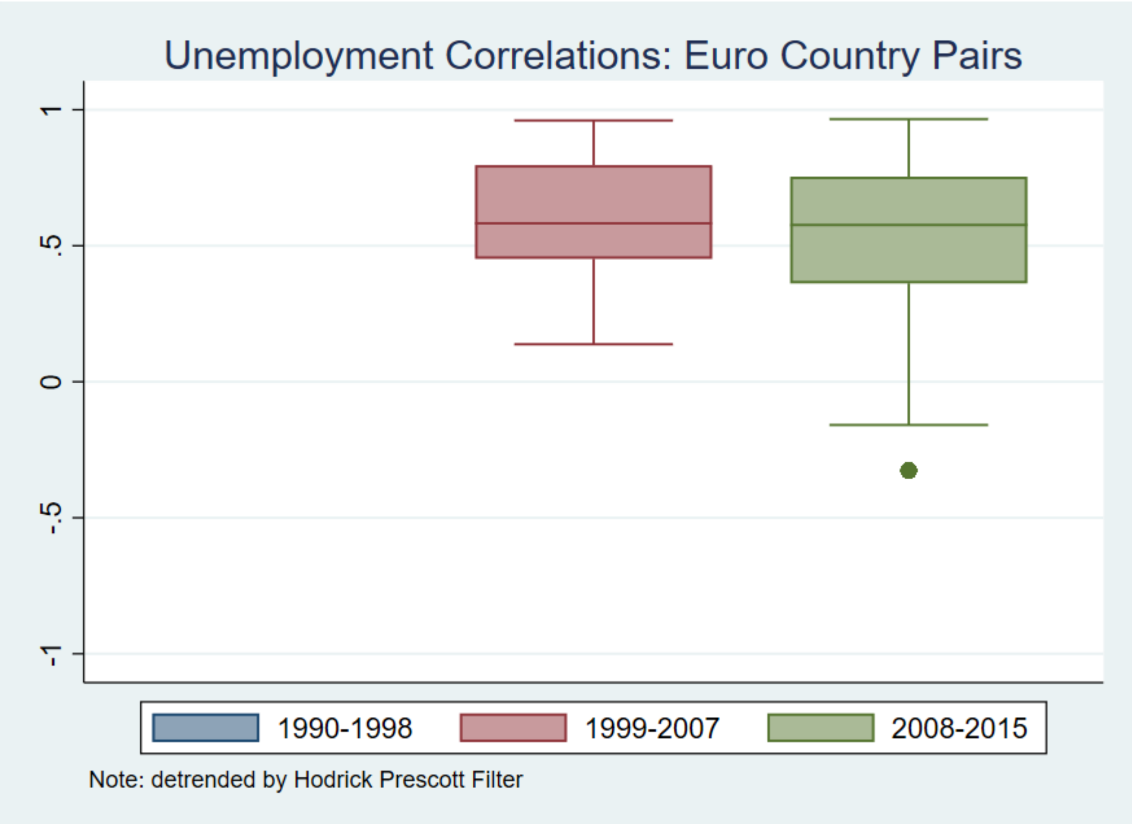


Figure 12: Box plot of Unemployment Rate correlations for Euro country pairs



Looking at the GDP, the trend is for correlations to decrease from the first to the second period and increase in the final third period. This is unlike all other measures of economic activity, whose correlations tend to increase in both the second and third periods. Eurozone countries are different, with correlations remaining either static or decreasing slightly from the second to the third period.

When compared to non-EU countries, EU countries tend to show a higher average correlation, and, in the case of the Industrial Production Index, significantly less dispersion, suggesting that the economic sectors of European economies are more tightly integrated than those of the rest of the world. However, by the third period, this difference tends to dissipate.

There are many outliers by the third period, which coincides with the aftermath of the 2007-2008 Financial Crisis. Eurozone country pairs consistently show less outliers than EU or non-EU countries, but while the average correlation for these countries increased, it remained stagnant for the Eurozone. Compared to EU countries, no significant difference exists in the average correlation. This seems to indicate that, not only the Euro impact on business cycle correlation is indistinguishable from that of the EU, the Euro has actually hindered synchronization after the Great Recession of 2008.

Figures 13 and 14 show the evolution of trade intensity through the dataset's timeframe, for Euro and Non-Euro country pairs. To control for inflation, the exports of each base country in the dyad are divided by their nominal GDP. This should give us an idea of the behaviour of real trade flows during the considered time period. Note that it is the weight of the exports towards the dyad's partner country that is being measured, and not towards all Euro or Non-Euro partners as a whole. That is why the percentages are all very low (>0.03%): they account for the weight of a single trading partner.

When comparing both figures, it is outright evident that Eurozone countries trade more with each other, as a percentage of their GDP's, than non-members. The average weight of exports towards Eurozone members is always above 0.01%, while for non-members is always bellow 0.01%. In some years, the weight is almost double.

Figure 13: Evolution of the Average Weight of Trade for non-Euro country pairs

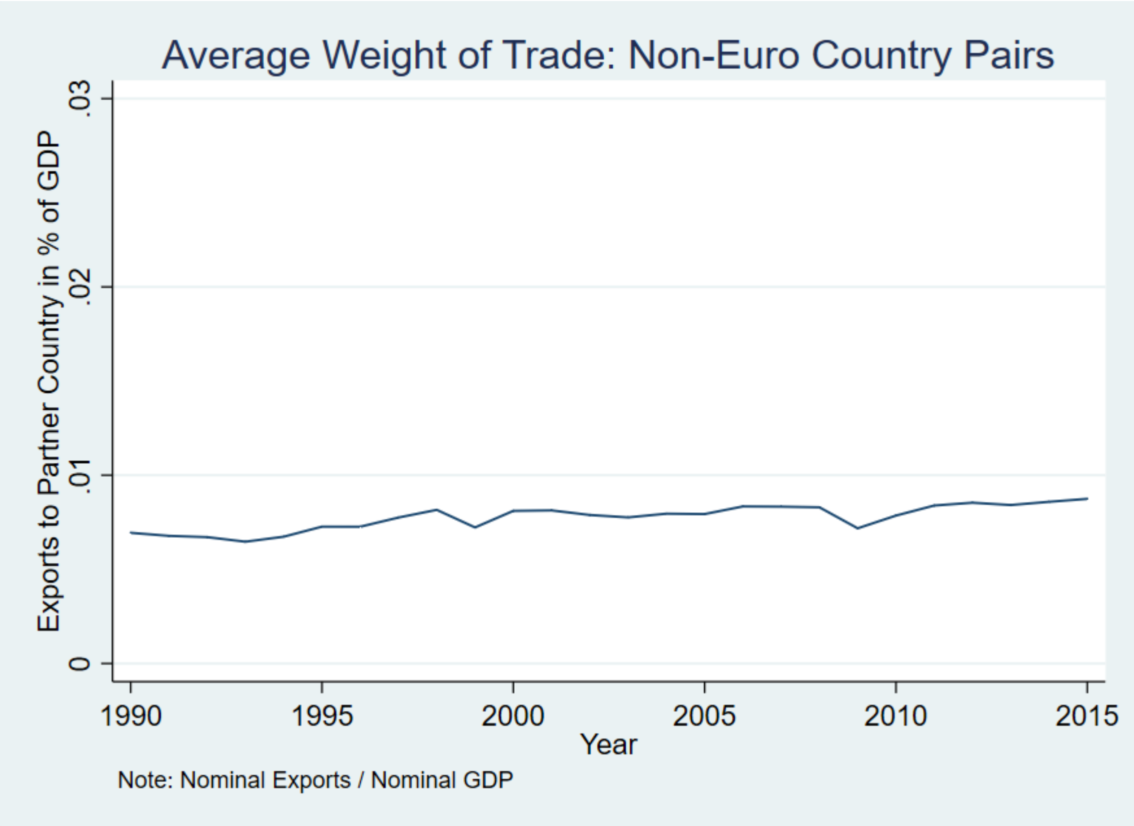
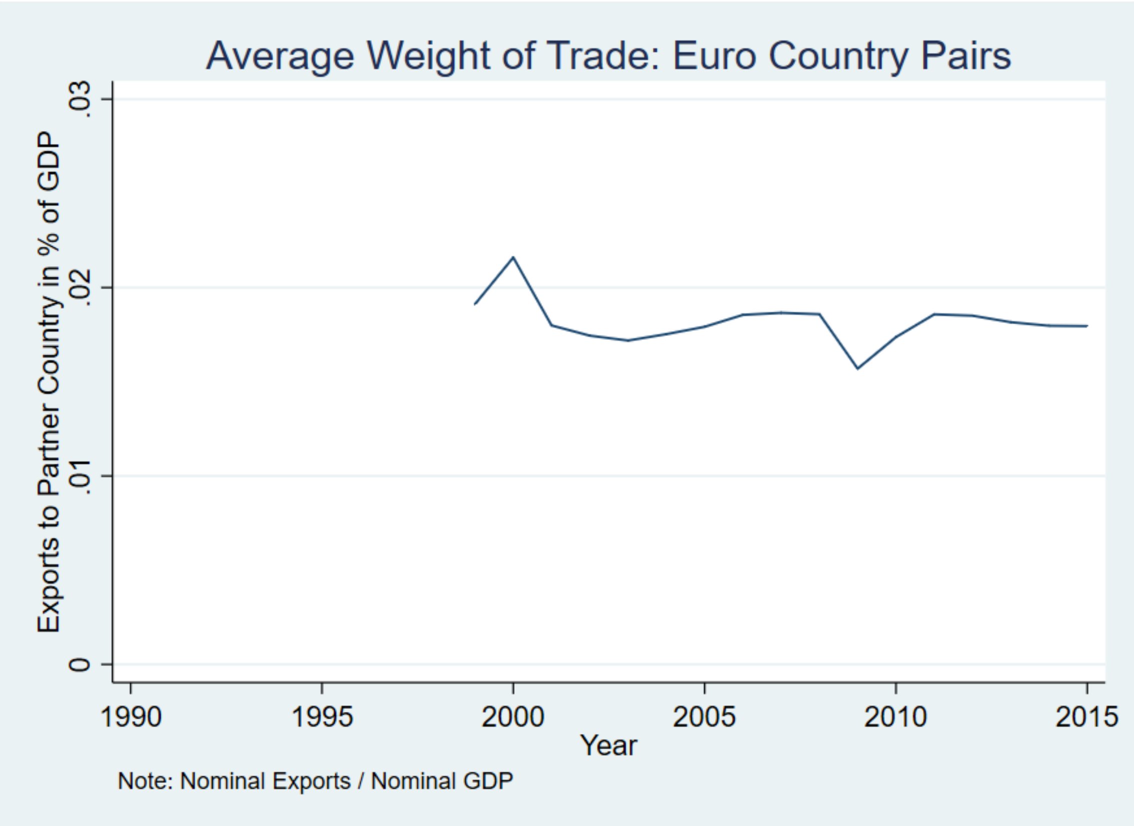


Figure 14: Evolution of the Average Weight of Trade for Euro country pairs



The weight of trade for Eurozone country pairs starts with a sharp rise in the first year, 1999, as expected. But that rise quickly diminishes to bellow 1999 levels before 2002, the year when the Euro fully replaced the previous currencies in the countries that adopted it. Despite the downward trend reversing in 2003, the weight of trade never surpassed 1999 levels. The impact of the 2008 financial crisis was also more pronounced when compared to non-Eurozone country pairs.

5. Methodology

The methodology employed in this study closely follows the one of Frankel & Rose (1998), but, with the benefit of hindsight, adopts several advancements. Nevertheless, this study has its own limitations and is not intended to be a thorough reassessment of the original work. It is more of an academic exercise, spurred by the student's interest in the subject. The goals are three:

- To estimate the effect EMU has had on trade;
- To provide intuition to the relationship between trade intensity and business cycle synchronization;
- To compare the results with the surrounding academic literature.

To estimate the effect the Euro has had on trade, an approach similar to Glick & Rose (2002) is used, where bilateral trade is predicted through a GMT, both by OLS and FE. Unlike Glick & Rose (2002), the OLS estimation incorporates time and country dummies, partially controlling for multilateral resistance effects. To examine the business cycle synchronization – trade intensity relationship, this same GMT is used again as the 1st stage of a 2SLS, where the 2nd stage is identical to the one used by Frankel & Rose (1998). But, instead of having a measure of bilateral trade as its dependent variable, the 1st stage GMT has a measure of trade intensity. This is necessary, because bigger countries will have a larger volume of trade, but not necessarily a greater weight of trade in their economy, biasing the results of the 2nd stage.

First, the natural logarithms of all variables (except unemployment rate) are computed, to capture their relative variation. Taking the advice of Baldwin & Taglioni (2007) into account, the averages of trade flows are calculated after computing their logs, avoiding the Silver Medal Mistake. Since no definitive choice can be made between using FOB or CIF data, an average of both measures is used to calculate each trade flow. Bilateral trade is therefore measured as:

$$logX_{i,j,t} = \frac{log\,X_{i,t} + log\,X_{j,t}}{2}$$

While trade intensity is measured as:

$$TI = \frac{X_{i,t} + X_{j,t}}{GDP_i + GDP_j}$$

Where:

- $X_{i,t}$ denotes the average of FOB and CIF data regarding the nominal exports from country *i* to country *j*, during period *t*;
- $X_{j,t}$ denotes the average of FOB and CIF data regarding the nominal exports from country *j* to country *i*, during period *t*;
- GDP_i denotes the nominal GDP of the base country;
- GDP_j denotes the nominal GDP of the partner country.

After this, the variables are de-trended to exclude seasonal fluctuations of economic activity. Following the methodology of Frankel & Rose (1998), three de-trending techniques are employed: fourth differences, a quadratic time trend, and the Hodrick-Prescott filter. The measures of economic activity used are real GDP, two Industrial Production Indexes (one seasonally adjusted, the other unadjusted), Total Employment and the Unemployment Rate.

After de-trending the variables, the next step is the computation of bilateral correlations of economic activity. To do this, the dataset must be divided into time periods: 1990 to 1998, 1999 to 2007, and 2008 to 2015. With 29 countries in our dataset, the number of correlations will amount to 1218: 406 (29*28/2) for each of the three periods. With 5 measures of economic activity and 3 de-trending techniques being used, a total of $5 * 3 = 15$ correlations will be estimated.

The estimation of the effect of trade on business cycle synchronization is a two-step process, due to the endogeneity of trade. The first step is to predict trade flows using a GMT. This is done with the employment of two different models: the first is a GMT estimated by OLS with Country and Year dummies, the second is a GMT estimated by Fixed Effects.

The Gravity Model of Trade used is the following:

$$logX_{i,j,t} = \beta_0 + \beta_1 ln\,(Y_iY_j)_t + \beta_2 ln\,(Y_iY_j/Pop_iPop_j)_t + \beta_3 ln\,(Area_iArea_j) + \beta_4 ln\,(Dist_{i,j}) + \beta_5 Language_{i,j} + \beta_6 Border_{i,j} + \beta_7 EU_{i,j,t} + \beta_8 Euro_{i,j,t} + \beta_9 NAFTA_{i,j,t} + \beta_{10} EFTA_{i,j,t} + \beta_{11} LandLocked_{i,j} + \beta_{12} Island_{i,j} + \beta_{13} Colony_{i,j} + \varepsilon_{i,j,t}$$

Where:

- $logX_{i,j,t}$ denotes the average of the logarithm of two-way trade between *i* and *j*, at time *t*;
- Y_iY_j denotes the product of real GDP of *i* and *j*;
- Pop_iPop_j denotes the product of the population of *i* and *j*;
- $Area_iArea_j$ denotes the product of the landmass of *i* and *j*;
- $Dist_{i,j}$ denotes distance between the capitals of *i* and *j*;
- $Language_{i,j}$ is a dummy that denotes if *i* and *j* share a common language;
- $Border_{i,j}$ is a dummy that denotes if *i* and *j* share a land or sea border;
- $EU_{i,j,t}$ is a dummy denoting if both *i* and *j* are members of the European Union (or EEC), at time *t*;
- $Euro_{i,j,t}$ is a dummy denoting if both *i* and *j* are members of the Eurozone, at time *t*;
- $NAFTA_{i,j,t}$ is a dummy denoting if both *i* and *j* are members of NAFTA, at time *t*;
- $EFTA_{i,j,t}$ is a dummy denoting if both *i* and *j* are members of EFTA, at time *t*;
- $LandLocked_{i,j}$ denotes the number of landlocked countries in the dyad (0, 1 or 2);
- $Island_{i,j}$ denotes the number of island countries in the dyad (0, 1 or 2);
- $Colony_{i,j}$ is a dummy denoting if *i* ever colonized *j*, or vice-versa.
- $\varepsilon_{i,j,t}$ designates the error term.

In order to address the problems of inflation and multilateral resistance, Year and Country Dummies are used. It is possible to add them directly to the GMT, but, to avoid problems of multicollinearity, the dummies are first regressed on the residuals of a standard OLS estimation:

$$\varepsilon_{i,j,t} = \{\lambda_{i,j}\} + \{\psi_t\} + \alpha_{i,j,t}$$

Where:

- $\varepsilon_{i,j,t}$ is the predicted residual of the GMT estimation by standard OLS;

- $\{\lambda_{i,j}\}$ represents a set of country dummies for all 29 countries in the dataset (=1 if country in dyad, =0 otherwise);
- $\{\psi_t\}$ represents year dummies for all 26 years in the dataset;
- $\alpha_{i,j,t}$ designates the error term that is not explained by multilateral resistance and inflation.

After computing this auxiliary regression, the values for the dependent variable are predicted to create a new variable: *mr_yd*. The GMT is then estimated again using this variable, controling for the time-invariant multilateral resistance and common inflation effects that were previously part of the error term:

$$logX_{i,j,t} = \beta_0 + \beta_1 ln\,(Y_iY_j)_t + \beta_2 ln\,(Y_iY_j/Pop_iPop_j)_t + \beta_3 ln\,(Area_iArea_j) + \beta_4 \ln\,(Dist_{i,j}) + \beta_5 Language_{i,j} + \beta_6 Border_{i,j} + \beta_7 EU_{i,j,t} + \beta_8 Euro_{i,j,t} + \beta_9 NAFTA_{i,j,t} + \beta_{10} EFTA_{i,j,t} + \beta_{11} LandLocked_{i,j} + \beta_{12} Island_{i,j} + \beta_{13} Colony_{i,j} + \beta_{14} mr\_yd + a_{i,j,t}$$

Where:

- mr_yd represents controls for multilateral resistance and inflation;
- $a_{i,j,t}$ designates the error term that is not explained by multilateral resistance and inflation.

Two additional auxiliary regressions are also estimated, one with only year dummies and the other with just country dummies. The predicted values for their dependent variables are used to create *yd* and *mr*, which will control for common inflation and time-invariant multilateral resistance, respectively.

Although the preferred solution for the multilateral resistance problem is an LSDV with time-varying country dummies, as proposed by Baldwin & Taglioni (2007) and Head & Mayer (2014), such an approach is too taxing on computing resources for a master's thesis study. There would be a total of $Countries * Years = 29 * 26 = 754$ dummies. The less taxing alternative employed in this study is the adoption of time-invariant country dummies, together with year dummies. This approach controls for the time-invariant aspect of multilateral resistance, as well as the effects of common inflation on trade flows. However, it will not control for the time-variant aspect of multilateral resistance, and therefore the accuracy of its results is not comparable to studies that do.

Another shortcoming of this methodology is its small dataset. Rose (2017) warns that studies with a low number of observations, specially a low number of countries, tend to underestimate the trade generating effect of the EMU, due to omitted multilateral resistance effects. This means that β_8 will be downward biased, possibly affecting the results of the 2nd stage equation. It also means that an opportunity for studying other CU's and comparing them to the EMU is missed. As Glick & Rose (2016) point out, the trade generating effects of the EMU are different from other CU's, but since this dataset lacks the countries that belong to such CU's, no comparisons can be made.

The 1st stage of the 2SLS model uses a similar GMT:

$$\begin{aligned} TI_{i,j,t} = \beta_0 + \beta_1 ln\left(Y_iY_j/Pop_iPop_j\right)_t + \beta_2 ln\,(Area_iArea_j) + \beta_3 \ln\,(Dist_{i,j}) \\ + \beta_4 Language_{i,j} + \beta_5 Border_{i,j} + \beta_6 EU_{i,j,t} + \beta_7 Euro_{i,j,t} + \beta_8 NAFTA_{i,j,t} \\ + \beta_9 EFTA_{i,j,t} + \beta_{10} LandLocked_{i,j} + \beta_{11} Island_{i,j} + \beta_{12} Colony_{i,j} \\ + \beta_{13} mr\_yd + a_{i,j,t} \end{aligned}$$

Where the dependent variable is Trade Intensity, and $ln\,(Y_iY_j)_t$ is omitted, due to potential multicollinearity.

Once the 1st stage has been estimated via OLS and FE, its results are used to estimate the 2nd stage:

$$Corr(v,s)_{i,j,t} = \beta_0 + \beta_1 \widehat{TI}_{i,j,t} + \varepsilon_{i,j,t}$$

Where:

- $Corr(v,s)_{i,j,t}$ denotes the correlation of economic activity between countries *i* and *j* during period *t*, *v* refers to the measure of economic activity used; *s* refers to the de-trending method used;
- $\widehat{TI}_{i,j,t}$ denotes the weight of nominal bilateral trade on combined GDP between *i* and *j* at time *t*, predicted in the 1st stage;
- $\varepsilon_{i,j,t}$ designates the error term.

As we have 15 correlations of economic activity and 2 sets of predicted values for the log of bilateral trade (OLS and FE), the total number of regressions for the 2nd stage will be $15 * 2 = 30$.

6. Results

Predicting the Euro's effect on Trade by OLS

To get a sense of the scale of the problem of multicollinearity, a direct estimation of the gravity equation with all the country and year dummies is performed. The highest Variance Inflation Factor (VIF) detected was 1680! This means that, due to collinearity, the variance of the coefficient in question was 1680 times larger than what it would be, if there was no correlation with other explanatory variables. In all subsequent regressions, where country and year dummies are employed indirectly through auxiliary regressions, the VIF's are much smaller, with the highest being in the order of 2.

Table 3 presents the results for the OLS estimation. The OLS_N_D model excludes country and year dummies. OLS_YD includes variable *yd*, which corresponds to the predicted values of the dependent variable of all year dummies regressed in the residuals of the OLS_N_D model. OLS_MR includes variable *mr*, which is the same as *yd*, but, country dummies are used instead of year dummies. OLS_MR_YD includes both *yd* and *mr*. OLS_MRYD includes the variable *mryd*, which corresponds to the predicted values of the dependent variable of all year and country dummies regressed on the residuals of the OLS_N_D model. OLS_resid uses the residuals of OLS as its dependent variable.

Table 3: Euro's effect on trade, predicted by OLS

VARIABLES	(1) OLS_N_D Log of Average Bilateral Trade	(2) OLS_YD Log of Average Bilateral Trade	(3) OLS_MR Log of Average Bilateral Trade	(4) OLS_MR_YD Log of Average Bilateral Trade	(5) OLS_MRYD Log of Average Bilateral Trade
lyy	1.3431***	1.3441***	1.1750***	1.1766***	1.1654***
	(0.0112)	(0.0106)	(0.0082)	(0.0076)	(0.0075)
lyypp	-0.7679***	-0.7643***	-0.7555***	-0.7523***	-0.7518***
	(0.0063)	(0.0062)	(0.0040)	(0.0039)	(0.0039)
laa	-0.0162***	-0.0176***	0.0034	0.0020	0.0012
	(0.0051)	(0.0051)	(0.0034)	(0.0033)	(0.0033)
ldist	-0.8910***	-0.9073***	-0.8448***	-0.8599***	-0.8613***
	(0.0123)	(0.0122)	(0.0084)	(0.0083)	(0.0083)
border	0.6360***	0.6329***	0.5053***	0.5030***	0.5049***
	(0.0292)	(0.0285)	(0.0252)	(0.0244)	(0.0241)
language	1.0298***	1.0134***	0.5025***	0.4897***	0.4939***
	(0.0237)	(0.0235)	(0.0208)	(0.0207)	(0.0206)
eu	0.4067***	0.3276***	0.7006***	0.6268***	0.6150***
	(0.0221)	(0.0220)	(0.0151)	(0.0147)	(0.0146)
euro	0.3003***	0.3212***	0.1718***	0.1916***	0.1871***
	(0.0209)	(0.0212)	(0.0148)	(0.0141)	(0.0140)
nafta	0.6155***	0.6276***	1.1190***	1.1280***	1.1295***
	(0.0528)	(0.0543)	(0.0697)	(0.0704)	(0.0705)
efta	1.0549***	0.9624***	-0.0829**	-0.1631***	-0.1434***
	(0.0343)	(0.0340)	(0.0342)	(0.0315)	(0.0319)
landl	-0.4875***	-0.4945***	-0.3535***	-0.3604***	-0.3708***
	(0.0175)	(0.0171)	(0.0124)	(0.0118)	(0.0117)
island	0.3633***	0.3669***	0.4056***	0.4088***	0.4108***
	(0.0168)	(0.0166)	(0.0114)	(0.0112)	(0.0112)
colony	0.0687**	0.0720**	0.5176***	0.5188***	0.5164***
	(0.0335)	(0.0334)	(0.0389)	(0.0393)	(0.0391)
yd		1.0209***		0.9363***	
		(0.0400)		(0.0261)	
mr			1.1023***	1.0978***	
			(0.0068)	(0.0066)	
mr_yd					1.0993***
					(0.0064)
Observations	20,552	20,552	20,552	20,552	20,552
Adjusted R-squared	0.7206	0.7294	0.8841	0.8915	0.8925

Robust standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Source: Own computations.

All these models are estimated with robust standard errors, due to them being heteroskedastic. This was discovered through the application of White and Breusch-Pagan tests. Like multicollinearity, heteroskedasticity does not compromise the unbiasedness of estimators, but affects their variance, invalidating significance tests. Global significance tests applied to robust errors confirm that the models are all globally significant, and Ramsey's RESET tests indicate no important explanatory variables are missing, at a 1% confidence level.

Table 4: R^2 of Auxiliary Regressions

	Just Year Dummies (*yd*)	Just Country Dummies (*mr*)	Year and Country Dummies (*mr_yd*)
	OLS_N_D Residuals	OLS_N_D Residuals	OLS_N_D Residuals
ALL Year Dummies	Yes	No	Yes
ALL Country Dummies	No	Yes	Yes
R-squared	0.0309	0.5309	0.5597

Source: Own computations.

Looking at table 4, the magnitude of the problem of omitting multilateral resistance effects is clear. When the country dummies are regressed on the residuals of OLS_N_D, the R^2 is very high: 0.53. Virtually half of the perturbation term is tied to multilateral resistance.

In contrast, the effects of world inflation, or of other common shocks to all countries, have a much smaller significance. When including *yd* in OLS_YD, the adjusted R^2 increases, but very little: from 0.72 to ~0.73. Unexpectedly, the point estimate for *euro* increases as well: from 0.3 to 0.32. It is reasonable to think that controlling for the common rises in price levels would return a lower point estimate, but Baldwin & Taglioni's (2007, p. 804) results behave in a similar manner.

When including controls for time-invariant multilateral resistance (*mr*) in OLS_MR the point estimate of euro decreases significantly: from 0.3 to 0.17. This is accompanied by a considerable increase in the adjusted R^2, from 0.72 to 0.88. Such a decrease in *euro* is in accordance with the literature: Rose (2000) predicted a currency union trade effect of ~235%, but that effect diminishes to ~50% when Glick & Rose (2002) estimate a GMT by fixed effects.

OLS_MR_YD and OLS_MRYD control for both time-invariant multilateral resistance and year effects. OLS_MR_YD does this by including both *yd* and *mr*, while OLS_MRYD includes *mryd* (which is the product of regressing all year and country dummies on the residuals of OLS_N_D, consult table 4 for reference). When compared with OLS_MR, which does not control for year effects, the adjusted R^2 increases again, but very little: from 0.88 to 0.89. The point estimate for *euro* also increases slightly, from 0.17 to ~0.19, following the behaviour of OLS_YD. It is clear that, out of multilateral resistance and common inflation (year) effects, it is the first that most significantly impacts the point estimate of *euro*.

Of all models, OLS_MRYD appears to be the most appropriate. It controls for time-invariant multilateral resistance (Gold Medal Mistake), inflation (Bronze Medal Mistake), and has the highest adjusted R^2.

The behaviour of the control variables is, with few exceptions, within expectations. According to the gravity theory of trade, the economic "mass" of a country has a positive effect on trade flowing towards that country, while distance to partner countries has a negative effect. This behaviour is reflected on *lyy* and *ldist*, which refer to the product of the pair countries' GDP and the distance between their capitals, respectively. The negative sign on *lxxpp* (product of per capita GDP) and *laa* (product of land area) is unexpected, but it should be stressed that these variables are added as "nuisance" controls. Perfectly estimating their impact on trade is not the intention, but rather use them to attain a more accurate estimate of *euro*.

The economically and statistically significant estimates of *border*, *language*, *landl*, *island* and *colony* are to be expected. Two countries that share a border will find it easier to trade with one another. The same is true if they both have the same official language. On the other hand, landlocked countries' trade ties with the rest of the world will not be as strong as the ones of those countries that have access to the sea. Island countries will trade more, due to a better access to the world's oceans. Although oil-tankers and super-cargo ships are expensive vehicles when compared to trucks and trains, they do not require (outside of ports) extensive infrastructure to operate on. The sea in which they roam is essentially free, while roads and railways are not. Better access to the sea means better access to the world's markets. Historical ties between colonized countries and colonizers also have a positive effect on trade, due to preferential treatment in trade deals. Note that the point estimate for this variable increases significantly when multilateral resistance is taken into account, from ~0.07 in OLS_N_D and OLS_YD, to 0.52 in all subsequent models.

Multilateral resistance has a significant impact on the point estimates of *eu*, *nafta* and *efta*. The point estimate for *eu* increases from ~0.4 to ~0.7 (or ~0.6 when inflation is taken into account). This increase is even more significant for *nafta*, going up from ~0.6 to ~1.12, almost the double of the OLS_N_D estimate. However, the most radical result is *efta*: it goes from ~1 to ~-0.08 (or ~-0.15 when inflation is considered). This once again stresses the importance of controlling for multilateral resistance: it not only affects the size of coefficients, it affects different estimators differently. It can increase the size of some, while decreasing others, sometimes enough to result in a sign swap.

The highest point estimate for *euro* when controlling for multilateral resistance is lower than 0.2, and it only accounts for the time-invariant part of this effect. If controls for time-varying multilateral resistance were included (like time-varying country dummies), the point estimate could be even lower, or higher. This means that the economic significance of these results is not 100% clear.

If *euro* has any effect on average bilateral trade, it is expected that the actual values for it will increase sharply at the time of entry in the Eurozone. This can be tested with a Chow test, which detects structural breaks in time-series data. To perform this test, two auxiliary OLS_MRYD models are computed: one where *euro* is 0, the other where it assumes the value 1. Their Residual Sum of Squares (RSS) is then used to compute the F statistic for the test.

$$H_0\text{: } no\ structural\ break\ exists \mid H_1\text{: } H_0\ is\ false$$

$$F_{observed} = \frac{\frac{RSS_T - (RSS_0 + RSS_1)}{k}}{\frac{RSS_0 + RSS_1}{n - 2k}} = \frac{\frac{9160.67 - (8740.79 + 279.04)}{14}}{\frac{(8740.79 + 279.04)}{20552 - 2 * 14}} = 22.89$$

$$f_{crítical\ (k;\, n-k)} = f_{\alpha=5\%/2(14;\, 20657)} = \pm 2.1$$

As $F_{observed} > f_{crítical}$, the null hypothesis is rejected for a confidence interval of 5%. Therefore, the hypothesis that a structural break does not exist when countries join the Eurozone is rejected. Even if these results are not the most accurate, we can at least rest assured that the effect *euro* has on trade intensity is not insignificant.

Predicting the Euro's effect on Trade by FE

The results for the fixed effects estimation are presented on table 5. Model FE has no common inflation or multilateral resistance controls. FE_YD has controls for inflation (*yd*). FE_MRYD uses variable *mryd*, which controls for both inflation and multilateral resistance.

Table 5: 1st Stage Fixed Effects

VARIABLES	(1) FE Log of Average Bilateral Trade	(2) FE_YD Log of Average Bilateral Trade	(3) FE_MRYD Log of Average Bilateral Trade
lyy	2.8427***	2.4597***	2.3284***
	(0.0316)	(0.0305)	(0.0307)
lyypp	-2.5487***	-2.1409***	-2.0130***
	(0.0330)	(0.0319)	(0.0321)
ldist	-0.0506	-0.0581	-0.0585
	(0.0717)	(0.0672)	(0.0666)
seaborder	0.2036**	0.2353**	0.2202**
	(0.1018)	(0.0953)	(0.0944)
eu	0.9843***	0.8514***	0.8269***
	(0.0118)	(0.0113)	(0.0113)
euro	0.1075***	0.1424***	0.1362***
	(0.0146)	(0.0137)	(0.0136)
nafta	0.1293	0.3730***	0.3849***
	(0.1053)	(0.0987)	(0.0978)
efta	0.2031***	0.0617	0.0691*
	(0.0426)	(0.0400)	(0.0396)
yd		0.7407***	
		(0.0140)	
mr_yd			0.8325***
			(0.0148)
Observations	20,552	20,552	20,552
Number of Country Pairs	812	812	812
Adjusted R-squared	0.7035	0.7402	0.7447

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Source: Own computations.

Two models are omitted from table 5, one that includes *mr*, and another that includes *mr* and *yd*. Due to the fixed effects transformation, the time-invariant *mr* is eliminated, and the results of these models are the same as FE and FE_YD, respectively. Nevertheless, they are estimated to test the behaviour of *mr*, which was eliminated by STATA as expected.

When compared to OLS_N_D, the FE model has a similar adjusted R^2 of ~0.7, but the *euro* estimate drops from 0.3 to 0.1. This can be explained by the fact that the fixed effects transformation controls for time invariant multilateral resistance. Despite this, the adjusted R^2 of FE is lower than that of OLS_MR (0.88). When controls for common inflation are included in FE_YD, the point estimate of *euro* increases to 0.14, and the adjusted R^2 to 0.74. Overall, the FE models show a lower adjusted R^2 and smaller point estimates for *euro* than the OLS models, but the magnitude of these values is still comparable. The point estimate for the most appropriate OLS model (OLS_MRYD) was 0.19.

The FE_MRYD model, instead of using the *yd* variable to control for common inflation, as in FE_MRYD, it uses *mryd*. This variable is the result of a regression of all year and country dummies on the residuals of OLS_N_D (consult table 4 for reference), so it controls for both inflation and time-invariant multilateral resistance. But, seeing as the fixed effects transformation already controls this last effect, it might be pointless to use this variable instead of *yd*.

Note that variable *ldist* (representing the logarithm of the distance between the capitals of both countries in the dyad) is not eliminated in the fixed effects transformation. Since distance does not change over time, it would be expected for this variable to be eliminated from the table of results by STATA, as were *laa*, *language*, *landl*, *island* and *colony*. This is probably due to an error in the dataset. But, as can be seen, the coefficient for *ldist* is very small and statistically insignificant, so its effect on the quality of the estimations is limited.

Another aspect to note is the variable *seaborder*. Instead of using the variable *border*, as was done in the OLS estimations, the variables *landborder* and *seaborder* are used instead (*border* is simply the sum of these two). Due to being time invariant, *landborder* is omitted during the calculations, but *seaborder* remains. This variable represents countries which, although not connected by land, are nevertheless connected by bridges (Denmark and Sweden) or undersea tunnels (United Kingdom and France). As most of these infrastructure projects have only opened to the public after 1990, this variable is time-variant and is retained by STATA. Its coefficient is relatively small and statistically insignificant, however.

Sensitivity Analysis

In tables 6 and 7 are presented the results of regressions that test the inclusion of *eea* (dummy for membership in European Single Market), in both OLS_MRYD and FE_YD, respectively. The aim is to see how sensitive *euro* is to these iterations.

Table 6: Ordinary Least Squares with variables EU and EEA

VARIABLES	(1) OLS_MRYD Log of Average Bilateral Trade	(2) OLS_eea Log of Average Bilateral Trade	(3) OLS_eu_eea Log of Average Bilateral Trade	(4) OLS_no_eu Log of Average Bilateral Trade
euro	0.1871***	0.2453***	0.1195***	0.5077***
	(0.0140)	(0.0134)	(0.0139)	(0.0135)
eu	0.6150***		0.4438***	
	(0.0146)		(0.0153)	
eea		0.5552***	0.3319***	
		(0.0148)	(0.0154)	
mr_yd	1.0993***	1.0460***	1.0739***	1.0789***
	(0.0064)	(0.0065)	(0.0065)	(0.0067)
Observations	20,552	20,552	20,552	20,552
Adjusted R-squared	0.8925	0.8909	0.8946	0.8831

Robust standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Regressors included but not reported: lyy, lyypp, laa, ldist, border, language, nafta, efta, landl, island, colony. Source: Own computations.

Table 7: 1st Stage Fixed Effects EU and EEA

VARIABLES	(1) FE_YD Log of Average Bilateral Trade	(2) FE_eea Log of Average Bilateral Trade	(3) FE_eu_eea Log of Average Bilateral Trade	(4) FE_no_eu Log of Average Bilateral Trade
euro	0.1424***	0.0683***	0.0540***	0.3453***
	(0.0137)	(0.0143)	(0.0137)	(0.0153)
eu	0.8514***		0.5927***	
	(0.0113)		(0.0139)	
eea		0.6601***	0.3576***	
		(0.0097)	(0.0117)	
Observations	20,552	20,552	20,552	20,552
Number of Country Pairs	812	812	812	812
Adjusted R-squared	0.7402	0.7291	0.7519	0.6656

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Regressors included but not reported: lyy, lyypp, ldist, seaborder, nafta, efta. Source: Own computations.

But why use *eea*? Doesn't *eu* already fulfil the purpose of representing the European economic block? In this dataset, *eu* is a dummy denoting if both countries in the dyad are members of the European Union (or its predecessor organization, the EEC), at time *t*. As some countries are members of this organization since well before 1990 (the starting year of the dataset), and no countries have left it as of 2015 (the final year of the dataset), the actual value for some dyads will always be 1. Because a fixed effects transformation is applied in FE models, the actual values for these dyads will be 0. The variable *eu* will, therefore, only return results different than 0 after a fixed effects transformation for dyads where at least one of the countries joined the EEC/EU after 1990.

Although the EEC exists since the late 1950's, the European Single Market only came into being in 1993. In 1994, the creation of the European Economic Area extended the privileges of the single market to European Free Trade Association (EFTA) countries. When we consider the relatively short time span of this dataset, any of these two variables will be better than *eu* at capturing the trade generating effect of EU membership, and its benefits (Single Market, Shengen Area, etc...).

It is important to capture this effect, because, as can be seen in table 7, the coefficient for *euro* diminishes by half when *eu* is swapped with *eea*, from 0.14 to ~0.07. The adjusted R^2 remained almost identical: decreasing from 0.74 to ~0.73. When both *eu* and *eea* are used in the regression, it increases to 0.75, with the point estimate of euro decreasing even further to ~0.05. However, keeping these two variables might simply be overcontrolling the model, as they are not that different from one another during the dataset's timespan.

The OLS models yield different results (table 6). Like in the FE models, the adjusted R^2 decreases slightly when swapping *eu* for *eea*, and increases (slightly) when keeping both. But in the first instance, the point estimate of euro increases to ~0.25, while diminishing to almost half of its original value in the second instance (similar to FE models). This means that in simple OLS regressions, using data for EEA membership instead of EU will return higher point estimates of the Eurozone effect on trade. However, as the increase in the adjusted R^2 is minimal, keeping both might be overcontrolling the model, just as in the FE estimations. It must be noted though, that no multicollinearity problem exists (the VIF for *eu* is 1.42 and for *eea* 2.83) with this approach.

To sum up, the point estimate for *euro* in both OLS and FE models is not that different: ~0.19 and ~0.14, respectively. But adding/removing *eea* significantly affects the magnitude of the coefficient. Simply using *eu* as a control variable for the European economic block affects the results of our FE estimation, due to our dataset ranging from only 1990 to 2015. But using *eea* in its place reduces the adjusted R^2, and increases the *euro* coefficient in the OLS, while reducing it in the FE estimation. However, some control must be kept, as outright removing both *eu* and *eea* results in a much higher point estimate for *euro* in both OLS_no_eu and FE_no_eu. It also reduces the adjusted R^2.

Comparison of Results with Gravity Literature

Compared with the results of studies and collaborations by Andrew K. Rose, the results of this study underestimate the Eurozone's effect on trade. Glick & Rose (2002, p. 1131), through a simple OLS, predict a currency union effect of 1.3, with ~200 000 observations and an R^2 of 0.64. This model does not control for multilateral resistance, so it is no wonder that the estimate is as large. The closest comparable model in this study, OLS_N_D (table 3) returns a much lower point estimate of 0.3, but it has to be noted that the variable used (dummy for euro) is not the same as the one used by Glick & Rose (dummy for currency union). This is important, because in a reassessment of their original study, Glick & Rose (2016, p. 81) disaggregate the results for each currency union in their dataset (that includes virtually all countries in the world) and find that the euro effect is substantially different than the effect of most other currency unions. In their subsequent 2016 estimation, Glick & Rose obtain a point estimate of 0.02 for the euro's effect on trade, much smaller than their previous estimate for the effect of currency unions

(1.12). It is even smaller than the point estimate of this study (0.3). This 2016 model has ~400 000 observations and an R^2 of 0.67, but, like the 2002 one, it has no controls for multilateral resistance.

Besides estimating the currency union effect by OLS, Glick & Rose (2002, p. 1133) also employ fixed effects. This approach controls the time-invariant multilateral resistance, and yields a point estimate of 0.65, roughly half of the OLS estimate. The model has ~200 000 observations and an R^2 of 0.12. In their 2016 reassessment (p. 82), the point estimate for euro is 0.41, while for other CU's is 0.75. The number of observations is ~400 000 and the R^2 is 0.2. The closest model in this study, FE_YD (table 5), returns a much lower point estimate of 0.14.

The Least Squares with time-varying Country Dummies, also known as LSDV model, is also employed by Glick & Rose (2016, p. 85). This is the best method for estimating a GMT, as it controls for both time-invariant and time-varying multilateral resistance, as well as inflation effects. It returns a point estimate for the euro effect on trade of 0.43, and 0.3 for other CU's. It has ~30 000 observations and an R^2 of 0.86. Baldwin & Taglioni (2007, p. 813) employ the LSDV as well, obtaining a point estimate of 0.34, with ~5000 observations and an R^2 of 0.91. The authors (2007, p. 808) also estimate an OLS regression with only country and year dummies, which returns a point estimate of 0.21, meaning that adding controls for the time-varying part of multilateral resistance increases the magnitude of the euro effect estimator.

There are no models in this study comparable to the LSDV. The most appropriate, OLS_MRYD (table 3), returns a point estimate of ~0.19, but it does not control for time-varying multilateral resistance. Its result, however, is very close to the estimate of Baldwin & Taglioni (2007, p. 808) of 0.21 (that also does not control for the full effect of multilateral resistance).

In a metanalysis of the literature, Rose (2017) plots the euro effect estimates of 45 studies and finds that most are within a threshold of 0.0 and 0.25, with very few exceptions. The average estimate is ~0.1. In this context, the results of this study are not outliers, although Rose criticizes most studies for the small size of their datasets (a crime of which this study is also guilty). He argues that, the smaller (or more incomplete) the dataset is, the smaller the point estimate will be, as critical information regarding multilateral resistance is not provided (refer to section 3 for an in-depth look at the small datasets problem). Therefore, applying the methodology of this study on a larger dataset would, according to Rose, yield a higher estimate of the euro effect on trade. And, judging from the results of Baldwin & Taglioni (2007), controlling for time-varying multilateral resistance with an LSDV would also increase the estimate.

The 2SLS Model

Table 8 presents the results of the 1st stage GMT. The results for the 2nd stage are presented in tables 9 through 14, using the predicted values for trade intensity estimated in OLS_ti and FE_ti. These models are identical to OLS_MRYD and FE_YD, respectively, which were used before to estimate the Euro's effect on trade. The only differences are the dependent variable (average bilateral trade swapped by trade intensity) and the omission of *lyy* (due to potential multicollinearity).

Table 8: First Stage Gravity Model of Trade

VARIABLES	(1) OLS_ti Trade Intensity	(2) FE_ti Trade Intensity	(3) OLS_resid OLS_ti Residuals
lyypp	-0.0002***	0.0003***	-0.0000
	(0.0000)	(0.0000)	(0.0000)
laa	-0.0001***		0.0000
	(0.0000)		(0.0000)
ldist	-0.0017***	-0.0001	-0.0000
	(0.0000)	(0.0004)	(0.0000)
border	0.0145***		-0.0000
	(0.0004)		(0.0004)
seaborder		0.0027***	
		(0.0005)	
language	0.0012***		0.0000
	(0.0003)		(0.0003)
eu	0.0023***	0.0013***	-0.0000
	(0.0001)	(0.0001)	(0.0001)
euro	0.0020***	0.0017***	-0.0000
	(0.0002)	(0.0001)	(0.0002)
nafta	0.0080***	0.0077***	0.0000
	(0.0004)	(0.0005)	(0.0004)
efta	-0.0036***	0.0001	-0.0000
	(0.0003)	(0.0002)	(0.0003)
landl	-0.0012***		-0.0000
	(0.0001)		(0.0001)
island	0.0010***		-0.0000
	(0.0001)		(0.0001)
colony	0.0014***		-0.0000
	(0.0002)		(0.0002)
yd		0.0012***	
		(0.0001)	
mr_yd	0.0019***		0.0000
	(0.0001)		(0.0001)
Observations	20,552	20,552	20,552
Adjusted R-squared	0.5888	0.1955	-0.0006
Number of c_pair_num		812	

Robust standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Source: Own computations.

The quality of these explanatory variables as instruments for trade intensity appears sound. Although the coefficients are small, they all appear minimally correlated with the dependent variable. The adjusted R^2 is also quite high: 0.58 (OLS_ti). When predicated on the residuals (OLS_resid), they return very small and statistically insignificant coefficients. Therefore, these explanatory variables seem to comply with the good instruments criteria.

Table 9: Economic Activity, detrended by First Differencing, regressed on Trade Intensity, estimated by OLS

VARIABLES	(1) 1d_ols_gdp Corr_GDP	(2) 1d_ols_ipi Corr_IPI	(3) 1d_ols_ipisa Corr_IPIsa	(4) 1d_ols_emp Corr_Emp	(5) 1d_ols_unemp Corr_Unemp
Trade Intensity	7.1040***	15.7963***	14.1073***	19.6480***	15.8102***
	(0.5318)	(0.4769)	(0.5038)	(0.5710)	(0.4620)
Observations	19,858	18,752	15,398	13,438	19,858
R-squared	0.0089	0.0553	0.0485	0.0810	0.0557

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, laa, ldist, border, language, eu, euro, nafta, efta, landl, island, colony, mr_yd. Source: Own computations.

Table 10: Economic Activity, detrended by Quadratic Filter, regressed on Trade Intensity, estimated by OLS

VARIABLES	(1) 4d_ols_gdp Corr_GDP	(2) 4d_ols_ipi Corr_IPI	(3) 4d_ols_ipisa Corr_IPIsa	(4) 4d_ols_emp Corr_Emp	(5) 4d_ols_unemp Corr_Unemp
Trade Intensity	26.8925***	16.4520***	17.0310***	16.1733***	6.4026***
	(0.8866)	(0.7276)	(0.7705)	(0.7830)	(0.5914)
Observations	20,670	19,520	16,248	13,990	20,670
R-squared	0.0426	0.0255	0.0292	0.0296	0.0056

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, laa, ldist, border, language, eu, euro, nafta, efta, landl, island, colony, mr_yd. Source: Own computations.

Table 11: Economic Activity, detrended by Hodrick Prescott Filter, regressed on Trade Intensity, estimated by OLS

VARIABLES	(1) hp_ols_gdp Corr_GDP	(2) hp_ols_ipi Corr_IPI	(3) hp_ols_ipisa Corr_IPIsa	(4) hp_ols_emp Corr_Emp	(5) hp_ols_unemp Corr_Unemp
Trade Intensity	10.3963***	15.9903***	14.3297***	17.7415***	13.7633***
	(0.4734)	(0.4402)	(0.4531)	(0.5298)	(0.4491)
Observations	20,670	20,182	17,590	13,990	20,670
R-squared	0.0228	0.0614	0.0538	0.0742	0.0435

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, laa, ldist, border, language, eu, euro, nafta, efta, landl, island, colony, mr_yd. Source: Own computations.

Table 12: Economic Activity, detrended by First Differencing, regressed on Trade Intensity, estimated by FE

VARIABLES	(1) 1d_fe_gdp Corr_GDP	(2) 1d_fe_ipi Corr_IPI	(3) 1d_fe_ipisa Corr_IPIsa	(4) 1d_fe_emp Corr_Emp	(5) 1d_fe_unemp Corr_Unemp
Trade Intensity	20.5813***	55.0955***	32.1504***	61.1426***	52.6858***
	(1.6214)	(1.4425)	(1.5885)	(1.8469)	(1.4000)
Observations	19,858	18,752	15,398	13,438	19,858
R-squared	0.0080	0.0722	0.0259	0.0754	0.0666

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, ldist, seaborder, eu, euro, nafta, efta, yd. Source: Own computations.

Table 13: Economic Activity, detrended by Quadratic Filter, regressed on Trade Intensity, estimated by FE

VARIABLES	(1) 4d_fe_gdp Corr_GDP	(2) 4d_fe_ipi Corr_IPI	(3) 4d_fe_ipisa Corr_IPIsa	(4) 4d_fe_emp Corr_Emp	(5) 4d_fe_unemp Corr_Unemp
Trade Intensity	97.3952***	12.3466***	13.9504***	71.3227***	17.7405***
	(2.6860)	(2.2484)	(2.4483)	(2.5166)	(1.8089)
Observations	20,670	19,520	16,248	13,990	20,670
R-squared	0.0598	0.0015	0.0020	0.0543	0.0046

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, ldist, seaborder, eu, euro, nafta, efta, yd. Source: Own computations.

Table 14: Economic Activity, detrended by Hodrick Prescott Filter, regressed on Trade Intensity, estimated by FE

VARIABLES	(1) hp_fe_gdp Corr_GDP	(2) hp_fe_ipi Corr_IPI	(3) hp_fe_ipisa Corr_IPIsa	(4) hp_fe_emp Corr_Emp	(5) hp_fe_unemp Corr_Unemp
Trade Intensity	44.2467***	65.2518***	49.5619***	67.4686***	57.5029***
	(1.4313)	(1.3115)	(1.4191)	(1.6995)	(1.3456)
Observations	20,670	20,182	17,590	13,990	20,670
R-squared	0.0442	0.1093	0.0649	0.1013	0.0812

Standard errors in parentheses: ***, 1%; **, 5%; *, 10%. Instrumental Variables for Trade Intensity are: lyypp, ldist, seaborder, eu, euro, nafta, efta, yd. Source: Own computations.

It must again be noted that the goal here is not to determine exactly how much do business cycles get correlated every time trade intensity goes up 1%. The 2nd stage equation does not allow for that, as trade intensity is its only explanatory variable. The low R^2 across all 30 regressions is expected, with the highest being ~0.11 (table 14). The goal is merely to find out the sign of the relationship between the dependent variable (real GDP correlation, Industrial Production Index correlation, Employment correlation and Unemployment correlation) and trade intensity (average bilateral trade).

All 30 regressions return a positive point estimate for trade intensity, statistically significant at the 1% level. The size of these coefficients is also significant, with the lowest being 6.1 (table 10), and the highest 97.3 (table 13). Coefficients are larger for the equations whose 1st stage was estimated by FE, with most being above 20. The highest coefficient for equations using OLS estimations of the 1st stage is 26.9 (table 10). It has to be noted that the explanatory power of the FE estimation of the 1st stage is much lower than the OLS's. While the adjusted R^2 for the OLS estimation is ~0.59, for the FE estimation it is only ~0.2. Maybe this has some effect on the magnitude of the coefficients.

These results suggest that the relationship between business cycle synchronization and trade intensity is positive, supporting the view of Frankel & Rose (1998). Therefore, intra-industrial trade is more prevalent than inter-industrial trade within currency union members, mitigating specialization and the occurrence of asymmetric demand shocks. Consequently, the need for independent monetary policy is not as great, and countries are better off joining the Eurozone and benefitting from its positive economic effects. However, as the R^2 of these 30 regressions clearly shows, trade intensity is far from being the sole explanation for the behaviour of business cycle synchronization. Perhaps trade integration is a necessary, but not sufficient condition for CU membership.

7. Conclusion

In this study, we reviewed the literature regarding the theory of Optimum Currency Areas, and the endogeneity of its criteria. Drawing from a modest dataset with 29 countries, from 1990 to 2015, a Gravity Model of Trade was used to predict the effect the Euro has had on trade. A 2SLS model, predicting the effect of trade intensity on business cycle comovement, was also estimated. Its results were compared with the work of Frankel & Rose (1998).

The best OLS model estimating the Euro's effect on trade, OLS_MRYD, yields a point estimate of 0.19. Economically, this translates to $e^{0.19} - 1 \sim 21\%$, *i.e.* Eurozone countries trade, on average, 21% more than non-members, *ceteris paribus*. The best FE model, FE_YD, yields a lower but comparable point estimate of 0.14, which translates to an economic effect of $e^{0.14} - 1 \sim 15\%$. The adjusted R^2 is higher for OLS_MRYD. These results are lower than the 0.43 of Glick & Rose (2016, p. 85), but are in line with most other studies, whose predictions fall within the 0.0 and 0.25 range (Rose, 2017).

Rose criticizes these studies for their small datasets, which affect the way multilateral resistance is calculated. The author (2016, p. 3) explains that "As multilateral trade resistance is a function of all bilateral trade barriers, all trade partners should be included for the most accurate estimates". The author claims that this is the reason most studies yield a lower point estimate. With a dataset composed of only 29 countries, this study does not escape his criticism.

Another limitation of this study is that time-varying multilateral resistance is not accounted for. Instead of applying an LSDV model with time-varying country dummies, as recommended by Baldwin & Taglioni (2007) and Head & Mayer (2014), time-invariant country dummies are used instead, together with time dummies. This is a form of saving computing power for a limited project such as this one. There would be almost a thousand variables for every model if an LSDV was employed. However, not controlling for time-varying multilateral resistance seriously affects the accuracy of the results. When Baldwin & Taglioni (2007, p. 808 - 813) account for it, their point estimate rises from 0.21 to 0.34. Since this study's dataset starts in 1990 and ends in 2015, it is absolutely certain the Euro has affected multilateral resistance among Eurozone member countries, diminishing it in comparison to non-members. Not accounting for this variation probably means that the results of this study underestimate the Euro's effect on trade.

The point estimate for Euro is found to be sensitive to the specification of the European economic bloc. This study uses a dummy for membership in the EU (or its predecessor organization, the EEC) in most regressions. However, when swapping this dummy with a dummy for membership in the European Single

Market, or European Economic Area (*eea*), the point estimate for Euro rises in the OLS estimation (table 6) and diminishes in the FE estimation (table 7).

Overall, the results of this study indicate that the two assumptions of Frankel & Rose's endogeneity hypothesis hold. The 1st assumption (CU leads to more trade) is supported by the results of the GMT estimation (Eurozone members trade 21% more on average amongst themselves than non-members). Although these results are not the most accurate, it is more likely that they underestimate rather than overestimate the Euro's effect on trade. The 2nd assumption (more trade leads to more highly correlated business cycles) is supported by the results of the 2SLS estimations (positive sign for trade intensity coefficient in all regressions). However, the R^2 of these regressions is very low with the highest being $\tilde{}0.11$. This means that trade intensity is far from being the most important factor in business cycle synchronization.

In the opinion of the student, both assumptions of the endogeneity hypothesis holding true is a necessary, but not sufficient condition, to prove that a country will attain the economic requirements for Eurozone membership *ex-post* rather than *ex-ante*. There are other factors, that the regressions of this study do not account for, that play a role in business cycle synchronization and must be considered when addressing this question.

If this study were to be revised, it would be possible to improve the accuracy of the 1st stage estimation by using a dyadic dataset encompassing all 200+ countries in the world, as well as an LSDV with time-varying country dummies. This would correct all biases related to multilateral resistance, but the computational power needed to perform these estimations would be orders of magnitude higher. There would be $201 * 200 * 26\ \tilde{}1$ million observations, compared to the current $\tilde{}21$ thousand. There would also be $201 * 26\ \tilde{}5$ thousand time-varying country dummies, compared to the current 29 time-invariant country dummies and 26 time dummies. As to the 2nd stage, it would be interesting to study inflation and balance of payments comovement, as their behaviour is highly dependent on monetary value fluctuations and monetary policy in general.

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