The European Economic and Monetary Union: Assessing the Impact of a Single Currency on Member States[1]

Giuliana Carozza

Senior Honors Thesis
Department of Economics
University of Notre Dame

Advised by
Professor Timothy Fuerst

[1]I am incredibly grateful to Professor Timothy Fuerst for advising me throughout this research. His guidance and instruction have been invaluable.

ABSTRACT

The establishment of the European Economic and Monetary Union marked the historically unprecedented and highly controversial introduction of major global currency without a state. A decade and a half later, still little is understood about the implications of this bold endeavor. This paper contributes to the literature with an empirical analysis of the effects experienced by euro-area countries as a result of the single currency. The findings indicate increased business cycle synchronization and intra-region trade among member states, but also severely restricted economic growth due the loss of domestic monetary policy as a tool for internal stabilization. Results suggest that the economic costs greatly outweigh the benefits, and that there is little evidence that these effects will be alleviated with time.

1. INTRODUCTION

The introduction of a single currency for the European continent was the first establishment of a major global currency without a state. The decision of large and developed economies to enter such a union was a topic of debate long before the formation of the European Economic and Monetary Union (EMU), with euro advocates claiming that the single currency would be a fundamental step towards the complete economic and political integration of the region, and skeptics maintaining that irreconcilable structural differences between European nations would prevent economic efficiency. However, both camps could argue on the basis of theoretical models alone, unable to empirically predict the implications of such a historically unprecedented event. In fact, the euro's effects on European countries are yet to be understood years later, despite an extensive body of literature on this issue of central importance to the global economy and European political stability.

The objective of this paper is to contribute to the existing empirical evidence of the impact of a single currency on EMU member states. I evaluate the region's performance as a currency area by investigating the economic costs and benefits experienced by national economies as a result of the euro, as well as the homogeneity of effects across countries. My results benefit from a decade and a half of ECB history, as opposed to earlier studies with limited data observations. Given the relatively recent establishment of the euro, this additional statistical information is invaluable. Furthermore, the counterfactual model I develop to hypothesize what would have happened if member states had maintained their national currencies is, to my knowledge, entirely unique. This allows me to quantitatively gauge the economic costs of the euro in a novel way.

My results suggest an increase in euro-area business cycle correlation of about fifteen percent when using GDP growth rates, but I find no converging effect on inflation or unemployment. I also assess countries' abilities to respond to internal and external shocks, and conclude that the responses of both interest rates and exchange rates change significantly upon the adoption of a single currency. These differing responses cost countries economically by considerably restricting economic growth; a counterfactual analysis implies an average decline of twenty-five percent of total GDP. These costs far outweigh the estimated benefits from increased intra-region trade, the leading economic benefit of a currency union, which I conclude to be between thirteen and sixteen percent. Furthermore, I find no evidence that the magnitude of the trade impact is growing over time.

The rest of this paper is organized as follows. The second section provides a historical and theoretical background on the euro, and a literature review of existing empirical evidence. The third and fourth sections detail the data and the empirical methodology employed to investigate the effects of a single currency, while the fifth section presents the results from each analysis. Finally, I conclude with a brief discussion in section six.

2. BACKGROUND

2.1 Historical Overview of the Euro

Although the euro did not come into existence as an official currency until January 1st, 1999, ideas of a European economic and monetary union had been raised long before. In 1969, the European Economic Community (EEC) – established with the Treaty of Rome in 1957 – first

called for "greater coordination of economic policies and monetary cooperation" amidst a turbulent market and concerns about the stability of the international monetary system as laid out at Bretton Woods (Delivorias, 2015). In 1970 the Werner Plan was published, introducing an exchange rate system in hopes of minimizing the volatility of European currencies. The national currencies of six original countries (France, Italy, West Germany, Belgium, Luxembourg, and the Netherlands) and later three additional ones (Denmark, Norway, and the United Kingdom) were pegged to each other as well as to the dollar and allowed to fluctuate within pre-established bands. This restrictive mechanism came to be known as "snake in the tunnel" (Shoup, 1998). However, the system eventually proved untenable and was superseded by the European Monetary System (EMS) in 1979, in another attempt to stabilize exchange rates and counter rising inflation in European countries.

The two foundations of EMS were the European Currency Unit (ECU), a basket of weighted national currencies, and the Exchange Rate Mechanism (ERM), which set an exchange rate towards the ECU for all participating member states. Each national currency was weighted within the ECU relative to the importance of that country's trade within the EEC (Delivorias, 2015). Then, based on the pre-established ECU central rates, bilateral rates were set between member states (which would ultimately comprised of the United Kingdom, Ireland, Denmark, Greece, Spain, and Portugal, in addition to the original six nations of the Werner plan).

The continued effort for increased economic integration culminated in 1989 when the Committee for the Study of Economic and Monetary Union (EMU) outlined the three-stage Delors' Plan. The report laid out a path to monetary union that involved (1) the achievement of a single European market through the elimination of internal barriers to the movement of goods, services, and capital, (2) the creation of the European Monetary Institute, and (3) the creation of

the European Central Bank (ECB) and a single currency, the euro.[1] Heads of State reached a final agreement on currency union with the Maastricht Treaty in 1992. The Treaty provided for the introduction of monetary policy conducted by a centralized independent central bank, with price stability as its principal objective, and also agreed on the creation of the euro by January of 1999. Lastly, the Treaty decided on convergence criteria that each member state would be required to meet in order to adopt the euro. The criteria imposed control over countries' inflation, public debt and public deficit, exchange rate, and long-term nominal interest rates.

European leaders met again in December 1996 to address public uncertainty in response to their vision of integration and conflicting concerns of various member states regarding the balance of price stability versus economic growth. This resulted in the proposal of the Stability and Growth Pact – a compromise among member states promising to maintain convergence obligations after joining the EMU (desired by the German leaders) and addressing French, Spanish, and Italian concerns that excessive focus on budgetary discipline would ultimately jeopardize their economic growth (Delivorias, 2015). In June of the following year, the European Council also resolved to set up an exchange rate mechanism (ERM II) to ensure that exchange rate fluctuations of non-euro member states would not negatively influence the economic stability of the single market.

The European Central Bank (ECB) was established in June 1998 in Frankfurt to take over responsibility from the EMI. Its decision-making bodies are the Governing Council, which makes monetary policy decisions, and the Executive Board, which implements actions and is responsible for daily management. The General Council also will exist as a third governing body until all non-exception EU member states adopt the euro as their currency. Additional monetary authorities of the Eurozone are the Eurosystem – the ECB and the national central banks of EU

[1] Stages of Economic and Monetary Union: https://www.ecb.europa.eu/ecb/history/emu/html/index.en.html

members on the euro – and the European System of Central Banks, which comprises the ECB and the national central banks of all EU member states.[2]

The euro came into existence virtually on January 1st, 1999 and three years later, circulated in all participating countries while national banknotes ceased to be legal tender. At this time, twelve member states adopted the single currency, after having been deemed by the European Council as satisfying the necessary convergence criteria: Austria, Belgium, Finland, France, Germany, Greece, Italy, Luxembourg, Norway, Netherlands, Portugal, and Spain. Denmark and the United Kingdom had previously negotiated with the Council to obtain exception status, choosing to opt-out of the euro while still maintaining membership in the European Union. Sweden joined the union in 1995. Though it voted by public referendum against adoption of the euro in 2003, it has not been granted opt-out status and according to the Treaty should have to adopt the currency upon satisfying the convergence criteria. Since 2002, the euro area has undergone six rounds of enlargement – Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014, and Lithuania in 2015 (Mushin, 2015). Thus, the total number of EU member states on the currency is nineteen, and there are an additional seven EU member states whose currency is not currently the euro, but who have committed to joining the euro area upon fulfillment of the entry conditions.

2.2 Theoretical Background

The creation of the European Economic and Monetary Union (EMU) is frequently assessed within the framework of optimum currency area (OCA) theory, a branch of literature first introduced by Mundell (1961) that evaluates the optimal geographic domain of a currency

[2] ECB, ESCB, and the Eurosystem: https://www.ecb.europa.eu/ecb/orga/escb/html/index.en.html

area to maximize economic efficiency. Various models have been proposed, but the most commonly identified criteria for a successful currency union include:

(i) Labor mobility

(ii) Degree of openness, with both capital mobility and price and wage flexibility, often measured by the extent of intra-region trade

(iii) Similarity of shocks and business cycles

(iv) System of risk-sharing, usually through fiscal transfers

Fulfillment of these conditions determines both the monetary efficiency to be gained and the economic stability to be lost from monetary union; a higher degree of economic integration with the currency area magnifies benefits and minimizes costs. Benefits arise from the elimination of transaction costs and exchange rate uncertainty, whereas relinquishing the national exchange rate and monetary policy reduces domestic control of internal economic conditions. In general, only when these benefits exceed costs should joining a currency union be a country's preferred course of action.

Doubts over Europe's qualifications as an optimum currency area began to be raised by critics even before the creation of the EMU, and since then it has generally been agreed that, upon formation, the region did not categorically satisfy the conditions set out by the theory. However, Frankel and Rose (1998) argue that the OCA definition inherently poses a paradigm, as its criteria – namely, cyclical correlation and trade integration – are jointly endogenous and cannot be considered independently. Their study suggests that entry into a currency union, through promoting intra-region trade, could subsequently increase business cycle correlation and economic integration. This would imply that a country is more likely to fulfill OCA criteria *after* the adoption of a single currency. This hypothesis is not universally accepted; there exists an

opposing view that increased intra-region trade can encourage industrial specialization, thus weakening cyclical correlations and increasing vulnerability to asymmetric shocks.

While discussing these contradicting hypotheses in depth is beyond the scope of this paper, it is clear that "the suitability of European countries for the EMU cannot be judged on the basis of historical data, since the structure of these economies is likely to change dramatically as a result of the EMU" (Frankel and Rose, 1998). A country's satisfaction of OCA criteria, and its cost-benefit analysis, is very possibly dynamic after entry rather than static, at least initially. The monetary efficiency gains and economic stability losses experienced by euro-area member states are yet to be fully understood in part because they were not immediately apparent or predictable at the time of EMU creation. The aim of this paper is to address this question by thoroughly investigating both the positive and the negative impacts of the euro.

2.3 Literature Review

Despite the importance of cyclical synchronization in evaluating the efficiency of a currency union, and extensive existing studies on the aggregate European business cycle, less is understood about the impact of the adoption of the euro on correlation patterns between countries. In the papers that have focused on this issue, there is a lack of consensus on evidence of characteristic changes since the formation of the EMU. Del Negro and Otrok (2008) found no change in average cross-country correlation of euro area business cycles from 1970 to 2005, but detected a decline in G7 average correlations. Giannone, Lenza, and Reichlin (2009) also conclude that euro area business cycles have hardly changed since the beginning of the EMU, but this is contradicted by a 2008 study by Furceri and Karras suggesting that the business cycles

of all EU member states, regardless of adoption of the euro, are more synchronized with the area-wide economy in the post-EMU period. In part, these conflicting results are due to numerous institutional changes during the nineties and an EMU regime that spans a relatively short amount of time, making it difficult to identify continuous patterns (Giannone et al., 2009).

Business cycle synchronization in a geographic region is crucial as it reduces the probability of asymmetric shocks and facilitates the interventions of a centralized monetary policy (Furceri and Karras, 2008). A fundamental concern of adopting a single currency is the nation's subsequent loss of monetary policy as an economic stabilization tool and the economic costs that could be incurred as a result. Empirical evidence supports the intuition that ECB policy differs from the actions national central banks would choose to take. The Taylor interest rate rules (the most common formulation of a monetary policy reaction function) that were followed by member states prior to the establishment of the EMU were quite distinct from one another (Eleftheriou et al., 2006), making it impossible to centralize monetary policy without compromise. Furthermore, the monetary policy of the ECB is conducted in a manner less sensitive to the internal conditions of each individual member state. In fact, the ECB's official policy stance itself is that all monetary policy decisions are based on the conditions of the euro area as a whole, and do not reflect the diversity among national economies within the region (Crowley and Lee, 2008).

The economic costs of imperfect synchronization and the loss of nationalized monetary policy across countries are certain, yet difficult to measure. Quantitatively gauging them involves a "counterfactual", hypothesized model that was not attempted until eight years post-union in 2007 by Dubois, Hericourt, and Mignon; very few studies have employed such techniques since. Of those that have, almost all have done so by looking backwards to estimate the heterogeneity

in countries' responses to an area-wide shock before the adoption of the euro, to infer the potential costs had there been monetary union[3] at the time (Giannone et al., 2009). Others have focused on the United Kingdom's exception status and hypothesized what would have happened domestically under the euro instead. Scarcely any studies have measured the propagation of United States or world shocks across euro area countries in the post-EMU period on the basis of structural models.

Recent literature has also evaluated the economic benefits of the formation of the EMU by assessing the euro impact on trade between member states. The way a currency union facilitates trade is clear – through the elimination of transaction costs and exchange rate uncertainty. There is evidence that reductions in trade cost can also reduce the cost of vertical specialization within the region and make goods produced there more competitive (Flam and Nordstrom, 2006). Previous empirical evidence overwhelmingly supports this notion. A groundbreaking study by Rose (2000) indicates that all else equal, a common currency increases trade with other members of the currency union by a factor of three – an impact famously dubbed "the Rose effect" in the literature – and this general conclusion still stands despite numerous early critiques that the estimate was biased upward. However, Rose's evidence relies almost entirely on currency unions involving countries that are small or poor, or both, and so his results may not be applicable to a union involving European countries.

Initial findings suggest that the euro has, in fact, significantly boosted trade among member states. Early results from Micco, Stein, and Ordoñez (2003) show a statistically significant four to ten percent increase in intra-euro bilateral trade as a result of a single currency, and a more recent study reproducing their same technique yields a slightly higher estimate of

[3] From this point forward, "currency union" and "monetary union" are used interchangeably. While it is possible to form a monetary union without also adopting a single currency, the phrasing in this paper specifically references the European and Economic Monetary Union.

approximately ten to fifteen percent (Frankel, 2008). Some studies believe that the effect is growing over time (Flam and Nordstrom, 2003). Overall, a comprehensive review of empirical literature on this topic reveals that the euro impact on trade between member states lies somewhere between five and fifteen percent on average, but the size of the effect is expected to change as new years of data are made available.

3. DATA

3.1 Sample

In this paper, the pre-EMU period is defined as Quarter 1, 1982 to Quarter 4, 1997. The post-EMU period ranges from Quarter 1, 1999 to Quarter 4, 2014. This is done in order to symmetrically consider an equal number of periods on either side of the adoption of the euro. The year 1998 was omitted from the analysis because, as a time of structural change, it may not accurately reflect characteristics of economic conditions. This methodology amounts to a total of 128 time periods per country.

These time periods are modified when evaluating monetary policy actions, so as to stop before the onset of the zero-lower bound and measure the true policy coefficients prior to the implementation of artificially low interest rates. Thus, to produce time periods of equal length, the pre-period for this analysis ranges from Quarter 1 of 1988 to Quarter 4 of 1997 and the post-period from Quarter 1 of 1999 to Quarter 4 of 2008.

This study only evaluates the impact of the EMU for the twelve countries that originally adopted the euro in 1999. The additional years of data are able to provide more robust results; these countries also tend to be the largest and most influential among member states. The results

for Denmark, Sweden, and the United Kingdom – EU member states that chose to maintain their national currency rather than adopt the euro – are included as a point of reference. In analyses that include other countries, such as those measuring bilateral trade or global correlation patterns, I use countries that are members or partners of the Organization for Economic Cooperation and Development (OECD) and for which relevant and reliable data is available.

3.2 Outcomes and Covariates

I obtain measures of a country's gross domestic product from the OECD's quarterly national accounts dataset. The quarterly GDP measures are seasonally adjusted and calculated using the expenditure approach. When applicable, I use the growth rate as compared to the same quarter of the previous year, in order to reduce volatility in the data.

The data for inflation, unemployment, interest rates, and exchange rates was gathered from the Federal Reserve Economic Data (FRED). Quarterly data is used in all instances. The inflation rate is measured by the consumer price index and the unemployment rate indicates the harmonized rate for all persons. For short-term nominal interest rates, I use the three-month interbank rates of the nation's central bank for the pre-period and of the ECB for the post-period. All exchange rates are expressed in U.S. Dollars, meaning that an increase in numerical value represents a currency appreciation and vice versa. Before the adoption of the euro, there is great variation in national exchange rates, making it difficult to compare fluctuations between countries. To resolve this limitation, exchange rates for national currencies in the pre-euro time period are scaled in order to obtain comparable units by applying the transformation:

$$ex_2 = \frac{ex_1}{\overline{ex}} \times \overline{euro}$$

where ex_2 is the scaled national exchange rate, ex_1 is the original national exchange rate, $\overline{ex}$ is the average exchange rate of that currency in the pre-period, and $\overline{euro}$ is the average exchange rate of the euro in the post-period.

Finally, the International Monetary Fund's Direction of Trade Statistics provides information on countries' exports and imports by trade partner, reported in U.S. dollars and deflated by U.S. CPI. I construct a measure of bilateral trade between each pair of countries by summing both countries' exports to one another. Exports are reported on a free on board basis, excluding international insurance and transport costs. My dataset includes 15 countries over a time horizon of 33 years, resulting in 105 country pairs and 3,466 observations.

4. METHODS

4.1 Business Cycle Synchronization

The extent of synchronization of national business cycles is an important indicator of the economic efficiency of a currency area, since diverging cycles raise the cost of implementing a single monetary policy. I assess the impact of the EMU on the business cycle synchronization of member states by measuring the change in correlation between national and European business cycles since the formation of the monetary union. Specifically, I look at quarterly GDP growth rates, inflation rates, and unemployment rates as indicators of business cycles. I separate the pre-period data from that of the post-period and evaluate each before comparing correlation outcomes across the two.

Then, in order to isolate the true euro effect from any other factors that differ across time periods and could be influencing the global economy, I estimate the ordinary least squares model:

$$(1) y_i = \alpha + \beta_1 \cdot Period\ 2_i + \beta_2 \cdot Euro_i + \varepsilon_i$$

where y_i is the correlation coefficient related to business cycles (GDP growth, inflation, or unemployment) between country i and the Eurozone, $Period\ 2_i$ is an binary variable equal to one if the time period is after the formation of the monetary union, and $Euro_i$ is an binary variable equal to one if the country adopted the euro as its national currency. The countries included in this regression are the twelve countries that originally adopted the euro in 1999 and thirteen other members of the Organization for Economic Cooperation and Development (OECD) for which this time period's data was available. Because this regression includes both the pre- and post-measures of correlation, there are two observations for every country considered.

4.2 Monetary Policy Response to Shocks

I investigate how the euro has affected the response of monetary policy to internal conditions and external shocks through an analysis of interest rate and exchange rate behaviors.

4.2.1 Interest Rate Response to Internal Shocks

As discussed, a serious negative implication of currency union is that the monetary policy of a single central bank is conducted in a manner less sensitive to internal conditions on a national level. To understand the degree to which monetary policy changed under the euro, I estimate Taylor Rules for the pre- and post-EMU periods and compare the response parameters of national central banks' to fluctuations in internal conditions to those of the ECB. I use a regression model of the following form:

$$(2) i_t = \rho \cdot i_{t-1} + (1-\rho) \cdot \left(\phi_\pi \cdot \pi_t + \phi_u \cdot u_t\right) + \varepsilon_t$$

where i_t, π_t, and u_t, are the short term nominal interest rate, the national inflation rate, and the national unemployment rate respectively. The interest rates are those of the nation's central bank for the pre-period, and of the European Central Bank for the post-period. This analysis is done for the ten countries originally on the euro for which reliable data could be obtained (excluding Greece and Luxembourg), as well as for the United States and the United Kingdom as a point of reference.

4.2.2 Exchange Rate Response to External Shocks

The national exchange rate is another stabilization tool that is renounced upon entering a monetary union. I assess how this has influenced euro-area countries' abilities to respond to shocks by employing a vector auto-regression and impulse response functions. The purpose of this particular analysis is to simulate an external shock to a country's economy. First, I identify discrepancies between the exchange rate responses of the pre- and post-EMU periods. Then, I study the subsequent movement of various economic indicators (inflation and unemployment rates) to observe the differing consequences of a shock. In theory, differences across periods are expected, since under the euro, countries' exchange rates will be given by the single currency and not domestic behavior.

A VAR is an *n*-equation, *n*-variable model in which each variable is explained by its own lags and the lagged or current values of the other *n-1* variables. The ordering of the variables implies assumptions about the timing of the intertemporal responses: a variable can be affected by current values and past lags of variables that precede it, but only by past lags for the variables that come after. This results in simultaneous and intertemporal equations that capture the linear interdependencies between time-series. For this analysis, exogenous shocks are represented by

fluctuations in oil prices (in dollars per barrel). I make the reasonable assumption that this is a variable that may influence economic conditions of European countries and yet does not depend on their monetary policy. I begin by estimating a four lag VAR for each time period of the form:

$$(3)\ x_t = \alpha_1 + x_{t-1}A(4) + \varepsilon_{1t}$$

$$(4)\ ex_t = \alpha_2 + ex_{t-1}B(4) + y_{t-1}C(4) + x_{t-1}D(4) + x_tD(0) + \varepsilon_{2t}$$

$$(5)\ y_t = \alpha_3 + y_{t-1}E(4) + ex_{t-1}F(4) + ex_tF(0) + x_{t-1}G(4) + x_tG(0) + \varepsilon_{3t}$$

where x_t is the price of oil, ex_t is the national exchange rate in the pre-period (scaled as noted in Section 3) and the euro exchange rate in the post-period, y_t is the outcome of interest (unemployment rate or inflation rate), and $A(4), B(4)$, etc. denote four lags of the relevant variable. This process is done for the four euro-area countries with the largest economies: France, Germany, Italy, and Spain.

I use the resulting equations to find impulse response functions. Impulse reponse functions trace out the response of current and future values of variables to a one-standard deviation increase (or "shock") in the current value of one of the VAR errors, assuming that this error will return to zero in subsequent periods and that all other errors are equal to zero (Stock and Watson, 2001). This is a way of representing a variable's behavior over time in response to shocks in the value of another variable. In this VAR, the impulse response functions for equations (2) and (3) model the behavior of the exchange rate and the unemployment/inflation rate, respectively, in response to an unexpected fluctuation of the price of oil.

4.3 Counterfactual Estimation of Economic Costs

If member states' responses to shocks under a centralized monetary policy do in fact diverge from their original positions, this will affect their national economies. In this analysis, I develop a model to simulate and quantify each period's impact on a country's GDP through a

modified vector auto-regression, an adaptation of the technique introduced in the preceding section. In this analysis, a VAR is used to study the responses of the GDP growth of a euro-area country to an exogenous external shock, which is represented by the GDP growth of the United States. To justify the assumption that U.S. growth rates serve as a proxy for exogenous shock, I use Granger causality, which determines whether one time series is useful in forecasting another. The results from this statistical test verify that the U.S. growth rate has predictive causality for Euro nations and reject the hypothesis that the GDPs of Euro nations have predictive causality in return, thus validating this choice of an exogenous factor. I estimate four lag VARs for both the pre- and post-EMU periods of the form:

$$(6)\ US_t = \alpha_1 + US_{t-1} \cdot A(4) + GDP_{t-1} \cdot B(4) + \varepsilon_{1t}$$

$$(7)\ GDP_t = \alpha_2 + US_{t-1} \cdot C(4) + GDP_{t-1} \cdot D(4) + \varepsilon_{2t}$$

where US_t is the quarterly GDP growth rate of the United States, GDP_t is the quarterly GDP growth rate of the EMU member state in question, and $A(4), B(4),$ etc. denote four lags of the relevant variable. This analysis is done for France, Germany, Italy, and Spain.

By estimating equation (2) for the pre- and post-EMU periods, I obtain two different measures of the parameters influencing interactions between national GDP growth and the United States' GDP growth: $C\_pre(4)$ and $C\_post(4)$; $D\_pre(4)$ and $D\_post(4)$. I then feed the actual values for post-period United States GDP growth into these predictive equations, to back out counterfactual pre- and post-period fitted values for GDP growth of the country. I compare the two measures of fitted values, rather than comparing the counterfactual pre-period fitted values to realized national GDP growth. This is done in order to remove any impact on the country's GDP from other factors and only report fluctuations that are a direct result of changes in the United States' growth rate. Thus, when applied to the years following the formation of the currency union, the fitted values represent (a) how the country's GDP growth rate responded the

United States' growth rate (the post-period fitted values), and (b) how the country's GDP growth rate would have responded during the same years had it continued the behavior it displayed before joining the EMU (the pre-period fitted values).

4.4 Intra-Euro Trade Impact

The notion that a single currency fosters trade among member states is frequently identified as the leading benefit of monetary union. My analysis of the euro impact on trade draws on the gravity model, which has been particularly useful for studying bilateral trade flows since its earliest presentation by Linnemmann (1966). In its simplest form, the gravity model predicts trade flows between two countries based on the product of their GDPs and the geographic distance between them (Micco et al., 2003); the former variable is positively correlated with bilateral trade and the latter negatively.

In this study, I modify the gravity model by employing the method introduced by Glick and Rose (2001) and including an indicator variable for each country-pair. This approach will omit cross-sectional variation and isolate the true euro effect; country-pair fixed effects absorb any time-invariant attributes such as distance, contiguity, common language, and free trade agreements, as well as any unobservable characteristics. The resulting model is given by the following:

$$(8)\ \ln Trade_{ijt} = \alpha + \beta_1 \cdot \ln Y_{it} Y_{jt} + \beta_2 \cdot EU_{ijt} + \beta_3 \cdot Euro_{ijt} + \beta_4 \cdot Years_t + \gamma_{ij} + \varepsilon_{ijt}$$

where $\ln Trade_{ij}$ represents the log bilateral trade (sum of exports and imports), $Y_i Y_j$ is the product of the real GDPs of the countries, EU_{ij} is a binary variable equal to one if both countries pertain to the European Union (only applicable for observations after 1993), $Euro_{ij}$ is an binary variable equal to one if both countries adopted the euro as their national currency (post-1999), $Years_{ij}$ is a

variable equal to one for the first year in the observation set and increasing in value by one for each additional year, and γ_{ij} are the country-pair indicator variables. In this regression, I include seven countries on the euro (Austria, Finland, France, Germany, Italy, the Netherlands, Spain), two additional EU member states (Denmark, the United Kingdom), and six extra-EU countries (Australia, Brazil, Canada, Japan, Switzerland, the United States).

It is possible that the trade effect is, at least in part, compounding, and was not fully realized in the moment of formation. To test this, I include a time trend variable measuring how long a country has been on the euro and estimate the equation:

$$(9)\ \ln Trade_{ijt} = \alpha + \beta_1 \cdot \ln \Upsilon_{it}\Upsilon_{jt} + \beta_2 \cdot EU_{ijt} + \beta_3 \cdot Euro_{ijt} + \beta_4 \cdot Years_t + \beta_5 \cdot Years * Euro_{ijt} + \gamma_{ij} + \varepsilon_{it}$$

where the covariates are defined as above.

5. RESULTS

5.1 Business Cycle Synchronization

The correlation coefficients for business cycle indicators before and after the formation of the European Economic and Monetary Union are compared in Table 1. These measures convey the degree of association between national and euro-aggregate fluctuations, with a value of one indicating perfect synchronization. The results show that the correlation of quarterly GDP rates increased substantially across time periods for every euro area country but one (Greece), the average correlation rising from 0.44 to 0.72. Smaller countries – Finland, Ireland, and the Netherlands – experience the greatest proportional change, but EU member states that are not on the euro also have a significant higher correlation in the second period, implying that the increase

is likely not solely due to the adoption of a single currency. For inflation rates, the correlation coefficients overall display a negative trend; nine of the twelve countries on the euro (excluding Austria, Greece, and Portugal) are less correlated with Eurozone inflation rates after 1999. The coefficients for United Kingdom and Sweden also decrease, while the number for Denmark remains relatively static. There appears to be a general reduction in correlation for unemployment rates as well, again with only three countries on the euro (Ireland, Netherlands, and Portugal) exhibiting a contrary pattern. The correlation estimates for the United Kingdom and Denmark in this case increase as well.

Table 2 reports the results from the correlation regression, which distinguishes the change in correlation that is a result of the euro from the portion that is instead due to a change in global atmosphere. The estimates using quarterly GDP growth rates are presented in Column 1. Coefficients on both covariates are positive and statistically significant at a 5% confidence level. The estimate for the global increase in correlation with the Eurozone in period two is 0.221 with a p-value of 0.002, whereas the single currency effect is 0.157 with a p-value of 0.048. These results suggest that although the formation of a monetary union contributed to the increase in GDP growth correlation among member states of the euro area, its impact was exceeded by that of global factors. For inflation rates, as shown in the second column, the time period indicator has a coefficient of -0.194 (p-value of 0.042) and while the effect of the euro on correlation is positive, it is statistically insignificant from zero. This implies that the observed decrease in correlation between the inflation rates of euro countries pre- and post-EMU is a global trend experienced by all countries, and the monetary union itself has not had a significant impact in this regard. Lastly, the correlation coefficients on both covariates in the unemployment regression are insignificantly different from zero. The higher standard error in this model could

be due to a smaller sample size: unemployment data for this time period was only available for nineteen countries, as opposed to twenty-five countries in the regressions for inflation and GDP growth rates.

Overall, the analysis of correlation coefficients provides evidence of increased, yet still imperfect, business cycle synchronization of euro-area nations when using GDP growth rates, but finds no effect of the monetary union on inflation rates or unemployment rates of member states.

5.2 Monetary Policy Response to Shocks

5.2.1 Interest Rate Response to Internal Shocks

The Taylor Rule parameter estimates for weights on lagged interest rate, inflation and unemployment fluctuations (ρ, ϕ_π, ϕ_u) are recorded in Table 3. The estimates for ρ – the coefficient on the lagged interest rate term – signify the amount of interest rate smoothing: how gradually the central bank adjusts rates to the benchmark level. The weights on inflation (ϕ_π) and unemployment (ϕ_u) indicate how drastically monetary policy responds to a gap between the realized rate and the target rate; a value higher in absolute value expresses policy choices that are more sensitive to fluctuations in internal conditions. Therefore, the most compelling insights into the implications of renouncing national monetary policy are gleaned from examining the changes in weights from the pre-period to the post-period: that is, the difference between the responses of domestic policy and those of the ECB's centralized policy.

Based on Taylor Rule theory, the inflation and unemployment weights should have opposite signs. Typically, a rise in the inflation rate will provoke an increase in interest rates and a rise in unemployment will stimulate a reduction; so the weights should be positive and

negative, respectively. This tendency is observed in every euro-area country but one (the Netherlands) when each country conducts its preferred monetary policy. However, the trend is reversed with the establishment of the ECB, after which only three of the ten still exhibit the standard signs for weights (Belgium, Germany, and Spain). For most countries, this is due to a switch to in the sign of the unemployment weight: nine countries have the standard negative coefficient in the pre-period, but only four do in the post-period. Both the United States and the United Kingdom continue to demonstrate weights with the expected signs in the latter period and thus, this difference does not appear to be a global trend.

Additionally, the absolute values of the inflation and unemployment weights decrease under ECB policy in almost every case. The only exceptions to this are an increase in absolute value for Portugal's inflation weight, but which is accompanied by an unexpectedly negative sign, and slightly larger inflation weights for Germany and Spain. For the remaining countries, the decrease in absolute value of both weights is significant, although there does not appear to be a pattern in which of the two decreases more, or by how much. For example, Belgium's estimates fall by 86% for inflation and by 18% for unemployment, and Austria's by 52% for inflation and 97% for unemployment. The median reductions in weights for inflation and unemployment are 49% and 59%, respectively. Moreover, only six of the twenty post-period estimates are statistically different from zero, which is striking since eleven were significant in the pre-period. Once again this trend is not exhibited by the United States and the United Kingdom, who maintain domestic control of monetary policy.

Lastly, it is interesting to note a general, but not universal, increase in the coefficient for lagged interest rate: ρ increases for six countries, remains static for one, and decreases for three. This means that the interest rate is more persistent in the post-period. It is no longer responding

to countries' internal conditions and so more of the variation in the left hand side is now being picked up by this covariate.

These observations are in line with expectations. Weights that are smaller, and frequently insignificant, demonstrate that the monetary policy actions of the ECB are hardly responding to internal conditions on a national level. Furthermore, the atypical signs in the post-period imply that as a result of the currency union, not only does monetary policy diverge from each country's preferred policy, but it even displays characteristics that contradict a widely accepted theory of optimal monetary policy. The disparities between the pre- and post-period estimates emphasize the difficulty of managing highly diverse and imperfectly synchronized countries with a single monetary policy. The effects this has on the economies of member states will be investigated in following analyses.

5.2.2 Exchange Rate Response to External Shocks

Centralizing monetary policy poses a cost when responding to external shocks as well, and it is this area that I explore next. Figures 1-4 show the projected pre-period and post-period behaviors of the corresponding series (exchange rate, unemployment rate, or inflation rate) in response to a one standard deviation shock in oil prices. The y-axis conveys the stimulated change in the variable. The pre- and post-period response functions are graphed together in order to identify any consistencies, or lack thereof, between the two. Each is graphed for ten quarters, thus measuring the impact for the two and a half years after a shock. The average post-period euro exchange rate that is used to scale national currencies is 1.22, so a fluctuation of 0.01 translates to a 0.8% change.

I first report the impulse response functions using inflation rates as the y_t outcome of interest. For all countries, the two exchange rate functions generally move in the same direction

for the first four quarters (appreciation in the first two, followed by a sharp depreciation in the next two), but the post-period values consistently remain slightly higher. This suggests that the euro appreciates more in response to an oil shock than national currencies used to. The discrepancies between the fluctuations vary across countries, as does the behavior after the first four quarters. For example, the difference for France is almost negligible in the first year, after which the post-period depreciates compared to the pre-period. On the other hand, Spain displays an initial post-period appreciation of 0.02 instead of a pre-period change of essentially zero, and the two functions diverge significantly after the first year.

Trends in inflation rates are consistent across countries, with higher post-period values exhibited in the first four to six quarters: an oil shock causes a sharper increase in inflation under a single currency. All graphs display a difference between the two functions during the third and fourth periods of about 0.25 percentage points. As a point of reference, quarterly inflation rates in the euro area averaged around 2 percent from 1991 to 2016,[4] so this gap translates to just over 10% of total inflation. However, three of the four countries have lower inflation in later quarters in the post-period.

Next, the results using unemployment rates are presented. Again, in response to a shock in oil prices, the euro undergoes an initial appreciation that is greater than national currencies' behavior was in the pre-EMU period, although scale of the difference varies across countries. However, there is heterogeneity across countries in the impact on unemployment. The unemployment rates of Italy and Spain react more strongly to a shock in oil prices once they are on the euro; by the tenth period, they are about half a percent higher in the post-period than they would have been in the pre-period. On the contrary, the impact of exogenous shock on unemployment rates for Germany and France is lessened after the formation of the monetary

[4] Euro Area Inflation Rate: http://www.tradingeconomics.com/euro-area/inflation-cpi

union. Both experience a fall in unemployment after an exogenous shock, with Germany reaching a surprising 0.4 percent decline.

These results provide preliminary evidence of differing pre- and post-period exchange rate fluctuations following an exogenous shock, but the impact that this has on key economic indicators is less clear. The shock does provoke higher inflation in the post-period, but the difference in inflation rates is fairly close to zero and may not be statistically significant. The results using unemployment rates are even less robust. Italy and Spain appear to experienced negative effects from the imposed monetary policy; however, France and Germany's exchange rate functions also change, although to a lesser degree, and yet these countries nonetheless see a betterment of unemployment rates after monetary union. This contradiction makes it difficult to assume a causal relationship between exchange rate responses and unemployment fluctuations. Additionally, it is important to note that the shock in oil prices is greater in the second period due to a higher standard deviation in the data, which could be shaping the difference in responses.

Based on this analysis alone it is difficult to come to a robust conclusion. Nonetheless, the higher inflation rates and increased unemployment rates of some countries in the post-period are intriguing. These patterns suggest initial support for the hypothesis that the loss of national exchange rates and monetary policy autonomy impedes countries' ability to respond to external shocks. Given the concerns about the robustness of these particular results, I attempt to answer this question with alternative, counterfactual method that addresses these limitations.

5.3 Counterfactual Estimation of Economic Costs

I present the results from the counterfactual model developed to quantify the economic costs suffered by individual member states as a result of a single currency. Figure 5 reports the

1999-2014 counterfactual GDP growth rates for France, Germany, Italy and Spain, using the fitted values for each period as previously discussed. Figure 6 shows the geometric sum of the growth rates from each projected function, thus capturing the overall growth compounded since period one instead of simply the growth rate of that quarter alone.

I find that for all countries, the post-period responses to external shocks have in fact limited their economy's potential for growth. This is already evident from the graphed growth rates, where the pre-period rates are consistently above the post-period ones, and further emphasized using the geometric sums. The difference in the geometric sum of growth rates is vast, ranging from a 0.153 (France) to a 0.343 (Italy) increase in GDP when the pre-period function is applied to the fifteen-year time span. These numbers translate to a fifteen to thirty-five percent gap in total GDP between the two scenarios by 2014. The post-period growth rates are also not only lower, but also generally more volatile: for France, this difference amounts to over three times the volatility, whereas Germany and Italy both have an increase in volatility of about fifty percent. Spain is the only exception, with volatility decreasing, but only slightly, from 0.88 percentage points to 0.76. Higher volatility is a negative impact as it indicates more dispersion among growth rates and, therefore, increased uncertainty and risk in the movement of the economy as a whole.

Because the methodology I employ measures only the fluctuations in national GDP that result directly from changes in the United States' growth rate, it isolates this impact from all other exogenous shocks and time-specific characteristics to provide a direct comparison between time periods. The only factor changed between the two scenarios is the country's ability to respond to exogenous shocks, an ability that is severely influenced by choice of monetary policy regime. The results from this analysis imply that as a result of changing their responses to the

United States' growth rate, member states' GDP growth has been severely restricted by 15-35% and has also become increasingly unstable. The single currency is imposing a detrimental economic cost on member states.

5.4 Intra-Euro Trade Impact

I now turn to quantifying the economic benefits experienced as a result of both EU membership and adopting the euro by assessing the intra-region trade impact, the leading economic advantage from monetary union (Table 4).

The general regression measures the average trade impact since the adoption of the euro in 1999. I find that the euro has increased trade among intra-euro country pairs by 13 percent (p value of 0.00), and that EU membership has had an impact of almost 10 percent (p value of 0.00). Given that countries on the euro by definition also belong to the EU, this produces an overall impact on trade of about 23 percent. These are larger than the previous estimates from Micco et al. – 3.9 percent and 4.2 percent, respectively – but still within reason. The effect of the logged product of real GDP is also positive and statistically significant; the coefficient of 0.856 signifies that a 100% increase in the product of real GDP generates an 86% rise in bilateral trade. This is as expected, since as countries' economies grow in size, so do quantities of exports and imports. Furthermore, the negative coefficient on the time trend implies that, after controlling for GDP growth, global trade flows have been decreasing at a rate of about 2 percent annually.

I investigate whether the euro effect is increasing with every additional year of monetary union by including a covariate to estimate the average annual effect (Equation 9). These results still demonstrate a negative trend in global trade flows of about 2.2 percent, and suggest a negative yearly euro effect as well, but of a much smaller magnitude (-0.003; p-value 0.000). In

this regression, the estimate of the euro trade impact is 16 percent and that of the EU effect is 17.5 percent. This implies a 33.5 percent increase in trade for euro-area countries, with half of it due to the single currency itself. These coefficients indicate the one-time trade impact upon adoption of the single currency, and not the average effect over time as in the previous general regression. In the general regression that did not control for years on the euro, the negative time effect was absorbed by the estimated coefficients, which is why those numbers were lower.

The euro impact on intra-region is in line with previous approximations from the literature, but on the high end, likely because additional years of data are now available. Nonetheless, my estimate still lies far below the expected "Rose effect" from his analysis of the historical impact of currency unions. Furthermore, my results show no evidence of a growing euro effect, and therefore this gap cannot be explained by a gradual trade adjustment. Perhaps the difference is due to earlier currency union effect estimates being biased upward by endogeneity of a country's choice of exchange regime, or maybe currency union effects are fundamentally dependent on country size (Frankel, 2008). Nonetheless, the euro effect appears to have roughly leveled off at approximately thirteen to sixteen percent, with a comparable increase resulting from EU membership alone. The reason EU participation alone, without the euro, influences trade is likely because of the benefits membership involves: tariffs are eliminated among all members, exporters no longer have to comply to numerous different rule books, and minimum regulatory standards are set such that goods that comply are allowed to be sold unhindered.

5.5 Cost-Benefit Analysis

The evidence from this study has proved that member states experience both economic costs and benefits and from monetary union, but the key question is whether the net effect

justifies monetary union. The trade impact analysis concluded that intra-region trade has increased by 13-16% for countries on the euro since the creation of the EMU. While this is a sizable increase in trade, the previously presented economic costs were denoted in regards to total national GDP as calculated by the expenditure approach. For European countries, exports amount to 20% of a country's GDP and imports to about 17%,[5] so the net balance of trade contributes to 3% of total GDP. Member states as a whole trade more with partners within the EU-28 than with countries outside, but there is a relatively large variation among countries in this proportion. For the twelve countries studied in this paper, the median value of the intra-EU to extra-EU trade ratio has traditionally been about 65%.[6] This means that intra-EU trade amounts to 2% of total GDP. Therefore, an average 13-16% increase in intra-region trade over the fifteen-year time horizon translates to only a 0.25-0.32% increase in GDP. This economic benefit is dwarfed by the costs, as the business cycle counterfactual analysis suggested a decline in average output of 15-35% as a result of the euro.

In making this comparison, I consider the trade impact of the euro and not of EU membership as a whole because the economic costs studied only resulted from the loss of control over domestic monetary policy. Certainly, the precision of this estimation is limited by its reliance on many assumptions. However, even if both a country's net trade contribution to GDP and its intra-EU fraction exceed the regional averages, this will hardly move the estimated impact on total GDP. Furthermore, even when comparing the most conservative estimate of costs to the highest estimate of benefits, GDP lost is of a much higher magnitude than GDP gained. The more reasonable comparison using averages yields an enormous difference: a 25% decline and a 0.285% increase in GDP. Given the degree of the difference, it seems impossible to deny

[5] Structure of the Euro Area Economy: https://www.ecb.europa.eu/mopo/eaec/html/index.en.html
[6] Intra-EU and Extra-EU Trade: http://ec.europa.eu/eurostat/statistics-explained/index.php/Intra-EU_trade_in_goods_-_recent_trends

that the economic benefits are immensely outweighed by the economic costs, despite the inherent difficulty in accurately quantifying the impact on national GDP resulting from a trade increase.

6. CONCLUSION

This paper assesses the impact of the euro on member states of the European Economic and Monetary Union and concludes that the region is not economically efficient as a currency area. My analysis uses a counterfactual model that is entirely novel in its approach and that allows for a compelling quantitative cost-benefit analysis. The evidence suggests that member states have suffered an enormous economic cost of a 15-35% decline in total GDP as a result of adopting the euro. This results from an impaired ability to respond to shocks after having surrendered to the ECB control of monetary policy and the national exchange rate, which are powerful tools to influence internal economic stabilization. The benefits of increased intra-region trade are not large enough to offset the negative implications: after controlling for growth over time, the contribution of trade to total GDP only amounts to an average increase of 0.25-0.32%.

This net effect is highly unlikely to reverse in coming years. I find that the trade impact is relatively static at this insufficient level and is not growing as euro optimists had previously hoped. Additionally, the most important problem of the EMU lies in the heterogeneity of member states, which is rendering impossible the implementation of optimal monetary policy under a single central bank. Such extensive economic and structural diversity between countries is extraordinarily difficult to influence, especially quickly. Therefore, barring drastic structural change, the economic stability lost as a result of the euro is expected to continue to outweigh the monetary efficiency gained.

The contribution of this study is an innovative and quantitative analysis of the impact of the EMU on member states. This evaluation not only enriches the general understanding of optimum currency areas as a whole, but also has practical applications for the current global economy. Further research might use the insights from this paper to investigate the most constructive approach to ameliorate the effects going forward. The future of the attempted European economic and political integration is still unclear, as evidenced by the rumored and hotly debated Greek exit from the euro in 2015 and the upcoming British referendum determining whether to remain in the European Union. A thorough understanding of the extensive economic effects of both the EMU and EU membership is critical in these cases, as well as for monetary and fiscal policy decision makers within the EMU. It also benefits all countries considering monetary union, within Europe or otherwise.

Lastly, this study does not claim to offer a comprehensive consideration of every implication of the euro. I have focused on the primary economic impacts experienced by member states, but effects are certainly felt in political, societal, and cultural contexts as well. Any discussion regarding the future of the EMU should consider these additional factors.

Table 1

Correlation Coefficients with the Euro Area, by Country

	GDP Growth Rate		Inflation Rate		Unemployment Rate	
Country	Pre-EMU	Post-EMU	Pre-EMU	Post-EMU	Pre-EMU	Post-EMU
Austria	0.461	0.712	0.219	0.388	0.670	0.639
Belgium	0.530	0.829	0.788	0.450	0.906	0.385
Finland	0.302	0.795	0.674	0.503	0.814	0.265
France	0.674	0.888	0.800	0.384	0.904	0.814
Germany	0.783	0.869	0.786	0.306	0.929	-0.200
Greece	0.475	0.473	0.367	0.510	-	-
Ireland	0.186	0.433	0.831	0.647	-0.237	0.711
Italy	0.561	0.931	0.804	0.613	0.721	0.385
Luxembourg	0.199	0.450	0.812	0.449	0.623	0.345
Netherlands	0.370	0.804	0.937	0.723	0.267	0.621
Portugal	0.352	0.631	0.480	0.680	0.381	0.573
Spain	0.438	0.776	0.707	0.605	0.917	0.775
——						
Denmark	0.176	0.620	0.710	0.727	0.189	0.303
United Kingdom	0.353	0.820	0.733	-0.188	0.252	0.728
Sweden	0.496	0.701	0.588	0.505	0.822	0.775

Notes: Greece is excluded from the unemployment analysis because consistent data was not available.

Table 2

Time Period Effect for Correlation Coefficients, All Countries
Parameter estimates (Standard errors) [p-value]

	OLS Coefficient Estimates		
Covariate	Quarterly GDP	Inflation	Unemployment
Period 2 (1999-Present)	0.221**	-0.194**	-0.057
	(0.066)	(0.093)	(0.157)
	[0.002]	[0.042]	[0.718]
Euro Area	0.157**	0.162	0.077
	(0.078)	(0.112)	(0.173)
	[0.048]	[0.151]	[0.658]

Notes: Countries included in all regressions are the 12 countries on the euro in 1999, Canada, Denmark, Japan, Norway, Sweden, the United Kingdom, and the United States. GDP and inflation regressions also include Australia, Korea, Mexico, Sweden, Switzerland, and Turkey. * Statistically different from 0 at the .10 confidence level. **Statistically different from 0 at the .05 confidence level.

Table 3

OLS Estimates of Taylor Rules, Pre- and Post-Zero-lower Bound
Parameter estimates (Standard errors) [p-value]

	Pre- EMU Period (Q1 1988 – Q4 1997)			Post-EMU Period (Q1 1999 – Q4 2008)		
Country	ρ	ϕ_π	ϕ_u	ρ	ϕ_π	ϕ_u
Austria	0.908**	1.685	-7.489**	0.904**	0.789	0.186
	(0.065)	(1.424)	(1.630)	(0.080)	(1.052)	(0.323)
	[0.000]	[0.245]	[0.000]	[0.000]	[0.439]	[0.551]
Belgium	0.804**	1.061	-1.383**	0.745**	0.145	-1.141*
	(0.060)	(1.133)	(0.485)	(0.124)	(0.235)	(0.655)
	[0.000]	[0.355]	[0.007]	[0.000]	[0.537]	[0.090]
Finland	0.785**	1.512	-0.260	0.583**	0.707**	0.211
	(0.080)	(1.400)	(0.507)	(0.150)	(0.293)	(0.161)
	[0.000]	[0.287]	[0.608]	[0.000]	[0.021]	[0.201]
France	0.760**	1.496	-1.483*	0.915**	0.588	1.401
	(0.093)	(0.264)	(0.198)	(0.127)	(1.914)	(2.701)
	[0.000]	[0.183]	[0.080]	[0.000]	[0.762]	[0.609]
Germany	0.716**	0.838**	-0.996**	0.857**	0.888	-0.363
	(0.070)	(0.282)	(0.183)	(0.117)	(0.762)	(0.811)
	[0.000]	[0.005]	[0.000]	[0.000]	[0.252]	[0.343]
Ireland	0.620**	2.237*	0.450	0.748**	0.778**	0.302
	(0.139)	(1.271)	(0.768)	(0.098)	(0.298)	(0.365)
	[0.000]	[0.088]	[0.562]	[0.000]	[0.013]	[0.411]
Italy	0.635**	1.090**	-0.800	0.922**	1.077	0.154
	(0.137)	(0.523)	(0.737)	(0.086)	(1.910)	(0.615)
	[0.001]	[0.045]	[0.287]	[0.000]	[0.580]	[0.812]
Netherlands	0.944**	-5.482**	-7.786	0.900**	-3.030**	-2.820**
	(0.044)	(2.000)	(2.500)	(0.100)	(0.820)	(1.340)
	[0.000]	[0.001]	[0.310]	[0.000]	[0.001]	[0.043]
Portugal	0.776**	1.125**	-0.411	0.987**	-8.923	-0.154
	(0.081)	(0.295)	(1.219)	(0.061)	(6.385)	(2.692)
	[0.0000]	[0.001]	[0.737]	[0.000]	[0.170]	[0.959]

Spain	0.796**	1.539**	-0.647*	0.902**	1.867**	-0.304
	(0.086)	(0.662)	(0.385)	(0.075)	(0.816)	(0.245)
	[0.000]	[0.026]	[0.072]	[0.000]	[0.026]	[0.220]

United Kingdom	0.905**	0.560	-1.925**	0.952**	6.760**	-9.981*
	(0.081)	(1.326)	(0.747)	(0.141)	(2.437)	(5.146)
	[0.000]	[0.660]	[0.011]	[0.000]	[0.007]	[0.051]
United States	0.910**	1.500**	-2.378**	0.468**	0.034	-2.583**
	(0.033)	(0.478)	(0.544)	(0.100)	(0.165)	(0.502)
	[0.000]	[0.003]	[0.000]	[0.000]	[0.831]	[0.000]

Notes: For the standard errors on the unemployment and inflation weights, the same transformation is applied as for ϕ, by multiplying the regression estimate by $\frac{1}{(1-\rho)}$

Table 4

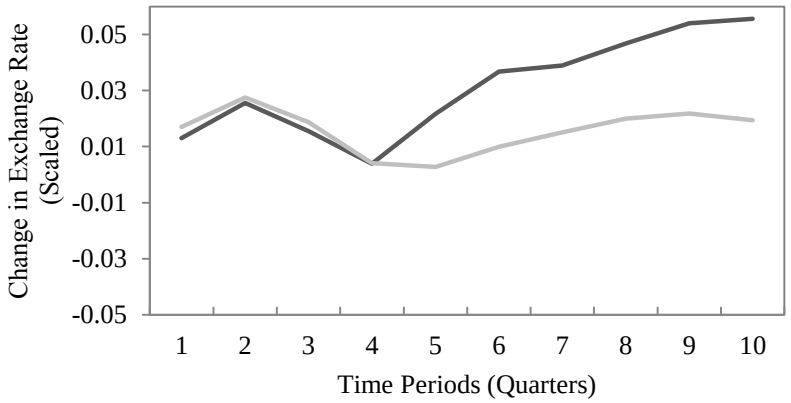
Euro Impact on Intra-Region Trade
Parameter estimates (Standard errors) [p-value]

Covariate	General Regression	Time Trend
Euro	0.129**	0.161**
	(0.019)	(0.022)
	[0.000]	[0.000]
EU	0.099**	0.175**
	(0.017)	(0.032)
	[0.000]	[0.000]
Real GDP*GDP	0.856**	0.855**
	(0.021)	(0.022)
	[0.000]	[0.000]
Time Trend	-0.021**	-0.022**
	(0.002)	(0.002)
	[0.000]	[0.000]
Years on Euro	-	-0.003**
		(0.002)
		[0.049]

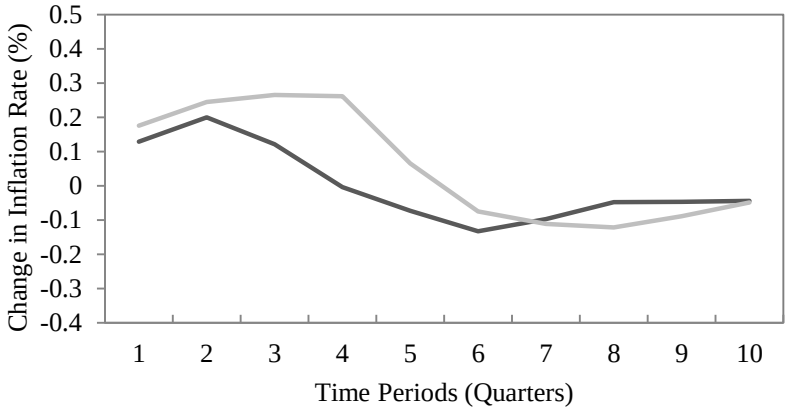
Notes: Countries included are 10 countries that adopted the euro in 1999 (excluding Belgium and Luxembourg), Australia, Brazil, Canada, Denmark, Japan, Switzerland, the United Kingdom, and the United States. Fixed country-pair effects are included in both regressions. * Statistically different from 0 at the .10 confidence level.
**Statistically different from 0 at the .05 confidence level.

Figure 1
Exchange Rate and Inflation Fluctuations after Exogenous Shock, Pre-Period (Dark) and Post-Period (Light) Response Functions

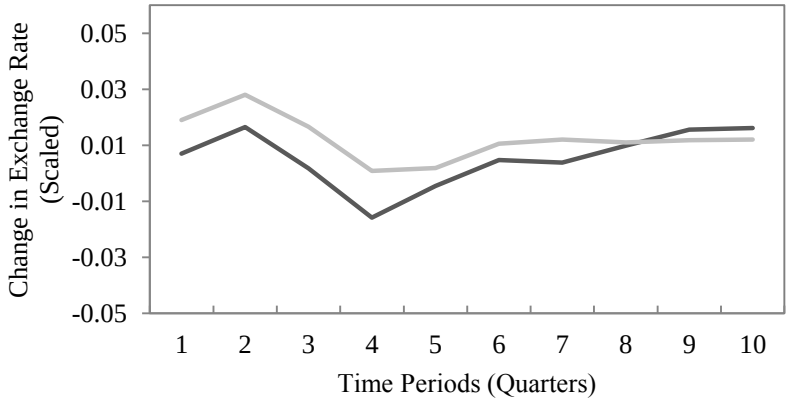
France – Exchange Rate



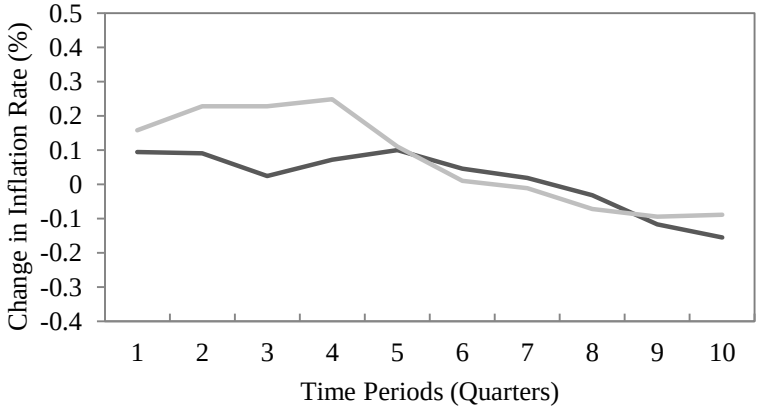
France – Inflation Rate



Germany – Exchange Rate



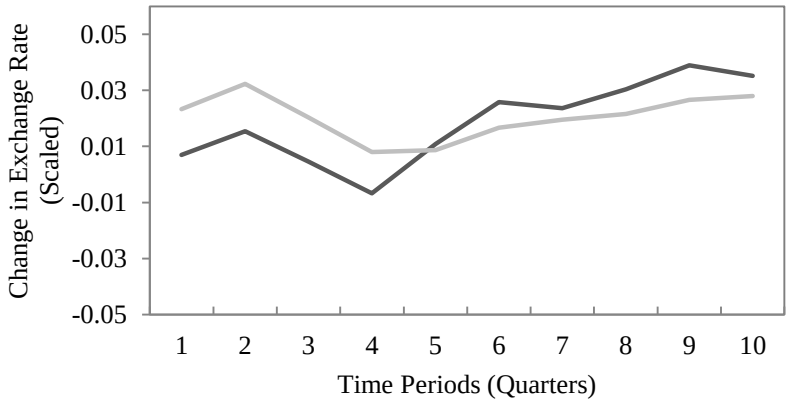
Germany – Inflation Rate



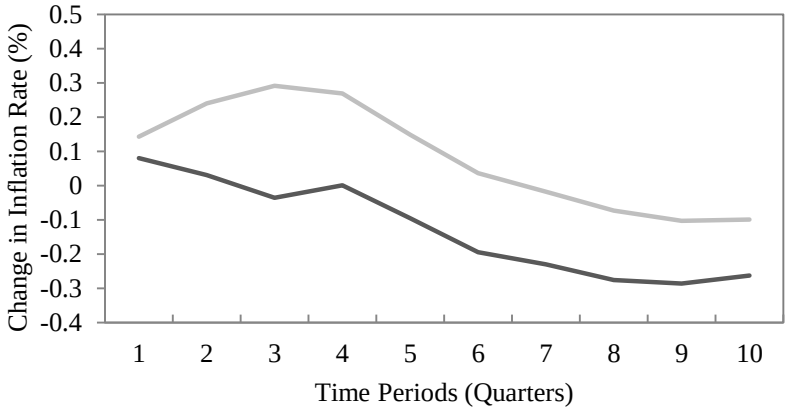
Notes: National currencies are scaled by applying the transformation: $ex_2 = \frac{ex_1}{\overline{ex}} \times \overline{euro}$ where ex_2 is the scaled national exchange rate, ex_1 is the original national exchange rate, $\overline{ex}$ is the average exchange rate of that currency in the pre-period, and $\overline{euro}$ is the average exchange rate of the euro in the post-period.

Figure 2
Exchange Rate and Inflation Fluctuations after Exogenous Shock, Pre-Period (Dark) and Post-Period (Light) Response Functions, (cont.)

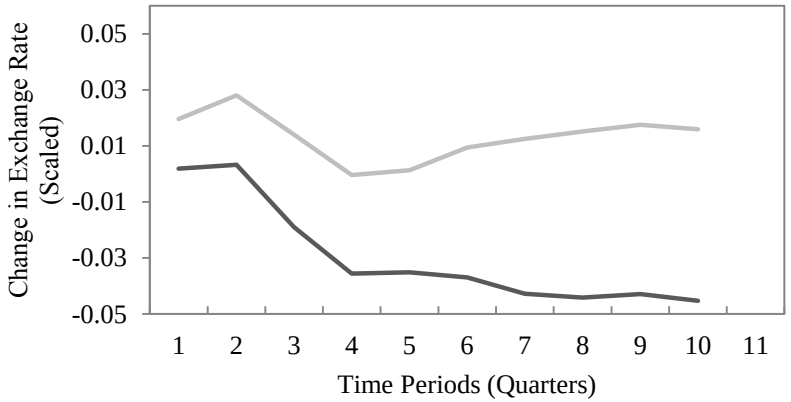
Italy – Exchange Rate



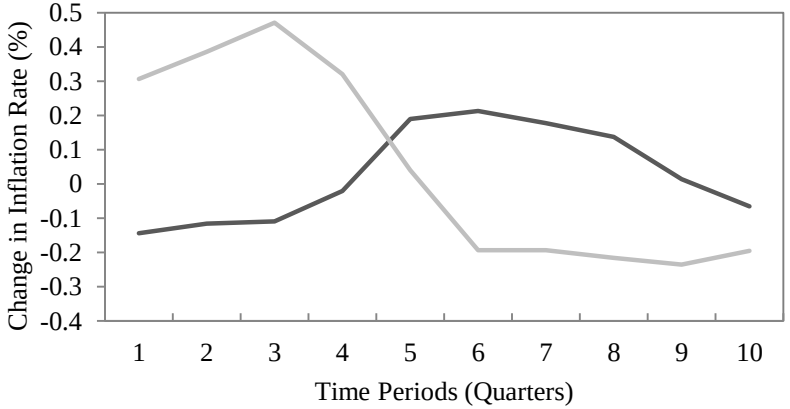
Italy – Inflation Rate



Spain – Exchange Rate



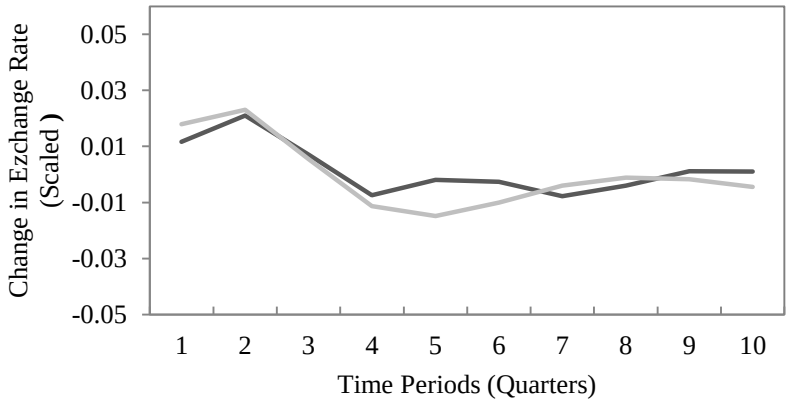
Spain – Inflation Rate



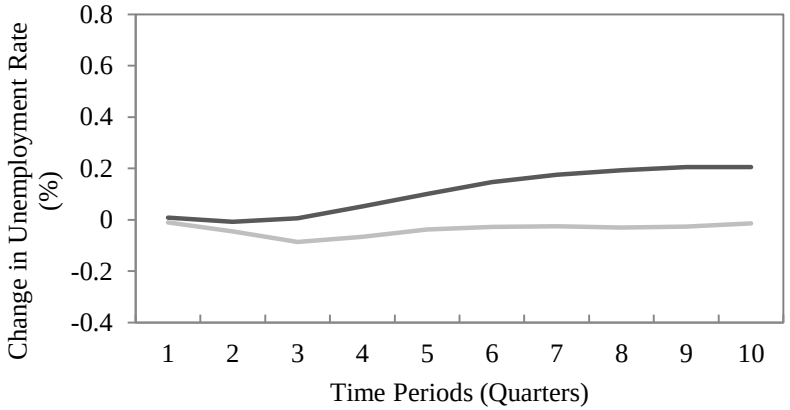
Notes: National currencies are scaled by applying the transformation: $ex_2 = \frac{ex_1}{\overline{ex}} \times \overline{euro}$ where ex_2 is the scaled national exchange rate, ex_1 is the original national exchange rate, $\overline{ex}$ is the average exchange rate of that currency in the pre-period, and $\overline{euro}$ is the average exchange rate of the euro in the post-period.

Figure 3
Exchange Rate and Unemployment Fluctuations after Exogenous Shock, Pre-Period (Dark) and Post-Period (Light) Response Functions

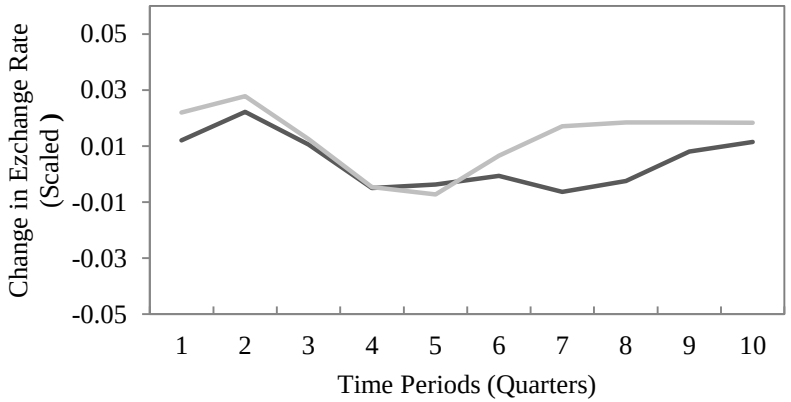
France – Exchange Rate



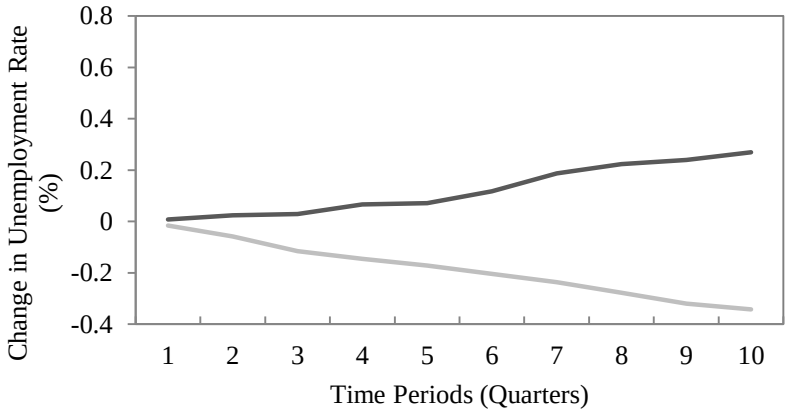
France – Unemployment Rate



Germany – Exchange Rate



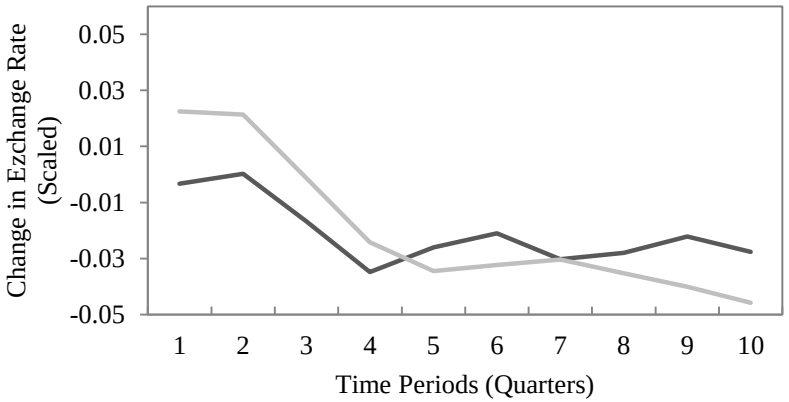
Germany – Unemployment Rate



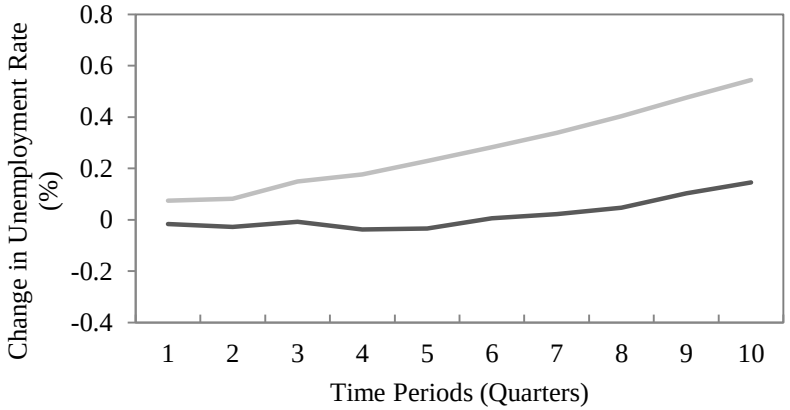
Notes: National currencies are scaled by applying the transformation: $ex_2 = \frac{ex_1}{\overline{ex}} \times \overline{euro}$ where ex_2 is the scaled national exchange rate, ex_1 is the original national exchange rate, $\overline{ex}$ is the average exchange rate of that currency in the pre-period, and $\overline{euro}$ is the average exchange rate of the euro in the post-period.

Figure 4
Exchange Rate and Unemployment Fluctuations after Exogenous Shock, Pre-Period (Dark) and Post-Period (Light) Response Functions, cont.

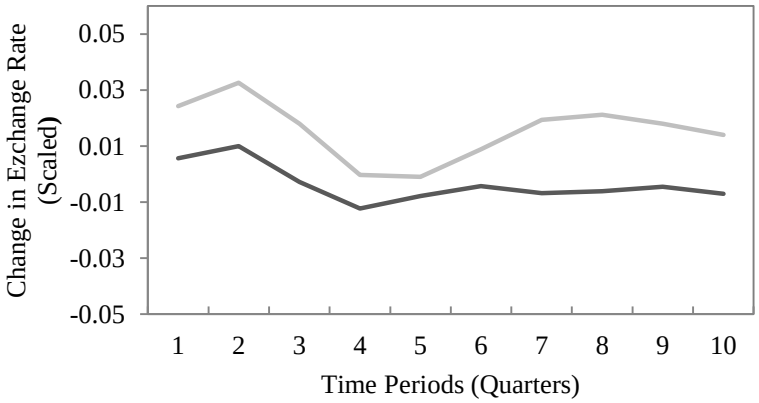
Italy – Exchange Rate



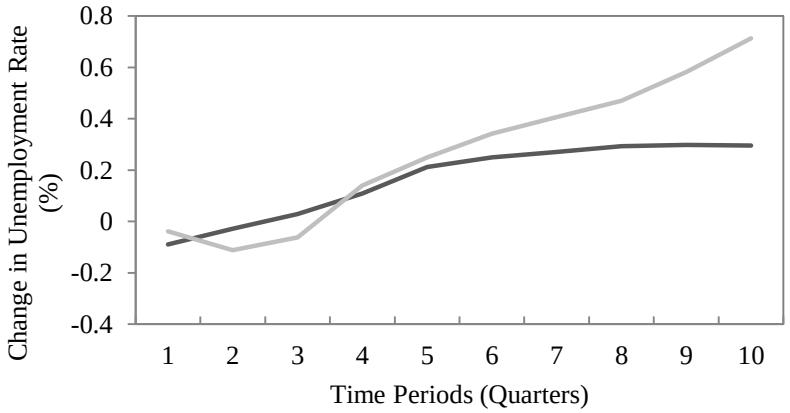
Italy – Unemployment Rate



Spain – Exchange Rate



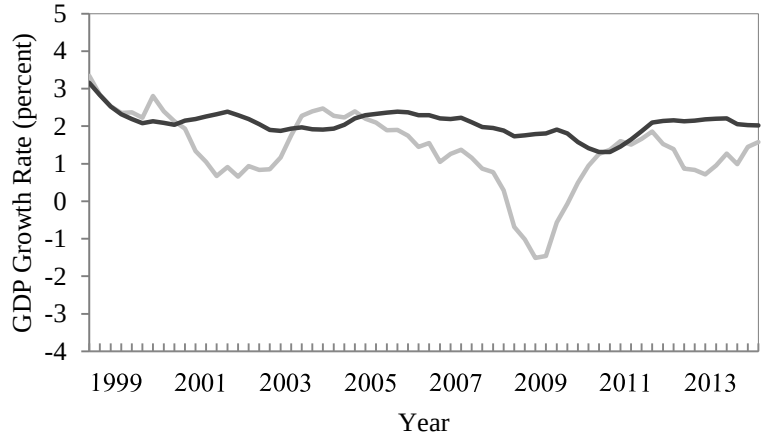
Spain – Unemployment Rate



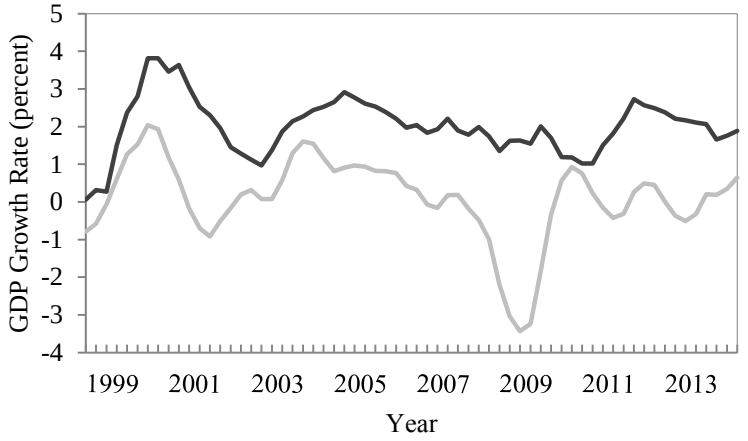
Notes: National currencies are scaled by applying the transformation: $ex_2 = \frac{ex_1}{\overline{ex}} \times \overline{euro}$ where ex_2 is the scaled national exchange rate, ex_1 is the original national exchange rate, $\overline{ex}$ is the average exchange rate of that currency in the pre-period, and $\overline{euro}$ is the average exchange rate of the euro in the post-period.

Figure 5
Counterfactual GDP Growth Rates (%), Given Pre-Period (Dark) and Post-Period (Light) Response Functions

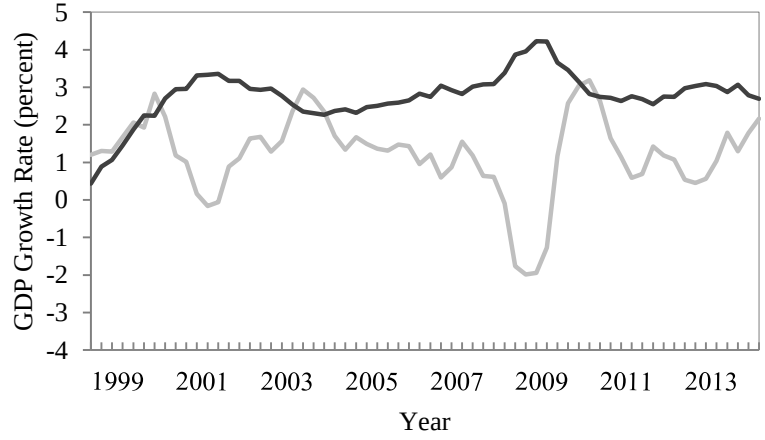
France



Italy



Germany



Spain

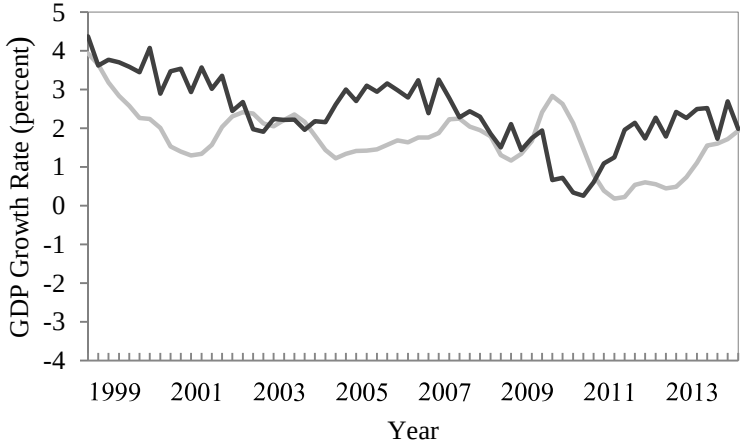
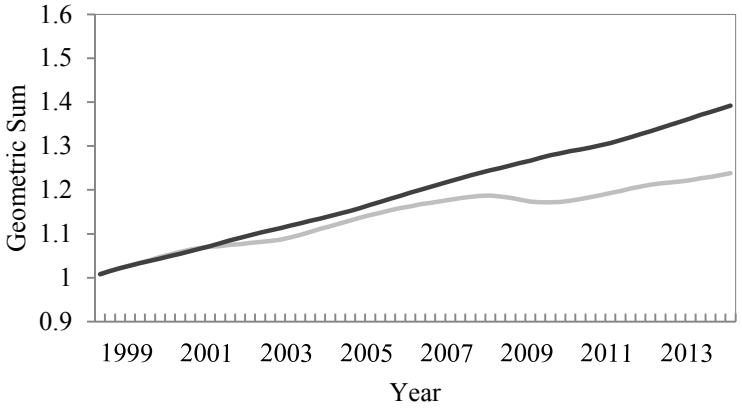
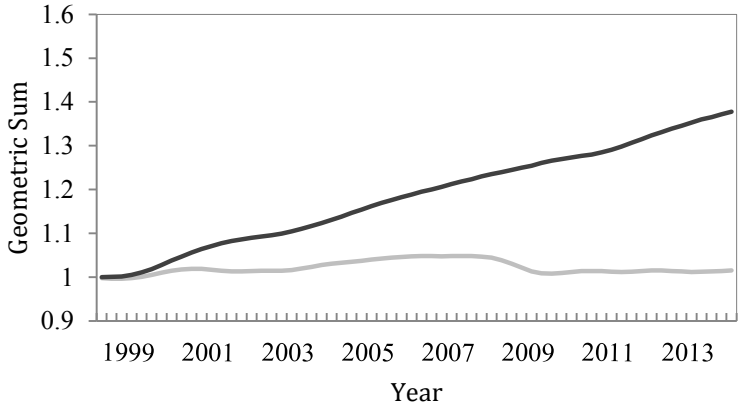


Figure 6
Geometric Sum of Counterfactual GDP Growth Rates (%), Given Pre-Period (Dark) and Post-Period (Light) Response Functions

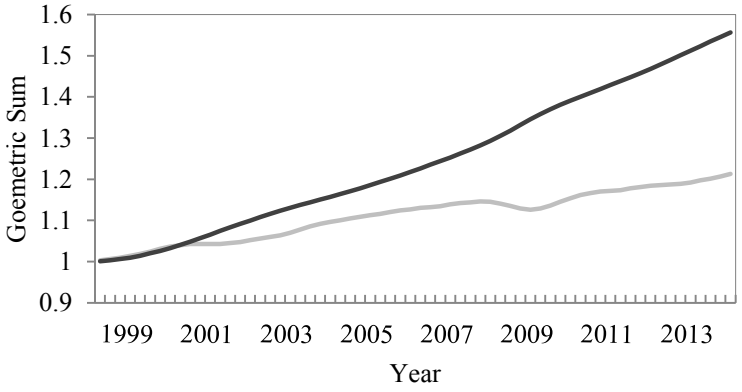
France



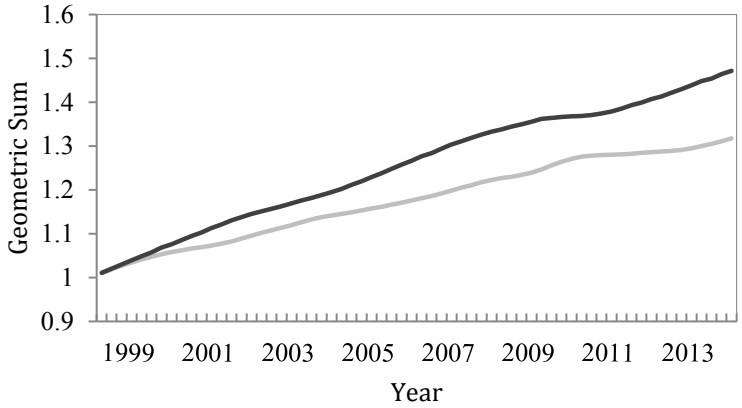
Italy



Germany



Spain



WORKS CITED

Crowley, Patrick M. and Jim Lee. 2008. “Do All Fit One Size? An Evaluation of the ECB Policy Response to the Changing Economic Conditions in Euro Area Member States.” *ACES Cases,* 2008.1.

Del Negro, M., and C. Otrok. 2008. “Dynamic Factor Models with Time-Varying Parameters: Measuring Changes in International Business Cycles.” *Federal Reserve Bank of New York Staff Reports*, 326.

Delivorias, Angelo. 2015. “A History of European Monetary Integration.” *European Parliamentary Research Service, Briefing.*

Dubois, Emmanuel, Jerome Hericourt, and Valerie Mignon. 2007. “What If the Euro had Never Been Launched? A Counterfactual Analysis of the Macroeconomic Impact of Euro Membership.” *Economics Bulletin,* 29(3): 2241-2255.

“The European Central Bank, the Eurosystem, the European System of Central Banks.” Updated 2009. *European Central Bank Brochures*. www.ecb.europa.eu/pub/pdf/other/escb_en_weben.pdf

Flam, Harry and Nordström, Håkan, 2006. "Trade Volume Effects of the Euro: Aggregate and Sector Estimates." *Stockholm University Institute for International Economic Studies Seminar Papers*, 746.

Eleftheriou, Maria, Dieter Gerdesmeier, and Barbara Roffia. 2006. “Monetary Policy Rules in the Pre-EMU Era: Is There a Common Rule?” *European Central Bank Working Paper Series,* 659.

Frankel, Jeffery A. 2008. “The Estimated Effects of the Euro on Trade: Why Are They Below Historical Effects of Monetary Unions Among Smaller Countries?” *National Bureau of Economic Research Working Paper Series,* 14542.

Frankel, Jeffery A. and Andrew K. Rose. 1998. “The Endogeneity of the Optimum Currency Area Criteria.” *The Economic Journal,* 108 (449): 1009-1025.

Furceri, Davide and Georgios Karras. 2008. “Business-cycle Synchronization in the EMU.” *Journal of Applied Economics,* 40(12): 1491-1501.

Giannone, Domenico, Michele Lenza, and Lucrezia Reichlin. 2009. “Business Cycles in the Euro Area.” *European Central Bank Working Paper Series,* 1010.

Glick, Reuven and Andrew K. Rose. 2001. 'Does a Currency Union Affect Trade? The Time Series Evidence.” *National Bureau of Economic Research Working Paper Series,* 8396.

Linnemmann, Hans. 1966. “An Econometric Study of International Trade Flows.” Amsterdam: North Holland Publishing Company.

Micco, Alejandro, Ernesto Stein, and Guillermo Ordoñez. 2003. “The Currency Union Effect on Trade: Early Evidence from EMU.” *Economic Policy,* 18(37): 315-356.

Mundell, Robert A. 1961. “A Theory of Optimum Currency Areas.” *The American Economic Review*, 51(4): 657-665.

Mushin, Andrew. 2015. “The Euro and Its Antecedents.” *Economic History Online Encyclopedia*, published online.

Rose, Andrew K. 2000. “One Money, One Market: Estimating the Effect of Common Currencies on Trade.” *Economic Policy,* 15(30): 8-45.

Shoup, Gary. 2012. “The International Guide to Foreign Currency Management.” New York: Routledge Taylor & Francis Group.

Stock, James H., and Mark W. Watson. 2001. "Vector Autoregressions." *Journal of Economic Perspectives*, 15(4): 101-115.