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The Euro Effect on Trade in the EMU Core and Periphery: a Pre and Post-Crisis Analysis

By

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A Thesis Submitted to the Honors Council

For Honors in Economics

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Abstract

As the world financial crisis hit Europe in 2008, the financial shock had asymmetric effects across the eurozone; by 2010, its effects led to a sovereign debt crisis in the euro area. The shock created a clear distinction between strong, core economies in the European Monetary Union (EMU), and a struggling indebted periphery that fared worse in the period of crisis. The sovereign debt crisis revealed inherent fragility in the EMU. In light of recent populist movements, the common currency is under unprecedented scrutiny. This study seeks to assess the euro effect on exports for a clearly distinguished EMU core and periphery. Using an econometric analysis, this paper will also determine if the euro effect has changed, with respect to three time periods: pre-crisis, crisis, and post-crisis. Through this, the euro effect on trade can be better understood, as its benefits (in terms of trade increase) will be identified for various groups that may weigh the costs of currency union differently in post-crisis Europe. The results find the euro effect on total exports is about a 9.5-10.9% increase. However, it is found that most of the the euro effect on exports is seen by the core. The euro effect on trade is negatively impacted by the sovereign debt crisis for all EMU groups, but the core was the only group to have a euro effect that remained positive during that period.

I. Introduction

i. The Euro: Creation, Crisis, & Concern

The euro came into existence on January 1, 1999, just seven years after the establishment of convergence criteria set forth by the Maastricht Treaty in 1992. The new European Monetary Union[1] included initially 6 countries, and has since expanded to a union of 19 of the 28 current member countries of the European Union[2]. Once an EU country meets the Maastricht convergence criteria, it is to further integrate by adopting the common currency[3]. A currency union comes with economic benefits: namely, easier trade. Through reduced transaction costs, a single currency may increase trade between member countries. There are costs of joining the euro, however, with perhaps the greatest being the loss of independent monetary policy. The official financial authority of the EMU is the European Central Bank[4], whose function is to safeguard financial stability and promote European financial integration, but exercises control on the monetary regimes of member countries (ECB, 2018).

Lack of fiscal discipline in periphery euro countries presented issues for the EMU when the effects of the global financial crisis reached Europe in 2008. The financial shock had asymmetric effects across the EMU. The transition to the sovereign debt crisis occurred in 2009 when periphery countries reported large increases in debt to GDP Ratios, and government revisions of the Greek deficit showed that the country had been falsifying its

[1] Hereafter, "EMU"
[2] See Appendix B for timeline of EMU accessions
[3] Currency union "opt-out" granted to U.K, Denmark, and Poland
[4] Hereafter, "ECB"

deficit numbers (Lane, 2012). Rising yields on sovereign bonds reflected credit risk in EMU periphery nations. Subsequently Greece, Ireland, and Portugal received a series of bailouts from the EU and IMF in 2010 and 2011, with additional bailouts for Greece in 2012 and 2015. The shock created a clear distinction between strong, core economies in the EMU, and a struggling indebted periphery that fared worse in the period of crisis.

The economic fragility of the EMU is not the only criticism. The global rise of populist movements attack the foundations of European integration the EMU was founded on. Sharing a common currency is just as much a political argument as it is economic, and "nationalistic sentiments concern currency unions, not monetary unions in general" (Visser, 2000). This is because a country's physical currency may reflect a national identity. In June 2016, the United Kingdom exited the European Union customs union, with subsequent EU-UK trade negotiations take place this year. In the 2017 French presidential elections, the anti-euro, anti-EU National Front party leader, Marine Le Pen, garnered substantial momentum until her eventual loss to Emmanuel Macron. Coinciding with the British exit are the terms "Frexit" (French exit), and "Grexit" (Greek exit). These countries have received international media attention in regard to their position on staying within the EU and EMU. In the U.S., "America First" populist rhetoric has been realized in trade policy under the Trump Administration - with increased import tariffs on aluminum and steel resulting in a pending trade war between the EU and U.S., and the U.S. and China. In light of these global populist movements, international trade has come to the forefront of economic policy, and the benefits of European economic integration are under unprecedented scrutiny as euro members recover from the sovereign debt crisis nearly 7 years after its peak.

ii. Research Questions

The effects of the world financial crisis of 2008 and subsequent Sovereign Debt Crisis showcased the costs of joining the EMU, as asymmetric shock brought the EMU periphery to its knees. Currency union literature focuses on the trade benefits associated with joining the EMU, but considering the economic differences among EMU members, it is imperative to find *who* realizes such benefits. By defining an EMU core and periphery that reflect economic differences in the EMU, this study will address the following research questions:

1) Who benefits more from the EMU, in terms of its effect on exports – the periphery or the core?
2) How has the European debt crisis changed the impact of the EMU on core and periphery exports?

iii. Structure

This paper will continue as follows: Section II will summarize economic theory underpinning currency unions, and will outline recent empirical findings on the currency union effect on trade, and more specifically, the euro effect on trade. Section II will conclude with research that will serve as a basis for how this paper defines the EMU core and periphery country groups. Section III will describe the Direction of Trade IMF dataset the IMF World Indicators datasets used in this study. Section III will further provide descriptive statistics and trade trends. Section IV will provide a brief introduction to the

gravity model of trade, and then will introduce the regression model used in this study and define the variables used in each model variation. Section V will discuss findings of the regression model. Section VI will conclude the findings of this study and discuss next steps in the EMU.

II. Literature Review:

i. Overview of Optimum Currency Area (OCA) Theory

The contribution of this study is to determine the currency union effect of the core and periphery nations in the EMU. It is then imperative to review the economic theory justifying currency unions and the benefits they yield for member countries. Robert Mundell's seminal paper, "A Theory of Optimum Currency Areas," explores the economic underpinnings of currency unions, and the criteria by which one can be considered optimal (Mundell, 1961).

A currency union, by definition, is a group of nations with one single currency and one central bank with note issuing power. This implies that each member country forsakes individual monetary policy. In a flexible exchange rate regime, independent monetary policy enables a country to combat domestic inflationary and recessionary pressures from demand and supply side shocks. Mundell (1961) explains this in the case of a demand shift from goods of country A to country B, causing unemployment in country A and inflationary pressure in country B. If prices do not rise in B to adjust the terms of trade, the full adjustment of the shock falls on country A. In a currency union, the central bank has to decide the extent to which to allow unemployment in deficit countries and inflation in surplus countries. As Mundell argues, with the example of the U.S. and Canada, an optimum currency union may be a region, not a country. Mundell (1961) emphasizes that an optimum currency area has significant labor mobility, as it may serve as an adjustment mechanism in the case of demand shock. In the case of demand shift from country A to B,

labour will move from country A to country B, thus combating unemployment in country A and inflationary pressure in country B.

Important additions to OCA theory have been made by Mckinnon (1963), who asserts that factor mobility alone does not constitute an optimum currency union, but also the economy's openness to trade. Mckinnon (1963) argues that the more open an economy is, the more affected its cost of living will be by changes in foreign prices; therefore, more open economies have greater incentive to join currency unions because exchange rate changes may not serve as an appropriate adjustment mechanism. Kenen (1969) finds that product diversification is also crucial in an optimum currency area, as a demand shift from country A to country B may may be combated through a change in production; if country A can produce the goods of country B, this may also serve as an adjustment mechanism by absorbing the job loss of goods from country B.

With these theoretical criterion in mind, a country considering union must weigh the economic benefits of union, with the inherent costs of forsaking independent monetary policy. The EMU project presented a unique challenge to OCA theory, as it joined eleven large advanced economies under one central bank. Among its immediate criticisms was that the EMU's lack of fiscal stabilizers made the union inherently fragile, and that the area did not comply with OCA theory criteria (James, 2012). Despite these objections, the EMU presented an opportunity to further integrate the single market, and for member states to benefit from reduced transaction costs in inter-European trade.

ii. Related Empirical Research on the Currency Union Effect on Trade

The effect of common currencies on trade was first seen in Andrew Rose's early paper, "One Money, One market: the Effect of Common Currencies on Trade," which assessed the separate effects of exchange rate volatility and common currencies on international trade (Rose, 2000). His path-breaking study found that trade increases within currency unions by a factor of three, all other things equal, and that the negative effect of exchange rate volatility on trade is less significant. Rose's findings were based on panel data of bilateral trade observations for 186 countries, from the years 1970-1990. In light of the then-recent formation of the EMU in 1999, Rose believed that his findings could reflect trade benefits for the new eurozone, even though the set of eleven countries already experienced low exchange rate volatility prior to the union (Rose, 2000). To capture this relationship between currency unions and trade, Rose uses an augmented gravity model, which serves as the basis for further literature on currency unions and trade, as well as the empirical model this paper. In the gravity model, bilateral trade flows are explained by the product of GDP between two countries, and by the distance between the two countries. Rose (2000) augments this model with dummy variables for the following: contiguity, common language, trade agreements, and colonial relationships between countries. This model will be discussed in more detail in the Data & Methods chapter.

To address concerns in his first paper, Rose revisits the gravity model in his paper "Does a Currency Union Affect Trade: the Time-Series Evidence" (Glick & Rose, 2002). In this paper, written with Reuven Glick, they refocus their attention on a new policy question: does *adopting* a common currency have an increased effect on bilateral trade? This study uses a large annual panel dataset of 217 countries from year 1948 through

1997. Analyzing changes in trade for countries that left currency unions during this period, they find that adopting a common currency doubles bilateral trade between member countries (Glick & Rose, 2002). This policy question is particularly relevant in the context of the Eurozone, as the EMU significantly expanded throughout the 2000's to western European nations.

Rose's work on the currency union effect has opened the discussion of the euro effect on trade over the past two decades. The subsequent literature aims to reevaluate the euro effect, while addressing concerns in the early work of Rose (2000) and Glick & Rose (2002); the following studies have weakened Rose's initial currency union effects, but have upheld the finding that the euro has had a significantly positive effect on trade between EMU members.

Analyzing the euro area within Rose's framework, the effects of the early EMU on trade were analyzed using a gravity model by Micco et al. (2003). During this time, the benefits of the euro area were re-examined in light of the Greece accession in 2001, and talks of further euro additions in the coming decade: Slovenia (2007), Cyrpus and Malta (2008), and Slovakia (2009). A common criticism of Rose (2000) and Glick & Rose (2002), is that their findings could not be directly applied to the EMU, as many of the currency pairs were from currency unions developed by very small or very poor nations, which is an unlikely comparison with the eurozone (Micco et al., 2003). To address this concern, Micco et al. use panel data for bilateral trade from 1992-2002 for twenty-two *developed* countries. Micco et al. find that the EMU positively increases intra EMU trade between 4-10%. Additionally, Micco et al. found that the common currency positively affects trade between members of the EMU and non-member countries; this effect on EMU/non-EMU trade is

between 8-16%. This means that membership in the currency union not only boosted bilateral trade between EMU members, but also between EMU members and their non-member trading partners.

Barr et al. found an even more significant euro trade effect in 2003. Their study also uses an augmented gravity model, but uses quarterly data for only EMU and EFTA nations (11 EMU members, 6 non-members) from 1978Q1 to 2002Q1; additionally, in critique of Rose (2000), their sample avoids using developing countries in analyzing the effects of the euro. Their results find a 29% increase in trade for eurozone members (Barr et al., 2003). Barr et al. use price and output co-movement averages from 1978 to 2002 as instrumental variables to distinguish this increase in trade as a result of EMU membership, from a result of a country's propensity to enter the eurozone.

In contrast with previous works measuring bilateral trade flows, Bun & Klaassen (2002) and Flam & Nordstrom (2003) use the dependent variable of bilateral trade *exports* to analyze the currency union effect on trade. Bun & Klaassen find an increasing effect for EMU to EMU exports over time: a 3.9% increase in 1999, 6.9% in 2000, and 9.6% in 2001. They estimate a 37.8% increase in intra-EMU trade in the long run, with half of the long-run effect achieved in 2006 (Bun & Klaassen, 2002). Contrasting to Rose (2000), who found a negative real exchange rate volatility effect on trade (although significantly smaller effect than the positive currency union effect), Bun & Klaassen (2002) find the negative effect of real exchange rate on exports to be statistically insignificant. In Flam & Nordstrom's (2003) assessment, they also find a positive effect of the euro on exports; in comparison with their 1989-2002 benchmark, the euro increased trade between euro countries by 15% on average for the period 1998-2002.

These studies critically assess the euro trade benefit in light of the shortcomings inherent in Rose (2000); they are better able to isolate euro effects by excluding many small, developing nations, and include actual euro data post the 1999 currency introduction. However, these studies use few years of actual EMU data. It is imperative to review more recent findings, as the eurozone has matured and expanded throughout the 2000's.

In more recent literature, the EMU effect on trade is still significant, and still found to be smaller than Rose's initial currency union effect: Baldwin and Taglioni (2007), Baldwin et al. (2008), and Berger and Nitsch (2008) have all estimated the intra EMU trade effect to be less than a 15% increase. Glick & Rose (2016) provide a much needed update to their 2002 study to include 15 years of EMU data. In their paper, they agree with, and statistically prove, the common criticism that the EMU is different than other currency unions. Their 2016 paper uses trade data from 1948 to 2013. The study still uses data from a vast number of small, poor, countries, but separates the euro effect from other currency unions; they find that the EMU effect on trade is an estimated 50% increase. In defense of their still-large, positive euro effect, Glick and Rose argue that studies narrowly focusing on the euro effect (as opposed to other unions) include time trend effects for European economic integration may mask the true effect of the euro on trade.

Since the euro's inception in 1999 (and even before), there has been disagreement in the economics literature as to the extent to which the EMU enhances trade flows between member countries, as well as with non-member countries. Despite disagreement on the extent to which the euro has impacted trade, the vast amount of literature on the topic overwhelmingly suggests that there *is* a positive currency union effect on trade within

the EMU, though it may be decreasing. The policy question behind most of this work is: "*should non-member countries join the eurozone?*" As countries in other regions around the world debate further economic integration, they weigh the benefits gained from one level of integration to the next. Now, in a post-Brexit Europe, policy questions have shifted toward the potential benefits of exit from one level of integration to the next. In answering these questions, it is imperative to address how gains in trade may differ among countries.

Addressing a potential difference in trade increases among different groups, Egger & Pfaffermayr (2002) are the first to address a European "core" and "periphery" and how trade may differ *within* and *between* these groups. The paper finds the effect of EU integration on trade flow between core and periphery trading blocs over the period 1960 to 1998. The paper defines the first six EU members as the "EU Core"(Belgium, France, Germany, Italy, Luxembourg, and the Netherlands) and the remaining members as the "EU Periphery." Using a gravity model, Egger & Pfaffermayr estimate the effect of EU integration on trade flow throughout various phases of integration in three dimensions: intra-core trade, core-periphery trade, and intra-periphery trade. Their results find that core-periphery and intra-periphery trade have experienced stronger positive effects than intra-core trade.

Glick (2017) focuses on the separation of the regional trade agreement effect of the EU from the EMU effect on trade. For the EU and the EMU, he finds 70% and 40% European trade export increases for older members, respectively. He finds even higher export boosts for newer members, but argues that more time is needed to assess these gains in European

trade[5]. Both Egger & Pfaffermayr (2002) and Glick (2017) provide insight as to how European integration has affected trade differently for different groups within the EU and EMU. Both papers define these groups by chronology of membership. In this thesis, I argue that chronology of membership does not accurately reflect the core and periphery in the EMU.

Much of the gravity model literature on the currency union effect on trade assesses the size of two countries, the distance between them, and a host of other factors that proxy for transaction costs of trade. However, it is imperative to keep in mind that trad between two countries is largely influenced by history and culture. In Campbell (2008), he finds that trade patterns are largely explained by culture and history, by analyzing habit persistence in consumer preferences and learning-by-doing in production. Campbell uses the example of chopsticks to explain that China may export chopsticks to Japan, not just because they are geographically near to one another, but because Japan is "culturally preconditioned" to eat with chopsticks. This cultural "pull" between these countries' trade is therefore influenced by culture. Campbell (2008) arguest that since China has been using chopsticks for centuries, it is therefore more likely to have an advantage in the chopsticks export market. This is an imporant consideration when looking at trade between various European countries, and particularly as we group these countries in a core and periphery reflective of currency union costs.

[5] Older members defined as countries that joined EMU 1999-2001, and new members defined as post 2001 members

iii. Defining an EMU Core and Periphery

In their seminal work pre-EMU, Bayoumi and Eichengreen (1993) use data on output and prices to analyze aggregate demand and supply disturbances for eleven European Community countries using a VAR decomposition. They analyzed the coherence of the shocks among member countries, as well as the speed of adjustment. In comparison with US monetary union (regional data), they use EC shock data to find that disturbances may have a more idiosyncratic effect in the proposed EMU than in the US. However, they find a european core that experiences shock cohesion similar to the US: Germany, France, Belgium, Luxembourg, Denmark, and the Netherlands. In contrast, they find that the United Kingdom, Italy, Spain, Portugal, Ireland, and Greece experience demand and supply shocks in a larger and more idiosyncratic manner. Updating Bayoumi and Eichengreen's seminal work with real EMU data, Campos and Macchiarelli (2016) use the same methodology, sample, and time span using data from 1989 to 2015 to find that this core-periphery divide exists, but that the pattern has weakened post-EMU.

This study will use Bayoumi and Eichengreen's study as a criterion for defining the core and periphery within the EMU. The core will consist of the five countries: Germany, France, Belgium, Luxembourg, and the Netherlands (excluding non-EMU Denmark). The periphery will be defined as Italy, Spain, Portugal, Ireland and Greece (excluding non-EMU United Kingdom). This definition of an EMU core and periphery is reflective of two groups that may consider the costs of monetary union differently, as they were expected (and did) experience shock asymmetrically.

iv. Defining Crisis

This paper not only seeks to determine the euro effect on exports for core and periphery countries, but how that potential trade benefit has changed with respect to the European debt crisis. This paper will define three crucial periods in the history of the EMU: pre-crisis (1999-2007), crisis (2008-2012), and post-crisis (2013-2016). Phillip Lane's book, "The Sovereign Debt Crisis", he defines three phases of the euro in regard to the sovereign debt crisis, which we will use for the purposes of this study. While Lane (2012) describes an "anticipated post-crisis" at the book's 2012 publication, the 2013 to 2016 post-crisis phase will be further supported by historic events that suggest recovery in the EMU from 2013 forward[6].

Lane (2012) describes the pre-crisis era of the euro as one in which the growth performance and relatively benign financial environment hid the potential of the crisis that was to hit in 2008. In the 1999 to 2007 time period, low sovereign bond yields indicated little credit risk among euro countries, although countries like Italy and Greece had significantly increased their debt to GDP ratios since their introduction of the euro in 1999 and 2001, respectively. With the new ability of borrowing in their own currency, the euro periphery experienced a credit boom; the periphery could now borrow without the worry of exchange rates moving against them. At this time, periphery countries increased fiscal deficits, while Germany experienced current account surplus. Lane (2012) provides insight that the more intense phase of the credit boom did not start at the inception of the euro,

[6] All information in Defining Crisis section is from Phillip Lane's "The Sovereign Debt Crisis" (2012), with exception of in-text citations and post-2012 historic information.

but instead from 2003 to 2007; this difference is hypothesized to be related to the global financial system and low, long-term prevailing interest rates.

The crisis period began in 2008, as the world global financial crisis took hold in Europe. In response, the ECB lowered short-term rates and focused on euro-wide stability. Lane (2012) notes that during 2008, investors withdrew from international markets, which asymmetrically affected countries with the greatest reliance on international funding. The global financial crisis drew attention to the large current account imbalances in the euro area, and the credit boom of the pre-crisis era came to a halt. In 2009, high deficit-to-GDP reports from Ireland and Spain signaled trouble in the periphery. In October of that year, Greece announced revisions of previously falsely reported budget deficits. The transition from global financial crisis to sovereign debt crisis was reflected in rising sovereign bond yields in the EMU periphery.

After IMF/EU bailouts of Greece (May 2010 & March 2012), Ireland (November 2010), and Portugal (April 2011), it was clear that the euro area would require fiscal reform to avoid future crises. In response to Lane's (2012) anticipation of EMU reform, we define the beginning of a post-crisis EMU with the establishment of such reforms: namely, the Fiscal Compact. On January 1, 2013, the Treaty on Stability, Coordination, and Governance in the Economic & Monetary Union came into effect. The main provision of the treaty, the Fiscal Compact, required new fiscal provisions in domestic legislation; this compact bound the nineteen euro members as well as Bulgaria, Denmark, and Romania (European Commission, 2017).

III. Data Description
i. Dataset Description

The dataset uses yearly trade data for the years 1992 to 2016 from the International Monetary Fund's Direction of Trade Statistics (DOTS). Export data is recorded on a free on board (FOB) basis and Imports are recorded on a cost, insurance, and freight (CIF) basis (IMF, 2017). All trade data is converted from domestic currency to current U.S. dollars using the highest available frequency of exchange rate available[7]. In Micco et al.'s gravity model, a sample of developed economies is used to measure the Euro impact, as the EMU is a unique currency union consisting of nineteen large, developed economies. For the purpose of this study, data is pulled for advanced economies, as defined by the IMF World Economic Outlook (IMF, 2017). Our dataset includes over 29,500 trade observations for 37 advanced economies. Some countries have been excluded due to insufficient GDP or trade data[8]. Appendix B provides a table of all IMF advanced economies and their relative economic size within this advanced economy pool. This dataset closely mirrors the lifespan of the euro, with observations beginning in the year that the Maastricht Treaty was signed. The dataset uses the most recent yearly trade data available through the IMF, thus allowing this study to conduct the most recent analysis of the euro effect, including seventeen years of EMU data.

[7] All information regarding DOTS dataset is from the IMF 2016 Direction of Trade Yearbook, which describes the IMF's most current methodology of reporting and recording trade.
[8] Puerto Rico and San Marino are excluded due to insufficient data.

Yearly GDP data is used from the World Bank's World Development Indicators (WDI) dataset. As defined by the World Bank, GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. GDP for all countries is recorded in current U.S. dollars, which is determined by converting domestic currencies using the official single year exchange rate. Likewise, GDP per capita data is extracted from the WDI database, and is recorded in current U.S. dollars. GDP per capita is measured by yearly recorded GDP divided by midyear population.

Data on Regional Trade Agreements is from the World Trade Organization, and includes all free trade agreements and customs unions between countries listed in our dataset. The data will acknowledge an RTA between two countries starting in the year that the RTA is in force as listed by the WTO, regardless of the month of year. All data used to determine EMU membership for dummy variables is from Politico Europe, which lists member countries by accession date.

ii. Descriptive Data

In its simplest form, the gravity model of trade says that trade between two countries will be positively correlated with the product of the economic "size" of two countries, and negatively impacted by the distance between them, due to transaction costs. The dependent variable in this study will be measured in F.O.B. exports. Like prior studies, economic size will be measured in terms of gross domestic product, and for use in the regression model, the natural log of GDP as well as the natural log of GDP per capita product will be used. Distance is measured by the natural log of the distance in kilometers

between the exporting country and the importing country. Table 1 records the summary statistics for the basic gravity model variables.

Table 1. Gravity variables

Gravity Variables	**Min**	**Max**	**Mean**	**Standard Deviation**
Ln $Exports_{ij}$	4.73	26.62	19.24	2.98
Ln GDP_{ij}	44.14	59.87	52.11	2.68
Ln GDP per $Capita_{ij}$	15.46	23.18	20.33	1.08
Ln Distance (km)	4.12	9.88	8.09	1.09

Table 1 shows that within our advanced economy sample, the natural log of F.O.B. exports has a mean of 19.24, with a large range of export values (4.73-26.62). As to be expected when using an advanced economy sample, GDP per capita is defined within a narrower range.

Prior literature on the gravity model of trade includes various dummy variables that factor into trade decisions between two countries. It is likely that sharing a border (contiguity) will cause higher trade, as transaction costs associated with shipping goods are low between countries that are very close to one another. Further, a common official language may influence trade, as different official languages may make trade more costly. Another augmentation of the gravity model is the existence of a regional trade agreement, which is defined by the WTO as an agreement between two or more countries, including both free trade agreements and customs unions (WTO, 2018). Table 2 shows the frequency of these characteristics, and their prevalence within our data.

Table 2. Gravity Augmentations

Gravity Augmentations	**Percent**
Contiguity	4.83%
Common Official Language	10.88%
Regional Trade Agreement (RTA)	41.33%

Here, we see that a small portion, only 4.83% of our trade data consists of an exporter and importer that share a border. Nearly 11% of the countries in our advanced economy sample share a common official language. Of all advanced economy trade observations for 1993 to 2016, 41.33% consisted of trade between two countries with a free trade agreement or a customs union.

This study will focus on the currency union effect for periphery and core countries in the EMU. To view the currency union effect on trade within the EMU, a dummy variable is used to indicate if both the exporting and importing country are EMU members. Further, a dummy variable is used for both the core and periphery to determine how the euro effect may differ for core and periphery exports to EMU countries. Table 3 shows that of our trade observations, 12.12% account for trade between two EMU countries. Core and periphery exports to any other EMU country account for 4.0% of the trade data each.

Table 3. Currency Union Effect

Currency Union Variables	**Percent**
EMU_i	30.3%
Intra EMU_{ij}	12.12%
$Core_i$ EMU_j	4.00%
$Periphery_i EMU_j$	4.00%

IV. Methodology

i. Introduction of the Gravity Model

Originally brought into use by Tinbergen (1962), the gravity model of international trade is regarded as one of the most robust findings in economics. Based on Isaac Newton's law of gravitational attraction between two objects, the gravity model of trade indicates that the trade flow between two countries is positively correlated with the size of their economies measured by GDP, and negatively correlated with the distance between the two countries. As mentioned in previous literature on the currency union effect, this model has been augmented by dummy variables to measure the effect of other factors on trade: if two countries share a common language, share a common border, are in a free trade agreement, or in a currency union.

iii. Presentation of the Regression Model

All gravity models used in this study measure the effect of independent variables on the same dependent variable -- the natural log of bilateral exports. In line with gravity model convention, they include independent variables regarding the economic size variables: natural log of GDP product and the GDP per capita product, as well as a distance variable measuring the natural log of distance in kilometers between the exporting country and importing country. Augmentations to the model include dummy variables for contiguity, common official language, and the existence of a regional trade agreement of any kind between the exporting country and importing country. All models include year fixed effects to control for year-to-year trends in international trade.

The first gravity model used in this study, which we will call the Basic Model, is a series of 3 regressions (i), (ii), and (iii) that focus on identifying a euro effect on trade and

disentangling this effect for the core and periphery. Basic Model (i) is the simplest model of the regressions, and focuses on determining the currency union effect on exports. As previous literature finds, adopting the Euro may also increase trade with EMU countries and non-EMU countries[9]. This regression will include dummy variable EMU_i that determines the euro effect on all advanced economy bilateral trade. EMU_i takes the value of 1 for all exports from an EMU to any economy in the advanced economy pool. The effect of the euro on intra-EMU trade will be determined by the dummy variable $IntraEMU_{ij}$ that is defined as 1 for all EMU exports to other EMU member countries, and as 0 for EMU exports to non-EMU countries. Coefficient β_8 will determine the additional percent boost in the euro effect on exports that an EMU country gets when its trade partner also shares the euro. The total euro effect on exports can be defined as the sum of coefficients for EMU_i and $IntraEMU_{ij}$.

Basic Model (ii) focuses on disentangling the effect of the euro on intra-EMU trade. By adding dummy variables for the core and periphery, we will be able to tell how much the euro effect on intra-EMU trade differs between the two groups, and the rest of the non-core, non-periphery, EMU. The dummy variable $Core_i\, EMU_j$ is defined as 1 for all core country exports to any other EMU member. The dummy variable $Periphery_i\, EMU_j$ is defined as 1 for all periphery country exports to any EMU member country. These variables of interest will tease out any differences in intra-EMU trade benefits between the core and periphery of the EMU. The sum of β_8 and β_9 will determine the euro effect on intra-EMU exports for core EMU members from. Likewise, the sum of β_8 and β_{10} will determine the

[9] Micco et al. 2003

same effect for periphery EMU members. With core and periphery dummies, the variable EMU_{ij} will tell us the intra-EMU trade boosts for non-core, non-periphery EMU countries.

Basic Model (iii) will further explore the early EMU findings of Micco et al. (2003), who found that the euro boosts developed economy bilateral trade by 9% compared to two countries who do not share the euro. In Model (iii), intra-EMU trade variables will be excluded. In place of the intra-EMU variables of Basic Model (ii), Model (iii) will include core and periphery dummies that will separate the euro effect of EMU to advanced economy exports. $Core_i$ takes the value of 1 for all trade observations for which the exporter is an EMU core member, and 0 for all other observations. $Periphery_i$ will take the value of 1 for all periphery exports to advanced economies, and takes the value of 0 for all other observations.

Basic Model

$$(i)\ Ln(exports_{ij}) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 IntraEMU_{ij} \delta_t + \varepsilon$$

$$(ii)\ Ln(exports_{ij}) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 IntraEMU_{ij} + \beta_9 Core_i\, EMU_j + \beta_{10} Periphery_i\, EMU_j + \delta_t + \varepsilon$$

$$(iii)\ Ln(exports_{ij}) = Ln(exports_i) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 Core_i + \beta_9\, Periphery_i + \delta_t + \varepsilon$$

This paper will examine the currency union effect for the EMU core and periphery in three distinct time periods: pre-crisis, crisis, and post-crisis. *Crisis* is a dummy variable defined as 1 for all years 2008 to 2012 and 0 for all years not defined within that period. *Postcrisis* is a dummy variable defined as 1 for all years 2013 to 2016, and 0 for all other years. The Crisis Model will use interaction terms for crisis and post-crisis time periods to find any significant changes in the euro effect on trade for the entire EMU, the core, and the periphery from the pre-crisis period of 1999-2007. The Crisis Model (i) will show changes in the euro effect on exports for each period. Crisis Model (ii) will determine how the crisis changed the effect on EMU to EMU trade for the core and periphery. Crisis Model (iii) will show changes in the euro effect on EMU exports to all advanced economies for the core and periphery.

Crisis Model

(i) $Ln(exports_{ij}) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 IntraEMU_{ij} + \beta_9 (crisis*EMU_i) + \beta_{10} (crisis*IntraEMU_{ij}) + \beta_{11} (postcrisis*EMU_i) + \beta_{12} (postcrisis*IntraEMU_{ij}) + \delta_t + \varepsilon$

(ii) $Ln(exports_{ij}) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 IntraEMU_{ij} + \beta_9 Core_i\, EMU_j + \beta_{10} Periphery_i\, EMU_j + \beta_{11} (crisis*EMU_i) + \beta_{12} (crisis*IntraEMU_{ij}) + \beta_{13} (crisis*Core_i\, EMU_j) + \beta_{14} (crisis*Periphery_i\, EMU_j) + \beta_{15} (postcrisis*EMU_i) + \beta_{16} (postcrisis*IntraEMU_{ij}) + \beta_{17} (postcrisis*Core_i\, EMU_j) + \beta_{18} (postcrisis*Periphery_i\, EMU_j) + \delta_t + \varepsilon$

(iii) $Ln(exports_{ij}) = \beta_0 + \beta_1 ln(GDP_{ij}) + \beta_2 ln(GDPperCapita_{ij}) + \beta_3 ln(distance_{ij}) + \beta_4 Contiguity + \beta_5 Comlang + \beta_6 RTA + \beta_7 EMU_i + \beta_8 Core_i + \beta_9 Periphery_i + \beta_{10} (crisis*EMU_i) + \beta_{11} (crisis*Core_i) + \beta_{12} (crisis*Periphery_i) + \beta_{13} (postcrisis*EMU_i) + \beta_{14} (postcrisis*Core_i) + \beta_{15} (postcrisis*Periphery_i) + \delta_t + \varepsilon$

V. Results and Discussion

i. Regression Results

Table 4. Basic Model Regression Results

Variables	(i)	(ii)	(iii)
Ln GDP_{ij}	0.977***	0.976***	0.979***
	(0.00427)	(0.00430)	(0.00434)
Ln GDP per $capita_{ij}$	-0.0877***	-0.0916***	-0.109***
	(0.0125)	(0.0125)	(0.0126)
Ln $distance_{ij}$	-0.945***	-0.941***	-0.925***
	(0.0136)	(0.0137)	(0.0137)
Contiguity	0.261***	0.245***	0.246***
	(0.0389)	(0.0393)	(0.0393)
Common Language	1.035***	1.030***	1.034***
	(0.0281)	(0.0282)	(0.0283)
RTA	0.0590*	0.0662**	0.0972***
	(0.0319)	(0.0320)	(0.0320)
EMU_i	0.0954***	0.0956***	0.0738***
	(0.0200)	(0.0200)	(0.0274)
$intraEMU_{ij}$	0.0139	-0.0472	-
	(0.0229)	(0.0376)	
$Core_i$ EMU_j		0.197***	-
		(0.0411)	
$Periphery_i$ EMU_j		-0.00592	-
		(0.0412)	
$Core_i$			0.264***
			(0.0293)
$Periphery_i$			-0.181***
			(0.0292)
Constant	-21.87***	-21.82***	-21.75***
	(0.298)	(0.299)	(0.300)
Observations	29,547	29,547	29,547
R-squared	0.802	0.803	0.804

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Looking at Basic Model (i), we see, in line with gravity model convention, a significantly positive effect of GDP product between the exporting country and importing country, and a significantly negative effect of distance on trade. Gravity dummy model augmentations of contiguity and common language also suggest a significant, positive effect on exports. Exports are increased by 26.1% when two countries share a land border. Surprisingly, a common language shared between two countries increases exports by over 100%. To explain such a large effect, we can review the common-language sharing economies in our advanced economy sample. Among those are the U.S., Canada, and the U.K. Taking the size of these economies into consideration, these three IMF country codes accounted for a total of 45.8% advanced economy trade in 2017. A much smaller, european example of a common official language in the sample is Germany and Austria. This large effect does not differ greatly from the results of Micco et al. (2003), which found an 81% increase in trade for common language countries, but it is important to consider that the countries with the most economic weight in the sample happen to share the English language.

Our findings suggest a 5.9% increase in exports to countries that share a regional trade agreement, significant at the .1% level. The coefficient of EMU_i tells us the boost in advanced economy, non-EMU trade received from an exporter joining the euro. This tells us that the euro currency will significantly increase trade by about 9.5%. This finding is in support of Micco et al. (2003), who found a 9% increase in EMU to non-EMU, developed economy trade. This is explained by the euro's role in opening up economies to boost international trade. Basic Model (i) also serves to distinguish the euro effect on intra-EMU trade, as the currency should theoretically increase trade among members due to

decreased transaction costs. Here, we see that beyond gains from non-EMU advanced economy trade, the euro will boost intra-EMU trade to the order of 1.4%, but it is not a significant increase. This means that that in total, EMU countries will export about 10.9% more to EMU countries than will non-EMU countries[10]. This means that the euro effect on exports is similar, regardless of if the importing country is in the EMU or not. Our results align with recent currency union literature that find a euro effect on intra-EMU trade to be less than 15%, with the exception of Glick & Rose (2016), who find a 50% EMU increase. As literature has been able to use more recent, actual EMU trade data, this currency union effect has dwindled. Studies using real EMU data have found less than a 15% increase in trade from EMU membership over the past decade. Also unlike Glick & Rose (2016), this study only includes advanced economies in its sample, and uses a shorter time span that reflects the life of the euro currency.[11]

Basic Model (ii) further disentangles the euro effect on intra-EMU trade. As discussed in the results from regression (i), the euro boosts exports from EMU members to non-EMU advanced economies by about 9.5%, all else equal, and the euro will boost trade to other EMU economies by about the same. $Core_i EMU_j$ and $Periphery_i EMU_j$ tease out the euro effect on intra-EMU exports for the core and periphery, respectively. In doing this, the euro effect of the core and periphery will be isolated from non-core/periphery EMU countries. Here, we see that non-core or periphery countries exporting to any EMU country will experience a negative euro effect of about 5%, but the effect is not statistically different from 0. A core EMU member exporting to an EMU country will increase exports by 19.7%.

[10] Total impact of euro effect determined by the sum of EMU_i and $IntraEMU_{ij}$ coefficients. 9.5+1.4=10.9. This is statistically different from 0 at the .01% level.
[11] Glick and Rose (2016) observe trade flows from 1948 to 2013.

The total impact of the euro effect on intra-EMU trade for the core is therefore a 14.98% increase[12]. Contrastingly, the periphery experiences a negative effect of about half a percent, but this finding is not statistically different from zero. These results suggest that trade boosts in previous studies on the euro effect on intra-EMU trade may have been concentrated in core trade, and not reflective of the currency union effect for the whole eurozone.

Basic Model (iii) allows us to review the euro effect on exports to all advanced economies, with our core and periphery dummy variables to tease out effects within the eurozone. Looking at the gravity model variables regarding GDP and distance, we find them all statistically significant, and relatively unchanged from Basic Model (i) and (ii). Augmentations of contiguity and common language also have similar effects. However, when looking at RTA, we see that the effect of two countries being in a regional trade agreement with one another has both increased in magnitude and significance, with an RTA increasing bilateral trade by 9.2%.

When looking at the variable EMU_i in regression (iii), the coefficient tells us that non-core, non-periphery, EMU countries have a 7.38% increase in advanced economy exports. $Core_i$ tells us that core countries in the EMU have a euro effect 26.4% greater than those that are non-core or periphery. Thus, the total impact of the euro effect on advanced economy trade is 33.78%, significant at the .01% level. In contrast, the periphery will experience a euro effect on advanced economy trade of 18.1% less than non-core or periphery EMU countries. The total euro effect on advanced economy exports for the periphery is an estimated decrease of 10.72%, significant at the .01% level.

[12] Significant at the .01% level

From these findings, it appears that the EMU benefits as a whole in terms of advanced economy exports, as seen in regression (i). However, the EMU core countries gain even more in terms of trade boosts than others; considering that the euro effect for the periphery has a total negative effect on advanced economy exports. The explanation for such differences can be attributed to the EMU exchange rate. As the currency union exports increase, the demand for that currency (the euro) increases. When the demand for a currency increases, it raises its value relative to other currencies. An appreciation of the euro makes EMU goods more expensive, and thus more costly for other countries to import. In the case of the euro periphery, a struggling economy may wish to devalue its currency to make its goods cheaper, thus increasing exports. However, as a member of the currency union, they are unable to do this. So although the euro impact on trade is significantly positive, the negative effect on periphery country exports can be attributed to their inability to control their exchange rate.

Table 5. Crisis Model (i) Regression Results

Variables	(i)
Ln GDP_{ij}	0.977***
	(0.00430)
Ln GDP per $capita_{ij}$	-0.0843***
	(0.0125)
Ln $distance_{ij}$	-0.946***
	(0.0136)
Contiguity	0.267***
	(0.0388)
Common language	1.036***
	(0.0281)
RTA	0.0561*
	(0.0319)
EMU_i	0.216***
	(0.0258)
$IntraEMU_{ij}$	-0.163***
	(0.0301)
Crisis*EMU_i	-0.323***
	(0.0479)
Crisis*$intraEMU_{ij}$	0.249***
	(0.0511)
Postcrisis*EMU_i	-0.121**
	(0.0535)
Postcrisis*$intraEMU_{ij}$	0.344***
	(0.0542)
Constant	-21.94***
	(0.302)
Observations	29,547
R-squared	0.803

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Crisis Model (i) uses the same gravity variable augmentations as the Basic Model, which are included in the table above. This table shows us the euro effect on exports throughout the three periods of interest: pre-crisis (1999-2007), crisis (2008-2012), and post-crisis (2013-2016). This regression is the most simple of the Crisis Model, and looks at the euro effect on exports for all EMU members, without core or periphery distinction. This model allows us to look at the general gains in trade assumed the whole EMU during these

time periods. Models (ii) and (iii) will allow us to tease out these effects for core, periphery, and all other EMU members.

The coefficient of EMU_i tells us that during the pre-crisis time period, EMU members had 21.6% more exports to non-EMU countries than exporters not in the EMU, all else equal. The coefficient of $IntraEMU_{ij}$ shows that there was no trade boost for intra-EMU members, but that a common currency decreased the euro effect on exports by about 16.3%. This negative effect could be attributed to a lag in the effect of the EMU on intra-EMU trade. The total euro impact on exports in the pre-crisis time period is about a 5.3% increase for all EMU exports, which is significantly different than 0[13].

The crisis interaction terms will enable us to see changes in the euro effect from the pre-crisis time period to the period of crisis, defined as 2008 to 2012. Here, we see that the euro effect on EMU to non-EMU exports decreased by 32.2%. In contrast, EMU members increased exports to other EMU members by 24.9%, compared to non-EMU to EMU exporters. The total change in EMU exports during this period shows that the crisis period showed a negative change in euro exports from the pre-crisis period by 7.4%, but is not statistically significant. The total euro effect on trade in the crisis period is therefore negative 2.1%, meaning that EMU member countries exported 2.1% less to all advanced economies than did non-EMU members, although this finding is not statistically different than 0.

Post-crisis interaction terms reveal the change in the euro effect on exports as the world recovered from the world financial crisis, and the EMU recovered from the sovereign debt crisis after 2012. Compared to the pre-crisis time period, the EMU still had a negative

[13] Significant at the .1% level.

impact on EMU to non-EMU exports, but is significantly less negative than that of the crisis period, which signifies a recovery from the crisis[14]. Looking at the euro effect on intra-EMU trade, the post-crisis period shows a promising change of 34.4% from the pre-crisis era. The total post-crisis change in the euro effect on trade from the pre-crisis to crisis is a positive 22.3%. From this, we can determine that the total impact of the euro on exports is 27.6%. This euro effect on exports in the post-crisis period is significance tested at the .01% level.

[14] Significant at the .01% level.

Table 6. Crisis Model (ii) Regression Results

Variables of Interest	(ii)
EMU_i	0.218***
	(0.0258)
$IntraEMU_{ij}$	-0.127***
	(0.0444)
$Core_i$ EMUj	0.0528
	(0.0507)
$Periphery_i$ EMU_j	-0.129**
	(0.0528)
$Crisis*EMU_i$	-0.325***
	(0.0479)
$Crisis*IntraEMU_{ij}$	0.00951
	(0.0777)
$Crisis*Core_i$ EMU_j	0.421***
	(0.0846)
$Crisis*Periphery_i$ EMU_j	0.321***
	(0.0876)
$Postcrisis*EMU_i$	-0.123**
	(0.0534)
$Postcrisis*IntraEMU_{ij}$	0.278***
	(0.0789)
$Postcrisis*Core_i$ EMU_j	0.0724
	(0.0873)
Postcrisis* $Periphery_i$ EMU_j	0.113
	(0.0864)
Constant	-21.87***
	(0.303)
Observations	29,547
R-squared	0.803

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Now that we have found the changes in the total euro effect on exports in different time periods, we can tease out these effects for the core and periphery EMU countries, to answer the question: who benefits the most from the euro, and when? To unpack this, Crisis Model (ii) will focus first on intra-EMU exports. Crisis Model (ii) shows the coefficients and robust standard errors for the variables of interest. Gravity model and

augmentation variables are included in the regression but excluded from the table[15]. The first four variables focus on the euro effect in the pre-crisis time period. The coefficient of EMU_i will denote the euro effect on exports for all EMU countries to non-EMU countries. $Intra\text{-}EMU_{ij}$ denotes the euro effect on EMU exports shared by non-core/periphery EMU countries during the pre-crisis. $Core_i\,EMU_j$ and $Periphery_i\,EMU_j$ coefficients will determine how much the core or periphery euro effect on EMU exports differed from that of the non-core/periphery EMU country group[16]. The interaction terms on the next set of 8 variables will determine how the euro effect has changed during the crisis and post-crisis periods, relative to the pre-crisis period.

Here, the EMU_i coefficient shows a 21.8% increase in EMU exports to non-EMU countries during the pre-crisis period, which is relatively unchanged from the results of regression (i). The non-core/periphery country group, here determined by the coefficient of $IntraEMU_{ij}$, appears to export 12.7% less with other EMU countries than do countries that are not in the eurozone during the pre-crisis period. In comparison, the core trades about 5% more with the EMU than the non-core/periphery, although this finding is not significant, and still shows a total negative euro effect on trade with EMU members. The periphery is found to export about 12.9% less with the EMU than the non-core/periphery group, totaling an impact of negative 25.6% for the periphery in the pre-crisis period. So while Crisis Model (i) finds a negative effect on intra-EMU trade, it is clear that these negative effects are concentrated in the periphery.

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[15] Excluded from table: *$ln(GDP_{ij})$, $ln(GDPperCapita_{ij})$, $ln(distance_{ij})$, Contiguity, Comlang, RTA. All statistically significant at the .01% level, except RTA which is significant at the .1% level.*

[16] For example, coefficient for $Intra\ EMU_{ij}$ will determine non-core, non-periphery euro effect when core/periphery variables are included. The $Core_i\,EMU_j$ coefficient is then the core group's difference from that change. Total Core impact for that period is the sum of both $Intra\ EMU_{ij}$ *and* $Core_i\,EMU_j$ coefficients.

The crisis interaction term variables indicate changes in the euro effect on trade from the pre-crisis period to the crisis period. As indicated in Crisis Model (i), the crisis period showed a significantly positive change for the euro effect on intra-EMU trade, although the total euro effect on exports was null for that period. $Crisis*Intra\text{-}EMU_{ij}$ shows that the change for non-core/periphery countries showed nearly a 1% increase, but is not significant. However, $Crisis*Core_i\, EMU_j$ and $Crisis*Periphery_i\, EMU_j$ show positive change in the euro effect on intra-EMU trade for the crisis period, to the effect of 42.1% and 32.1% for the core and periphery groups, respectively. These changes are not significantly different from one another. From this, we see that the crisis period presented a time when the core and periphery both experienced similar gains in intra-EMU trade boosts from the euro, while non-core/periphery countries did not. However, the total euro effect on intra-EMU exports for the crisis period shows that an inequality still exists in the currency union effect, despite equal gains between the core and periphery. In the crisis period, the core exports an additional 35.6% to EMU countries than non-EMU countries do[17]. The periphery exports 7.5% more than non-EMU countries, and the non-core/periphery group exports about 11.8% *less* in the crisis period, all else equal. However, we can only attest that the core experiences a significant effect.

As determined by Crisis Model (i), the post-crisis period shows a significant increase in the total euro effect on exports from the pre-crisis time period. As seen in (i), most of this positive euro effect is from gains intra-EMU exports. The post-crisis interaction terms allow us disentangle this effect. From the pre-crisis period to the post-crisis period, the non-core/periphery countries had a positive change of 27.8% in the euro effect on intra-EMU

[17] Significant at the .01% level.

exports. The coefficients of *postcrisis*Core$_i$ EMU$_j$* and *postcrisis*Periphery$_i$ EMU$_j$* tell us that the core and periphery experienced a change about 7% and 11% higher, respectively, but that they do not statistically differ from the 27.8% change seen in non-core/periphery countries. In total, the non-core/periphery group exported 15.1% more to EMU countries than non-EMU countries did[18]. The core exported 27.62% to other EMU countries than did countries not in the eurozone[19]. The periphery shows an intra-EMU trade boost of 13.5% in the post-crisis period, but is not statistically different than 0[20].

[18] Sum of coefficients *IntraEMU$_{ij}$+postcrisis*IntraEMU$_{ij}$* significant at the .05% level.
[19] Sum of coefficients *IntraEMU$_{ij}$+Core$_i$* EMU$_j$ + postcrisis**IntraEMU$_{ij}$+Postcrisis*Core$_i$* EMU$_j$. Significant at the .01% level.
[20] Sum of coefficients in the same fashion as core calculation.

Table 7. Crisis Model (iii) Regression Results

Variables of Interest	(iii)
EMU_i	0.385***
	(0.0348)
$Core_i$	-0.0313
	(0.0388)
$Periphery_i$	-0.484***
	(0.0395)
$Crisis*EMU_i$	-0.597***
	(0.0592)
$Crisis*Core_i$	0.533***
	(0.0645)
$Crisis*Periphery_i$	0.449***
	(0.0647)
$Postcrisis*EMU_i$	-0.243***
	(0.0615)
$Postcrisis*Core_i$	0.264***
	(0.0667)
$Postcrisis*Periphery_i$	0.392***
	(0.0645)
Constant	-21.64***
	(0.303)
Observations	29,547
R-squared	0.804

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Crisis Model (iii) allows us an overview of the entire euro effect (EMU to non-EMU and EMU to EMU) on exports for the core and periphery. All gravity model variables and augmentations used in previous Crisis models are included in the regression but excluded from the table. Using the same method as Crisis Model regressions (i) and (ii), interaction terms will allow us to distinguish significant changes in the euro effect from the pre-crisis period to both the crisis and post-crisis time periods. The variables EMU_i, $Core_i$, and $Periphery_i$ determine the euro effect for non-core/periphery countries, core countries, and periphery countries, respectively. Interaction terms will denote changes from the pre-crisis

period for stated variables. The results of this model focus on the total euro effect for each EMU group, and how it changes during each time period.

The pre-crisis euro effect for non-core/periphery country group is a positive 38.5%, meaning that this group will export 38.5% more to advanced economies (both EMU and non-EMU) than will non-EMU countries. The total euro effect for the core group in the pre-crisis period shows a negative 3.13% coefficient, which means that it trades about 35.2% more to advanced economies than non-EMU countries, but is not statistically different from this 38.5% non-core/periphery euro effect. The periphery, however, will export about 10% less to all advanced economies than non-EMU countries in the pre-crisis period[21].

The crisis period shows significant change in the euro effect across all three groups. Non-core/periphery countries experienced a 59.7% change from the pre-crisis to crisis period, for a total euro effect of negative 21.2% in the crisis period[22]. The core and periphery coefficients show that these groups fared significantly better than the non-core/periphery group during the crisis (in terms of total euro effect change), but were still negatively impacted. The total euro effect for the core group during crisis is a 28.97%, compared to its 35.2% effect in the pre-crisis period[23]. The total euro effect on exports for the periphery in the crisis period is a negative 24.7%, compared to its negative 10% effect in the pre-crisis period.[24] Here, we see that the core still experiences a positive euro effect on exports while the rest of the EMU has a significantly negative impact.

[21] 0.385+(-.484) = -0.099. This effect is significant at the .01% level.
[22] Significant at the .01% level.
[23] SIgnificant at the .01% level
[24] Significant at the .01% level

In the post-crisis period, we see change of negative 24.3% for the non-core/periphery country group, for a total post-crisis impact of 14.2%[25]. For the core country group, the total change in euro effect is a 2.1% increase, which accounts for a total euro effect on exports of about 37.5% in the post-crisis period [26]. The total change in euro effect for the periphery from pre-crisis to post-crisis is a positive 14.9%, which determines a total post-crisis euro effect of 5%[27]. However, this total crisis impact is not statistically different from 0.

[25] Significant at the .01% level.
[26] 2.1% increase determined by sum of *postcrisis*core*$_i$ and *postcrisis*EMU*$_i$. The 2.1% increase is not significantly different than zero. This means that the total euro impact in post-crisis period is not statistically different than pre-crisis euro effect.
[27] The increase of 14.9% in total euro effect for the periphery is significant at the .01%.

V. Conclusion

The purpose of this study was to add to the literature on the currency union effect on trade, by examining the effect of the euro and how a positive "euro effect" on exports might 1) differ for certain groups within the currency union who have shown macroeconomic differences since the euro's inception, and 2) how the recent world financial crisis and subsequent European sovereign debt crisis may have impacted this effect. Our study finds that there is a significant euro effect on exports to advanced economies - around a positive boost of 9.5% for all advanced economy exports - and about a 10.9% for EMU to EMU countries, although these increases do not statistically differ from one another. So therefore, there are two components of the total "euro effect" on exports.

From our 1992 to 2016 dataset, we find that although the EMU as a whole does not experience a significant intra-EMU trade boost, the core does. The EMU core will export about 15% more to EMU countries than a non-EMU member will. When looking at the total euro effect on all advanced economy trade, it is clear that the core appears a clear winner again. The EMU core will export around 34% more to advanced economies than a non-EMU member would, all else equal. In contrast, the periphery will export 10.72% less to advanced economies than a non-EMU member would. This can be explained by exchange rates. When the EMU as a whole is exporting more, the demand for the euro increases. When the demand for a currency increases, it raises its value relative to other world currencies. An appreciation of the euro makes EMU goods more expensive for other countries to import. When some countries (like the core) experience positive trade, others may not. The periphery may wish to devalue its currency to make its goods cheaper to

increase exports, but in the case of a common currency, it cannot control its exchange rate. Thus, the negative effect on all advanced economy trade for the periphery is explained by its inability to control its exchange rate. In both intra-EMU and non-EMU, advanced economy exports, the core benefits more from the euro.

Is this euro effect on trade impacted by the sovereign debt crisis? In short - yes. But how does it change, and for whom? This study first looks at intra-EMU trade. The core and periphery both experience a negative euro effect on EMU exports in the pre-crisis period, although the periphery experiences this to a much greater degree. In the crisis period, the core shows a significantly positive euro effect on EMU exports of 35.6%. The periphery shows a positive effect of 7.5%, but the effect is not significantly different from 0. Post-crisis, the core has euro effect on intra-EMU exports of about 27.62%, while the periphery still does not show a significantly positive impact on exports to EMU countries. From this, we see that the core experienced a larger euro effect on Intra-EMU exports during the crisis, and maintained most of that effect post-crisis. The periphery did not show a positive intra-EMU trade boost relative to non-EMU countries, but showed increase in intra-EMU trade from the pre-crisis period. In terms of all advanced economy trade, the core, periphery, and non-core/periphery countries experienced similar trends in the euro effect on all advanced economy trade. From pre-crisis to crisis, the euro effect decreased. From crisis to crisis, the euro effect on exports increased.

V. Limitations & Future Research

Although our dataset provides the most recent analysis of the euro effect on trade, with 18 years of euro trade data, recent accessions to the eurozone are still difficult to analyze. The original members account for the core and periphery groups of this study, with the exception of Greece joining two years later in 2001. However, the non-core/periphery group changes over the life of the euro as new countries are ushered into the currency union. For this reason, our study is limited in its analysis of non-core/periphery countries that have recently introduced the euro.

Another limitation of this study is in the selection of core and periphery countries. The study of Bayoumi & Eichengreen (1993) provides insight into how a proposed EMU experiences supply and demand shock, which may influence how a country perceives the economic costs of currency union. My definition of the core and periphery sought to align the economic costs of currency union with the economic benefit (in this paper, increased trade); however, this particular grouping of countries groups the strongest econonomies in the eurozone and the weakest. Further, this study does not control for trade patterns between country pairs, which may also play a role in the currency union decision, as countries that are already trading a lot with one another may be more motivated to share a currency.

Lastly, and most importantly, this study's analysis of the euro is solely economic. The primary limitation of this study is that although economic literature may influence a country's currency union decision, politics play a significant role. A politicial persepctive of the benefitcs of EMU member memebership for core and periphery countries before,

during , and after the sovereign debt crisis woud be benefical in providing a compehensive analysis of the euro. Further, this study uses historic trade data to determine how euro countries may view the euro benefits in the future. This may be supplemented with future research in political sentiment between the core and periphery countries to determine how countries may regard the euro and their future within the currency union.

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B. Appendix

Table 8. EMU Accession by Date

Date	Country/Countries
January, 1 1999	Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain
January 1, 2001	Greece
January 1, 2007	Slovenia
January 1, 2008	Cyprus and Malta
January 1, 2009	Slovakia
January 1, 2011	Estonia
January 1, 2014	Latvia
January 1, 2015	Lithuania

*Source: Politico.eu, 2015. EU members not in the EMU are: Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, and Sweden

Table 9. IMF Advanced Economies & Percent total GDP, Exports, and Population of Advanced Economy group

Advanced Economies	GDP	Exports of Goods and Services	Population
U.S.	37.0%	16.6%	30.5%
Euro Area (19)	28.1%	41.2%	31.9%
Japan	10.4%	6.1%	12%
U.K.	5.5%	5.6%	6.2%
Canada	3.3%	3.6%	3.4%
Other Advanced Economies (16)	15.6%	26.9%	16.0%

* Source: IMF, 2017. Percentage values are of total for Advanced Economy group. Other advanced economies: *Australia, Czech Republic, Denmark, Hong Kong SAR, Iceland, Israel, Republic of Korea (South), Macao SAR, New Zealand, Norway, Puerto Rico, San Marino, Singapore, Sweden, Switzerland, and Taiwan Province of China. Note that People's Democratic Republic of Korea (North) is not a member of the IMF and therefore is excluded. As noted in the paper, San Marino and Puerto Rico are excluded from this study.*

Table 10. Variable Descriptions

Variable	Description
ln(Exports)	Natural log of Free on Board (FOB) exports recorded in U.S. dollars
$\ln(GDP_{ij})$	Natural log of product of gross domestic product for export $country_I$ and import $country_J$ in U.S. dollars
Ln GDP per $Capita_{iJ}$	Product of GDP per capita of export $country_I$ and import $country_J$ in U.S. dollars
ln(Distance)	Natural log of distance (km) between export and import country
Contiguity	1 If export and import country share a border
RTA	1 If export and import country are in a regional trade agreement: including free trade agreements and customs unions (EU)
Common Official Language	1 if both export and import country share a common official language
EMU_i	1 if export country is a member of the European Monetary Union (EMU)
Intra-EMU_{ij}	1 if export country and import country are members of the EMU
$Core_i$	1 if export country is defined as EMU "Core" country
$Periphery_i$	1 if export country is defined as EMU "Periphery" country
$Core_iEMU_j$	1 if export country is defined as "Core" and import country is (any) member of the EMU
$Periphery_iEMU_j$	1 if export country is defined as "Periphery" and import country is (any) member of the EMU