The Effect of Currency Unions on Business Cycle Correlations: the EMU Case

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Abstract

This paper examines empirically the effects of the introduction of the euro on the output correlation among the member economies. The similarity of shocks affecting the members is an important condition to minimize the costs from the loss of national monetary policy implementation. Bayoumi and Eichengreen (1993) pointed out that this is an important condition to be satisfied before joining a currency union. Frankel and Rose (1998) state that membership could lead to an ex-post rise in output correlations. In the current study, we employ ex-post and ex-ante data on output for 11 members and 11 non-members of the EMU and we test whether the adoption of the euro increased the output synchronization among members compared to non-members. The main findings of this paper are that there is weak, but not robust, evidence for a decrease in the average correlation among members compared to the co-movement among non-members. Our sensitivity analysis reveals that for a group of countries considered to be the core of the European Union, the effect is statistically insignificant. Any decrease in correlation could be attributed to the countries of the periphery, giving credit to Bayoumi and Eichengreen's (1993) and Krugman's (1993) arguments about increased specialization giving rise to idiosyncratic shocks.

Keywords: Business Cycle Synchronization, Currency Union Membership, Difference in Difference Estimation.

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1 Introduction

In his seminal paper, Mundell (1961) introduces the criteria that candidate countries should satisfy in order to form a currency union. The two mostly cited criteria are the degree of trade intensity between the candidate economies and the degree of similarity of the countries' response to shocks affecting them. Joining a currency union has benefits and costs. Among the benefits are lower trade costs and lower exchange rate uncertainty. The benefits in terms of trade flows are greater, the higher the trade intensity among the candidate countries. The introduction of a common currency incurs some costs as well. The most important is the abandonment of national use of monetary policy as a mean of insulating the economy against shocks that are country specific. This cost will be lower, the more symmetric the response of the candidate economies to the shocks that affect them.

The effects of currency union formation on trade flows have been vastly studied. Rose (2000) finds a positive and significant effect of currency unions on trade. Many authors tried to cast doubt on this high in significance and magnitude effect, but they still found a positive effect on trade (Persson, 2001). More recently, Micco et al. (2003) assess the effects of the formation of EMU on trade, finding a positive effect for the euro. Other studies (Santos Silva and Tenreyro, 2010, Berger and Nitsch, 2008) find no euro trade effect.

Although the effects of currency unions on trade flows have been examined using many methods and samples, this is not the case with the other important criterion for joining a currency union. The effect of currency unions on similar responses to shocks, or business cycle convergence, as is the term used in the literature, has remained almost unexplored by the empirical literature, compared to the currency union trade effect literature. Existing studies assessing the effects of currency unions on business cycles focus mainly on small countries. Other studies focus on a sample of small and rich countries, whose currencies are adopted by the former. Could the results from these studies be generalized to the case of a currency union among developed economies? One of the contributions of this paper is to study the relationship between currency unions and business cycles for the case of the European Monetary Union (EMU). This monetary union has recently undergone a crisis due to divergence among country members in key macroeconomic variables such as fiscal policy divergence and structural differences that were translated into inflation and growth rate differentials inside the union and the recent depreciation of the euro. Such developments undermine the functioning of a single monetary policy and the whole monetary union. Therefore, the study of divergence/convergence after the introduction of the euro has important implications about the correct functioning of the euro area and suggests that there may be future steps to be taken to improve the functioning of the euro area.

One of the well documented facts in the business cycle literature is that business cycles are endogenous with respect to the currency unions. Frankel and Rose (1998) point out that currency union membership may result in higher business cycle correlations and trade intensity among the members, even though these members did not seem to fulfill *a-priori* these two criteria. Therefore, more correlated business cycles could lead to the formation of a currency union and a currency union could lead to higher business cycle correlations.

In the trade intensity-currency union literature, many instruments have been proposed to solve the endogeneity problem between currency union membership and trade, but the authors admit that they were not functioning very well. Many of these instruments such as the probability of adopting a different currency (Alesina et al., 2002, Barro and Tenreyro, 2007) would not apply in the case under study, namely the EMU case, as it consists of economies, whose currencies were adopted by other economies. We try to overcome this difficulty to find a plausible instrument, by using a Difference in Difference (DID) estimator for the effect of currency union membership on business cycle correlations. More details on the method are given in Section 4.

A final contribution of this paper is the construction of the dependent variable. Many studies on the determinants of business cycle correlations use the usual Hodrick- Prescott filter (HP) to obtain the cyclical component of a measure of economic activity, usually GDP, and then calculate the correlation coefficients of the cyclical components. The introduction of the Euro in 1999 is a policy that could have affected the responses of economies to shocks after this event. The HP filter is a symmetric filter that makes use of all the observations in the sample to predict the trend and cyclical components of a series at a given point in time. Since we make use of the Difference in Difference estimator, we need to separate the information set for the period before and after the year 1999. We should use a modified version of the HP filter to take into account this change in policy in 1999. Therefore, we account for this using a structural break in the calculations of the filter. Two additional measures of business cycle correlation are computed: one based on the analysis of Alesina et al. (2002) and the other based on the residuals of a Vector Autoregressive (VAR) process. More details on the construction of the variables are given in Section 5.

The main findings of this paper are that there is a weak, but not robust, negative effect on the average correlation among members compared to the co-movement among non-members. Our sensitivity analysis reveals that for a group of countries considered to at the core of the European Union the effect, is statistically insignificant. Any decrease in correlation could be attributed to the countries of the periphery, giving credit to Bayoumi and Eichengreen's (1993) and Krugman's (1993) arguments about increased specialization giving rise to idiosyncratic shocks. Finally, the robustness checks section shows that the results depend heavily on the assumptions underlying the filtering procedure.

The rest of this the paper is organized as follows. In Section 2 we give a brief literature review of existing studies on the effect of currency union membership on business cycle correlations. Section 3 introduces the methodology of Difference in Difference estimation. Section 4 describes the data used in this paper and gives some descriptive statistics. Section 5 discusses the results of this study and section 6 summarizes the main conclusions of this paper.

2 Existing Literature

As mentioned in the introduction, few studies exist on the effects of currency union membership on business cycle correlations. Among the first to study the effect of currency union membership on business cycle correlations is Rose and Engel (2002). In a paper testing empirically the effect of currency unions on trade, prices, business cycles and risk sharing, the authors find a positive and significant effect of currency unions on business cycle correlations. After performing different perturbations in their baseline model, Rose and Engel (2002) find that output correlations are on average 0.1 higher for countries that are members of a currency union than for non-members. The authors acknowledge that they cannot distinguish if this effect is one of currency unions on business cycles or of business cycles on currency unions. Therefore, their estimate suffers from reverse causality issues.

From the literature on the determinants of business cycle correlations, some authors have considered currency unions as a potential determinant of business cycle correlations. Baxter and Kouparitsas (2004) consider a large number of countries and use Leamer's (1983) Extreme Bound Analysis to determine which variables robustly determine business cycle correlations. They find that trade intensity and distance are the only robust determinants. Currency unions are not found to have a robust significant effect on business cycle correlations.

Frankel and Rose (2002) examine the effects of currency unions on trade and output. The authors find a positive and significant effect of currency unions on trade and output. They find that the main channel through which currency unions affect output growth is trade. However, they do not consider the effect on output co-movements.

Alesina et al. (2002) argue that the more related the shocks are between two countries, the more suitable the policy selected by the anchor country or the central bank will be for the countries that adopt the common currency. Therefore, the cost for abandoning monetary policy independence will be small. According to the authors, for developing countries it is ambiguous whether abolishing monetary policy independence will be a cost. They cite different views. According to one view, developing economies do not use monetary policy properly as a stabilization tool, so the cost would be small. On the other hand, there is evidence that a floating exchange rate effectively helps to face terms of trade shocks, so the cost would be high. The authors use a sample of economies, that anchor their currency to that of a larger economy. They find no significant effect of currency unions on output co-movements. They attribute this finding to the ambiguous theoretical link between currency unions and output co-movements.

Barro and Tenreyro (2007) use an Instrumental Variables (IV) approach to estimate the effects of currency unions on trade, price and output co-movements. The authors try to solve the endogeneity problem between currency unions, trade and output co-movements by using as an instrument the likelihood with which two countries independently adopt the currency of the same anchor country. They find that currency unions have a positive effect on trade and increase the co-movement of prices. However, currency unions might decrease output co-movements. The authors suggest that the reason for this negative effect on output co-movement is that currency unions induce more sectoral specialization among the members. Therefore, the industry specific shocks become country specific shocks and the cost of abolishing national monetary policy to join a currency union will be higher. The sample used by the authors consists of small countries adopting the currency of anchor countries. The conclusion is that there may be sectoral specialization in those economies and this might explain the negative effect found by the authors. However, this may not be the case for a currency union among developed economies with more similar economic structures. If developed economies have more similar economic structures, they will be subjected to similar shocks and integration may lead to a higher correlation of outputs.

Fielding and Shields (2004) examine the impact of CFA Franc Zone on the volume of trade and business cycle correlations using data from 19 African economies. The authors use three alternative measures for business cycle correlations. These measures are the correlation between the annual GDP growth in each country pair, the correlation between the innovations from a VAR and the correlation of the innovations from a structural VAR. For the last measure the authors follow the methodology outlined by Blanchard and Quah (1989).[1] The authors use a regression framework based on the gravity model and include country fixed effects. The main finding of this study is that while the adoption of a single currency seems to foster trade and business cycle synchronization, this effect has declined over time. In particular, the authors find that the effect on business cycle correlations has become insignificant.

Eichengreen in a series of papers (1990, 1991, 1993) emphasizes the costs incurred by adopting a common currency and abandoning the conduct of national monetary policy. These costs are found to be high if there is no similar reaction to shocks affecting the potential members. Moreover, the costs would be high if there were no other mechanisms, such as labour mobility or fiscal transfers, to battle country specific negative shocks. Bayoumi and Eichengreen (1993) compare the nature of correlations of demand and supply shocks across European countries with that of the correlations across United States. The authors show that the shocks across Europe are found to be less correlated compared to those in the United States. The authors conclude that the costs from forming a monetary union in Europe could be substantial. It is stressed, however, that countries

[1] Applying the Blanchard and Quah methodology could be a potential extension of the current work.

at the core of the Europe (Germany and its neighbours) were found to experience high enough correlation of shocks to form a monetary union.

Recently, Goncalves and Soares (2007) perform a Difference in Difference analysis for the EMU case for the period 1980-2005. These authors perform a basic regression controlling only for an EMU dummy and changes in real variation in average bilateral trade. Their main finding is that the correlation of business cycles between EMU members has increased by approximately 5%. The authors attribute this positive effect not to the increased trade volumes between countries sharing a common currency, but to the conduct of a common monetary policy that might have led to greater business cycle similarities.

In the present study, we use the HP filter to calculate one of the measures of our dependent variable as in Goncalves and Soares (2007). However, as it will be explained in Section 5, the HP filter needs to be amended while employing a Difference in Difference estimator. While Goncalves and Soares (2007) consider trade as an independent variable, existing literature argues that there is potential endogeneity between trade and business cycles. In our case, we consider gravity variables in our regression to capture to some extent the effect of bilateral trade on business cycles similarity.

The above studies reveal that the focus of the literature is mainly on small countries adopting the currency of a larger economy. Secondly, the theoretical predictions about the effects of currency unions on business cycle correlations are ambiguous. On the one hand, currency unions can lower the trading costs and increase the benefits from trade. Simultaneously, this decrease in costs could cause specialization in production and give rise to idiosyncratic shocks affecting the economies. This would result in a decrease in output co-movements due to currency union participation. At the other end of the spectrum, if currency union participation does not induce specialization, then it enhances output co-movements. Finally, the most promising attempts (Alesina et al., 2002, Barro and Tenreyro, 2007) to deal with the endogeneity issues in the relationship studied in the current study cannot be applied to the case of the EMU experience. This union is formed by developed economies whose currencies are more likely to have been anchor currencies for other economies. We try to deal with this endogeneity by using the Difference in Difference estimation introduced in the next section.

3 Estimation Methodology

3.1 Difference in Difference Estimator and related issues

In this section we introduce the estimation technique used in this paper to test the relationship between the introduction of the euro and the business cycle correlations among the union members. The Difference in Difference (DID) methodology is based on the identification of a treatment or policy. The technique requires that we have observations for the outcomes of two groups of individuals (countries in our case) over two periods of time: the period before and the period after the treatment is realized. The two groups of individuals consist of the individuals subjected to the treatment (treatment group) and those that are not subjected to the treatment (control group). The treatment effect is then the difference between the average gain of the second group subtracted from the average gain of the first group.[2]

Ashenfelter and Card (1985) and Abadie (2005) show that the treatment effect could be obtained by running the following regression:

$$y_{it} = \beta_0 + \beta_1 treat_{it} + \beta_2 post_{it} + \beta_3 treat_{it} * post_{it} + \epsilon_{it} \tag{1}$$

where $treat_{it}$ is a dummy that is 1 if the individual unit belongs to the treatment group and 0 otherwise, $post_{it}$ is a dummy equal to 1 if the time period is after the introduction of treatment and 0 before, $treat_{it} * post_{it}$ will be 1 if the unit belongs to the treatment group and is observed after the treatment is realized and 0 in every other case. Finally, ϵ_{it} is an error term assumed to satisfy the classical linear regression model assumptions. The OLS coefficient of the interaction term gives us the estimate of the treatment effect:

$$\hat{\beta}_3 = (\bar{y}_{T,2} - \bar{y}_{T,1}) - (\bar{y}_{C,2} - \bar{y}_{C,1}) \tag{2}$$

The expression above states that $\hat{\beta}_3$ is the difference between the average effect in the treatment group between period 2 (after treatment) and period 1 (before the treatment) and the average effect in the control group between period 2 and period 1. The above estimator is unbiased based on the assumption that on the absence of the treatment, the treatment group would have followed a similar time path as to control group. Since it is difficult to provide a counterfactual for the treatment group after it has been subjected to the treatment (i.e. an observation for the treatment group had they not be subjected to the treatment), we make use of a control group that, under the above assumption, is such that it differs from the treatment group only in that it was not subjected to the treatment. Consequently, the time path of the control group serves as the counterfactual case for the treatment group. It is well understood that if such an assumption is violated, then the coefficient on the interaction term captures the effect of other differences in the two groups apart from the treatment. To sum up, the choice of the control group in this case is critical for the results.

Good control groups will also respond similarly to the treatment group to changes in any variables that cause the policy change. By contrast, there exist forces that would affect the treatment group in a different way to the control group and these forces may cause the treated individuals to be more likely to receive the treatment. This causes the

[2]Other early studies using the Difference in Difference framework in other applications are Card (1990, 1994), Card and Krueger (1994).

treatment to be endogenous to other forces happening simultaneously with the introduction of the treatment and have a differential effect on the outcomes in the two groups in the after-treatment period (Besley and Case, 1994). This would bias the treatment effect estimation as well. For the treatment effect to be unbiased it must be the case that both groups are affected in the same way by the change in those variables; or that those variables remain unchanged in the pre and post treatment period.

The coefficients β_1 and β_2 account for effects of time varying and time invariant factors that are assumed to affect the outcomes in both groups in the same ways. According to the discussion so far, it can be the case that state laws or macroeconomic conditions could affect the groups in a different way (β_2 is not common in both groups). Moreover, β_1 may not be common in both groups, as the outcomes of the two groups may depend on group specific time invariant characteristics, if the control group is dissimilar to the treatment group in terms of outcomes in both periods with the outcome of the treatment group in the period before the treatment.

It is well understood that the choice of the control groups to perform our analysis is important. Meyer (1994) has pointed out many of the potential biases in the DID framework. He proposes different ways to examine the comparability of the control and treatment groups. Among those is the use of different control groups to avoid the uncertainty in estimation due to a single control group. Moreover, he proposes the use of many pre and post intervention periods to check whether the two groups move together in time. Finally, it could be observed if there are substantial differences in mean characteristics among the groups.

In this study we form the treatment group including the 11 economies that adopted the euro as their common currency in 1999. These are developed European economies that include: Austria, Belgium, Luxembourg, France, Finland, Germany, Spain, Portugal, Italy, Netherlands, Ireland.[3] One could think that possible candidates for the control group would be countries with the same level of development that have been subjected to similar time and cross sectional changes. In this paper we use as potential units in the control group 11 OECD economies like USA, Canada, Japan, Australia, New Zealand, and other European economies that have not adopted the euro like Sweden, Switzerland, Denmark, Norway, UK, Iceland.

To check for the comparability of the two groups, we follow the ways proposed by Meyer (1994). We use different control groups, by splitting the initial control group into three subgroups. The three control groups resemble those used in Santos Silva and Tenreyro (2010). The first group consists of all the 11 economies indicated previously. This group will be denoted as OECD 11. The second group consists of the 6 European economies that have not adopted the euro (Sweden, Switzerland, Denmark, Norway, UK, Iceland). This group will be denoted as EU6. The third control group includes three

[3] Greece adopted the euro in 2001. Because of its late entry it is not easy to include it in our treatment group. Therefore, Greece is not included in the present study.

countries that were members of the European Union (EU), but did not adopt the euro in 1999 (Denmark, Sweden and the United Kingdom). This group will be denoted as EU Moreover, we use a large sample period at least before the introduction of the treatment. The sample starts at 1971 for two of our measures of the dependent variable and 1960 the third one. This allows us to check if the control groups have been moving together over time. Finally, we provide some evidence about mean differences in characteristics, such as inflation, government expenditure and industrial specialization.

We estimate Equation (1) by augmenting it to include a vector of gravity variables and country fixed effects:

$$\begin{aligned}\rho_{ij\tau} \;=\;& \beta_0 + \beta_1 treat_{ij\tau} + \beta_2 post_\tau + \beta_3 treat_{ij\tau} * post_\tau + \\ & \beta_4 ln(GDP_{i\tau}) + \beta_5 ln(GDP_{j\tau}) + \beta_6 Cont_{ij} + \beta_7 lnD_{ij} + \\ & \beta_8 Lang_{ij} + \beta_9 RTA_{ij\tau} + \beta_{10} Colony_{ij} + \beta_{11} Landl_{ij} + \\ & \beta_{12} Island_{ij} + \beta_{13} ln(Area_i) + \beta_{14}(Area_j) + \\ & \sum \theta_t CountryDummies + \epsilon_{ij\tau} \qquad (3)\end{aligned}$$

In equation (3), $\rho_{ij\tau}$ is a measure of bilateral business cycle correlations between country i and j over period τ, where τ refers to two periods: before and after the treatment. This indicates that for each country pair we end up with two observations in total, one before and after 1999. The basic setting of Equation (1) is augmented to include gravity variables for common border ($Cont_{ij}$), the log of bilateral distance (lnD_{ij}), a common language dummy ($Lang_{ij}$), a dummy for colonial relationship ($Colony_{ij}$), and variables for the number of islands and landlocked countries in a country pair ($Island_{ij}$ and $Landl_{ij}$ respectively). We also include the log of the mean of each country's GDP per capita over period τ ($ln(GDP_{i\tau})$ and $ln(GDP_{j\tau})$), the log of each country's area ($ln(Area_i)$ and ln($Area_j$)) and an RTA membership dummy ($RTA_{ij\tau}$).[4] We follow Alesina et al. (2002) in choosing this specification.

Trade intensity is one variable that should be included in the specification for Equation (3). It is regarded as one of the main determinants of business cycle correlations, but is endogenous (Frankel and Rose, 1998). By including the gravity variables in Equation (3), we account partially for factors that lead to higher trade and business cycle correlations. Following Alesina et al. (2002), country fixed effects (FE) are included in Equation (3) to account for unobserved effects affecting each economy's performance in each of our groups.

One word of caution here is that all the variables and criteria to choose the control group proposed above are just to provide ways of partially alleviating the problems of endogeneity and comparability among groups if there are unobserved, non-measurable

[4]The RTA dummy is constructed by using information for the years 1998 and 2005/2007, the last years of each period before and after the treatment.

characteristics affecting the two groups in a different way. We attempt to control for time invariant unobservable characteristics by including country FE in our regressions. Moreover, we may only partially identify a comparable control group due to the many different factors influencing in different ways even the OECD economies. We bear this in mind when conducting the analysis in the next sections.

3.2 Selection of control groups

In this section we provide rough evidence about the suitability of other OECD economies as members of our control groups. Tables 5 to 12 and Figures 4 to 11 in Appendix A, provide evidence that these countries have been affected in a similar way by general macroeconomic conditions.

Table 5 shows mean inflation rates for the treatment and control groups of countries for the period before (pre-treatment) and after (post-treatment) the introduction of the euro. Also the means for the entire period and the aggregate means for the two groups appear in the two last lines of this table. According to Table 5, there is a general decrease in mean inflation between the two periods for all the countries in both groups. Mean inflation is slightly higher in the control group in both periods, but there is a general decrease. Also from Figure 4 we can observe that there is a general decrease in mean inflation for both groups of economies. From the figure, we could say that the time series dimension reveals a common movement in inflation for both groups for the period studied.

Table 6 and Figure 5 show the mean government expenditure as a percentage of GDP for both groups in both periods. There is a slight increase in mean government expenditure for most of the countries and for both groups. Figure 5 shows that following the increase until 1980, government expenditure fluctuated at around 19% to 20% after 1980.

From Figure 6 and Table 7, it is observed that budget deficits have improved (less negative numbers) in the second period for both groups. The numbers are smaller in absolute value for the majority of the countries in the control group compared to those in the treatment group.

In Table 8 and Figure 7 we can see the evolution of mean openness (exports plus imports as a percentage of GDP). For both groups there is an upward tendency in the whole period as observed in Figure 7. This tendency is stronger in the case of the treatment group. The mean openness increased from 80.11 to 107.56, whereas the mean increase for the control group is only from 52.27 to 62.12.

Tables 9, 10, 11 and Figures 8, 9, 10 represent the evolution of the shares of the three main economic sectors in an economy: agriculture, industry and services. From the tables and the figures we observe a common change in these sectors for both groups. The agriculture and industrial shares decline over time, whereas there is a sharp increase in the services' sectoral share. However, these trends are stronger for many of the treatment group members and for the treatment group compared to the control group. The biggest difference is in agriculture, where the mean share fell from 6.03 to 2.38 for the treatment group, but only from 4.87 to 2.61 for the control group. The decline is more similar for the industrial shares (a decrease from 33.08 to 27.56 for the treatment group and a decline from 33.30 to 28.48 for the control group). Finally, the mean increase in services share in the treatment group was slightly higher (from 60.89 to 70.06) compared to the one in the control group (from 61.83 to 68.71).

Table 12 and Figure 11 show how the Net Foreign Asset Positions, as percentages of GDP, have evolved over time for the two groups. The mean change between the two periods for both groups is very similar (from -0.09 to -0.08 for the treatment group and from -0.11 to -0.07 for the control group). A closer look at Table 12 reveals that in both groups we have countries whose position improved i.e. they ended up paying back less for loans from foreign financial institutions (a lower negative number would indicate that) and other countries whose position worsened. The figure shows that the two series move together except for the periods between 1985-1990 and 1998-2000.

In a nutshell, it could be said that the two groups tend to move together in terms of inflation, government expenditure, openness and the change in sectoral shares. One important point from the previous analysis is that there are cases where there are specific trends particular in each group, which should be taken into account when analyzing the effect of currency unions on business cycle correlations.

4 Data and Variables

In this section we describe the data sources and the way we construct the measures of our dependent variable. We also give details about the dummy variables in the DID methodology.

4.1 Data Sources

We collect annual data for 22 OECD economies (see Tables in Appendix A) for the years 1962 to 2005. Our data sources for GDP are mainly from the World Bank WDI (World Development Indicators), the IMF IFS and the UN Common Dataset. Real GDP data are constructed by deflating the nominal GDP series in local currency units using national deflators (we express the series using 1995 as a base year). Data on the variables (inflation, government expenditure, agriculture share of GDP, industry share of GDP and services share of GDP) used in the analysis in the previous section are collected from the World Bank. Data on budget deficits are from the World Bank, the Eurostat and DataStream. Openness data are from the Penn World Tables 6.0. Data on Net Foreign Asset (NFA) positions are taken from Lane and Milessi-Feretti (2005). These data are available until

2004. We need to note here that we were unable to find data on budget deficits for the countries that are not assigned any values in the post-treatment period in Table 7. To obtain the GDP per capita variables used in the gravity models, we expressed real GDP in local currency units to US dollars using the base year exchange rates (base year is 1995). Then we divided the real GDP series in US dollars with total population. Data on total population were obtained from World Bank, the IMF and the UN Common Dataset. Finally, data on gravity variables were taken from the CEPII and Andrew Rose's website. The RTA membership dummy was constructed using information on RTAs based on Rose (2004a).

4.2 The Dependent Variable

The dependent variable in the present study is a measure of similarity of business cycles. The measure most widely used in the empirical literature of business cycles is the bilateral correlation coefficient of the cyclical component of a measure of economic activity. Three measures for the dependent variables are considered. The first measure is constructed as follows. We construct real GDP annual data for the economies (as described in Section 5.1), and we take logs. Then we extract the cyclical component from the original series. The most common way to filter a series in its trend and cyclical components is the Hodrick-Prescott (HP) filter. When the cyclical component for each individual GDP series is extracted, the correlation coefficient of the filtered GDP series for every country pair is calculated. This is the first measure of the dependent variable. The data used for this measure span the years 1971 to 2005.

There are many studies that have pointed out the drawbacks of using the HP filter as a way of decomposing a series into trend and cyclical components. The most important one is that the filter creates spurious cycles at business cycle frequencies in the filtered data, which do not appear in the original (unfiltered) series (Harvey and Jaeger, 1993, Cogley and Nason, 1995, Guay and St-Amant, 1997). This is because the filtered series from this filter can capture better the properties of a stationary series, and not those of a non-stationary series like GDP. In the case of a non-stationary series, there are many permanent innovations on the level of the series, which are not well-captured from a filter that imposes a smooth trend and suppresses the rest of the fluctuations in the cyclical component, thus creating spurious cyclicality. A second issue is that there is no provision for the existence of structural breaks on the original series. In the case of a structural break in the series, there is a jump in the series that is not well-captured by the smooth trend imposed by the HP filter. The change due to a structural break would only appear on the trend a few periods after the actual change happened. Finally, there is the so called end-points problem. The HP filter is essentially a symmetric filter that takes into account all the observations in the sample to predict the values of the trend and the cycle. The filter acts like a weighting scheme giving higher weights to more recent observations.

The filter performs well for observations in the middle of the sample, but as we approach the endpoints of the sample, the filter behaves like a one-sided filter.

Employing the DID estimator, a potential problem would be that since the filter is a two-sided filter, it will be using observations from the period after the introduction of the euro to predict the trend and cycle components for periods before 1999, and vice versa. Since the introduction of the euro could have an effect on the observations after the year 1999, there is a need to consider the potential existence of a structural break in the series. One of the problems associated with the classic HP filter is that it does not account for a structural break in the series. In this paper we use an amendment of the classic HP filter to account for a structural break around 1999, when it is used to decompose the original series in trend and cycle components. This amendment is due to Mohr (2005). Mohr's trend-cycle filter (TCF) is an effort to bring together the two families of methods used to decompose a series into filter and cyclical components: the *ad hoc* mechanical filters like the HP filter and the unobserved component models (UCM). In the UCM, a model for each one of all the different components of a series (trend, cycle, seasonal and daily components) could be specified and the model could be estimated into a state space form via the Kalman filter (see Harvey, 1989).

The HP filter is a special case of the TCF filter for particular parameter values. The TCF filter allows us to specify a model for the trend (up to an I(2) process), for the cycle (up to a second order process) and/or the seasonal components. The drawback of this method is that the length of the period of the cycle needs to be exogenously determined. The author provides the code in Matlab, which allows the incorporation of a structural break in the filter. This solves the potential problem of a structural break around the introduction of the euro that was not accounted for by the classic HP filter. In the next section the results based on the HP filter with a structural break as a special case of the TCF filter, are reported. In the robustness checks section, results are presented based on the HP filter with a specifically modelled cyclical component. Additionally, results are reported, where the trend is assumed to follow a random walk with a drift and the same model for the cycle as before.

Mohr (2005) gives evidence in his paper that the TCF filter, compared to the classic HP filter, provides a better treatment for the end-points problem. Moreover, the TCF filter allows for specific parameter values to model the trend as a non-stationary process and not as a smooth trend. Finally, it allows for a structural break in the trend, which is not the case for the HP filter.

The improvement on the classic HP filter is due to the explicit modeling of the cycle as a separate component in the filter. The classic HP filter is an one component filter. It extracts a smooth trend from the low frequencies of the series and leaves the rest of the frequencies in the irregular component. Hence, there is no explicit assumption about the cycle, but in the HP filter the irregular component is treated as the cyclical component. Because the trend and irregular components add up to the original series, there is no residual term capturing non-cyclical random influences. For instance, if there is a new data point that is actually an outlier and not generated by the data generating process characterizing the HP filter, then it has to become part of the trend or the cycle (Mohr 2005).

The HP filter is characterized by the choice of a parameter called λ to minimize the volatility of the cycle and the changes in the direction of the trend (Mohr, 2005). There is a trade off between the two as the higher the value of λ, the smoother the trend. A higher value of the λ parameter gives a better approximation in low frequency components (better approximation for a smooth trend), but suppresses in the cycle frequencies that would belong to the trend. A lower value of λ leads to a more volatile trend as high frequency components (shorter cycles) are attributed to the trend, giving a better approximation for the trend. The two components add up to the original series without allowing for a random disturbance to account for random influences not resulting from the underlying data generating process. These influences are attributed to the trend or cycle, making them even more volatile. The TCF filter allows the original series to be decomposed in a trend, cycle and irregular component, with the third component allowing for such random influences. This could reduce the extra variability that random influences would create on the trend or the cycle. Another problem is that there is no consensus about the value of λ, at least for annual data used in this paper.

One assumption about the data generating process of the HP filter is that the trend is a second order random walk. However, it has been argued that many macroeconomic processes like GDP are I(1) processes (Nelson and Plosser, 1982). The TCF filter allows a first order random walk process for the trend to be specified. In the robustness checks section, results are reported, where a first order random walk process for the trend is specified. In this study the HP filter results accounting for a structural break around 1999 are presented. In the robustness checks section, the same process for the trend as in the HP filter (a second order random walk process) is considered. An explicit model for the cycle is assumed as well, allowing for a separate irregular component. The model for the cycle is assumed to be a first order stochastic cycle as the one in Mohr (2005) and in Harvey (1989, page 39). The length of the cycle is set to 8 years, as suggested by Mohr (2005). As already mentioned this is one drawback of the method, as it is necessary to set the value of this parameter exogenously. However, the TCF filter allows for higher flexibility in setting the properties of the trend and the cyclical components, allowing for a separate irregular component. Once the cyclical component is obtained, the bilateral correlation coefficient is calculated for the period before and after 1999. Each country pair has two observations in the final dataset.

The second measure of our dependent variable is similar to the one used in Alesina et al. (2002). This is a measure of the volatility of the relative size of the shocks in GDP per capita for a pair of countries. To construct this measure, real GDP per capita data are used, which are constructed as described in Section 5.1. The GDP per capita ratios for each country pair in a given year are calculated as y_{it}/y_{jt} (where we use y to denote GDP per capita in this instance). The log of this ratio is calculated and it is regressed on a constant and its first and second lags:

$$ln(y_{it}/y_{jt}) \quad = \quad \gamma_0 + \gamma_1 ln(y_{i,t-1}/y_{j,t-1}) + \gamma_2 ln(y_{i,t-2}/y_{j,t-2}) + u_{ijt} \tag{4}$$

The estimated residual, $\hat{u}_{ijt}$, from this regression measures the relative output per capita that would not be predicted by its two previous values (Alesina et al., 2002, page 11). The last step is to calculate a measure of (lack) of output correlations as:

$$VY_{ij} \quad = \sqrt{\tfrac{1}{T-3}\textstyle\sum_{t=1}^{T}\hat{u}_{tij}^2} \tag{5}$$

A minus sign is considered so that this measure is interpreted as presence (and not lack) of output correlations between a country pair:

$$VY_{ij} \quad = -\sqrt{\tfrac{1}{T-3}\textstyle\sum_{t=1}^{T}\hat{u}_{tij}^2} \tag{6}$$

The higher the value of this measure, the higher the correlation between outputs in countries i and j. This measure is computed for the period before 1999 (1960 to 1998) and the period after 1999 (1999 to 2007). Therefore, there are two observations for each country pair, one before and one after the introduction of the euro as a common currency.

The third measure takes into account that other factors might affect the business cycle correlations. In particular, monetary policy might play a role on business cycle correlations as shown in previous studies of the determinants of business cycle correlation (Inklaar et al., 2005). To consider this factor, it is necessary to obtain a measure of business cycle correlations conditional on monetary shocks. For this reason, the estimated residuals from a 2 by 2 VAR are used, which considers the effects of monetary policy on output. The model estimated is as follows:

$$\begin{pmatrix} \Delta y_{it} \\ \Delta m_{it} \end{pmatrix} = \beta(L) \begin{pmatrix} \Delta y_{it-1} \\ \Delta m_{it-1} \end{pmatrix} + \begin{pmatrix} u_{it}^{y} \\ u_{it}^{m} \end{pmatrix},$$

where y_{it} is the log of real GDP in country i and m_{it} is the log of nominal M1,[5] $\beta(L)$ is a 2 by 2 matrix of lag polynomial operator. The estimated residuals, $\hat{u}_{it}^{y}$, are used from fitting a VAR with two lags of the type described above for each country. A dummy variable is also included as an exogenous variable, to account for the introduction of the euro. The correlation between $\hat{u}_{it}^{y}$ and $\hat{u}_{jt}^{y}$ for every pair i j are computed. This is a conditional measure of output correlations and removes one channel via which the adoption

[5]Data for M1 are gathered from DataStream and consistent measures for the M1 growth rates are constructed using the splining method. This was not possible for Luxembourg, so this country is not included in this last measure of output correlations.

of a single currency could affect business cycle correlations. A similar measure was used by Fielding and Shields (2004). We use data from 1963 to 2007. The M1 series is shorter for almost half of the countries, so for each country the maximum available number of observations is used in the calculations of bilateral correlations. For each country pair there are two observations in the final dataset, one referring to the period before and one to the period after the introduction of the euro.

Figures 1-3 offer a rough representation of the three measures for our dependent variable. The figures represent the average for each measure for the first and second half of the pre-treatment period and the average for the post-treatment period. Figure 1 shows that the average correlations diverged between the first half and second half pre-treatment period. After the introduction of the euro both averages rose in a similar way. We might expect no significance difference in the correlations after the adoption of euro according to the figure.

Figure 2 shows that while both groups experienced a similar decrease in average correlation before 1999, after 1999 the average correlation of the control group decreased more than that of the treatment group. Finally, the third measure in Figure 3 shows a decrease in both groups before 1999, but an increase after the introduction of the euro. The average correlation in the control has risen more than that of the treatment group. This means that the DID might deliver a negative treatment effect, which masks the greater rise in average correlation in the control compared to that in the treatment group.

4.3 The Independent Variables

According to the previous analysis of the DID methodology, it is necessary to construct certain dummy variables to carry out this estimation. The first dummy is the $treat_{ij\tau}$ dummy that is attributed a value of 1 if the pair of countries in the sample adopted the euro in 1999 and 0 otherwise. For instance, a pair with France and Italy is attributed the value 1 in the $treat_{ij\tau}$ dummy, while for pairs like France and Sweden or Sweden and Norway, this dummy is 0. In the control group, there are pairs where only one country adopted the euro and the other did not or where both countries did not adopt the euro. The second dummy variable is the $post_{ij\tau}$ variable appearing in Equation (1). This dummy is equal to 0 for the observations before 1999 and equal to 1 for any observation after 1999. Additionally, several controls, mainly gravity variables, are included to isolate some part of the trade effect on business cycle correlations. Moreover, variables are included to account for size like the log of each country's GDP per capita and each country's area. Finally, an RTA membership dummy is used. This specification resembles the one used in Alesina et al. (2002). Country fixed effects are used to account for unobserved time invariant effects that might affect business cycle correlations. Alesina et al. (2002) used country fixed effects in their analysis as well. The next section presents the main results of this study.

5 Empirical Analysis

5.1 Main results

In this section our main findings are presented. Table 1 below shows the results for each of the three measures of our dependent variable and for each of the three control groups. The first three columns in Table 1 refer to the first control group, where all the 11 OECD economies are included. The first column refers to the first measure of business cycle correlations, where the cyclical component is extracted using an HP filter with a structural break around 1999. Interest lies in the coefficient on the third line that corresponds to $\hat{\beta}_3$ in Equation (2). This gives the treatment effect. This effect is positive and significant at the 5% level. This means that the average output correlation among members of the euro has risen about 12% compared to the average output correlation among the pairs that did not share the euro. The coefficient on the $treat_{ij\tau}$ dummy is positive and significant, showing that the country members of the euro experienced higher output correlation over the entire period of study. The second column of Table 1 presents the results for our second measure of business cycle correlations. The treatment effect is small and significant at the 10% level. This indicates that the output correlations have become slightly lower compared to the ones in the control group. Finally, Column 3 of Table 1 presents the results for our last measure of output correlations, once monetary shocks are taken into account. The treatment effect shows that countries that adopted the euro seem to have experienced a rise in their output correlations by approximately 15% less compared to the increase in the control group. The countries in the treatment group seem to experience higher output correlation over the whole period (the coefficient on the $treat_{ij\tau}$ dummy is positive and significant, equal to 0.141).

Columns 4 to 6 in Table 1 repeat the same analysis as performed in the first three columns. Now the second control group with the six European economies is used. The effect of adopting a common currency on output correlations is negative and significant for the first and third measures (the coefficients are -0.136 and -0.159 respectively). On the other hand, the euro adoption does not seem to affect significantly output correlations when the second measure is used (the effect is equal to -0.002 in Column 5 and it is insignificant). Finally, the last three columns of Table 1 show the results when the last control group (Denmark, United Kingdom and Sweden) is used. The effects of the common currency are similar to the ones in Columns 4 to 6.

Our analysis reveals that in the case of more homogeneous control groups consisting of the other European economies, the treatment effect is negative and significant for two out of the three measures of output synchronicity. These results could be interpreted as follows: the average correlation among business cycles in the member countries does not seem to have increased more compared to the average correlation of the countries that did not adopt the euro. This supports Krugman's (1993) view that a currency union membership lowers trade costs and could induce specialization in production. This could result in country specific shocks causing business cycle divergence.

Table 1: Business Cycle Correlations and the Euro Effect

Variables	OECD11	OECD11	OECD11	EU6	EU6	EU6	EU3	EU3	EU3
$treat_{ij\tau}$	0.142***	0.003***	0.141***	0.198***	0.002	0.141**	0.183**	0.002	0.094
$post_{ij\tau}$	-0.027	0.029***	0.161*	0.262***	0.028***	0.201*	0.301**	0.027***	0.183
$\hat{\beta}_3$	0.119**	-0.004*	-0.148**	-0.136**	-0.002	-0.159**	-0.154**	-0.000	-0.152*
GDP per capita 1	-0.090	-0.022**	-0.031	0.407**	-0.028**	0.079	0.158	-0.025	-0.231
GDP per capita 2	0.273	-0.004	0.182	-0.190	0.000	0.018	-0.036	-0.004	0.281
Border	0.049	0.000	0.097*	-0.058	-0.000	0.121*	-0.008	0.001	0.201**
Distance	-0.041	-0.001	0.025	-0.230***	-0.002***	0.025	-0.135***	-0.001*	0.095
Language	0.114**	0.001*	0.068*	0.019	-0.000	-0.052	0.030	-0.001	-0.044
RTA	-0.039	0.000	0.105***	0.129***	-0.000	0.163**	-0.030	0.000	-0.005
Colony	-0.039	-0.000	0.044	0.046	-0.001	0.130*	0.011	-0.001	0.112
Landlocked	-0.091	-0.018***	-0.220	0.121*	0.015***	0.050	0.000	0.014***	-0.142
Island	0.424***	-0.013***	0.080	0.000	-0.007***	-0.193	0.000	-0.000	0.000
Area 1	-0.035	-0.001	-0.028	0.030	0.005***	-0.028	0.074**	0.005***	0.000
Area 2	0.007	0.002***	-0.018	-0.018	0.008***	0.016	0.004	0.008***	0.080
Constant	0.442	0.108*	0.135	0.614	-0.032	-0.306	-0.207	-0.026	-1.573
R^2	0.610	0.806	0.442	0.689	0.798	0.381	0.632	0.744	0.286
Number of Obs	380	462	420	210	272	240	132	182	156

* p<0.10, ** p<0.05, *** p<0.01, OLS results, Columns 1, 2 and 3: Results refer to the use of the first control group of the 11 OECD economies. Columns 4, 5 and 6: Results refer to the use of the second control group of the six European economies. Column 7, 8 and 9: Results refer to the use of the third control group of the three European economies. Results in columns 1, 4 and 7 refer to the dependent variable measured as the correlation coefficient between the cyclical components of real GDP. The cyclical component is obtained by applying the HP filter with a structural break in 1999. Results in columns 2, 5 and 8 refer to the dependent variable measured as in Alesina et al. (2002) and is explained in the text.
Results in columns 3, 6 and 9 refer to the dependent variable measured as the correlation coefficient between the predicted residuals from a VAR with GDP and money growth rates. The regressions include dummies for common border, common language, common colonial relationship, RTA membership, the log of bilateral distance and size measures like the log of GDP per capita and area for each country separately in each pair. Finally, country fixed effects are included in all the specifications.

Our second measure of business cycles indicates no effect of common currency on business cycles. This is in line with the finding of Alesina et al. (2002), that there is no effect of common currency adoption on output correlations (the authors use the same dependent variable like our second measure). Their study was mainly for small and open economies adopting the currency of richer economies. Our study extends their result in the case of a currency union among developed economies.

5.2 Robustness Checks

We perform three robustness checks. Firstly, the treatment group is separated into different country groups, to check whether there is a particular country group driving the results. Secondly, the analysis is performed at the country level i.e. each country is considered separately in the treatment group to check if the treatment effect is stronger for a particular country. Finally, results are reported by filtering the GDP data using two alternative sets of assumptions for the trend and the cycle.

In Table 2, the results for the first robustness check are reported (the treatment group is separated in different subgroups). We follow Micco et al. (2003) and we separate the EMU members into three groups: the core group that includes the original EU members (Belgium and Luxembourg, France, Germany, Netherlands and Italy), the DM bloc countries (Austria, Belgium and Luxembourg, Germany, France and Netherlands) and the less developed EMU economies (Ireland, Portugal and Spain). The layout of Table 2 is similar to that of Table 1. Only the coefficients of the treatment effect and the two basic dummy variables are reported. Panel A presents the results for the core group. The results are more robust for the second and third measures of business cycle correlations across all the control groups. In particular, in Columns 2, 5 and 8 the treatment effect is negative and significant. These models refer to the second measure of output correlations. This negative and significant effect means that on average the business cycles in member economies have become less synchronized compared to non-members (approximately around 1%). This result is confirmed by the models in Columns 3, 6 and 9, where the third measure is used. Results based on the first measure of output correlations are less robust and depend on the control group used.

Panel B of Table 2 shows the results for the DM block of countries. The common currency has affected negatively the business cycle convergence in all the cases apart from the first model. In most of the cases the effect on this block of countries is lower in absolute value compared to that in Panel A. Finally, in Panel C of Table 2, the results for the less developed EMU members are presented. The results indicate that the average correlation for these economies has increased less compared to that of non-members. This is the case for the first and third measure of business cycle correlations (Columns 1, 3, 4, 6, 7 and 9). The second measure indicates a small increase in the correlation between the less developed EMU members and any of the control groups (Columns 2, 5 and 8).

In the case where the effect is negative, this effect is greater (more negative) compared to the core and DM block of countries.

Table 2: Business Cycle Correlations and the Euro Effect :
Country Groups

Variables	OECD11	OECD11	OECD11	EU6	EU6	EU6	EU3	EU3	EU3
Panel A : Core Group									
$treat_{ij\tau}$	0.226***	0.009***	0.296***	0.290***	0.007***	0.347***	0.261***	0.007***	0.280**
$post_{ij\tau}$	-0.010	0.033***	0.164	0.174	0.038***	0.182	0.381	0.059***	0.126
$\hat{\beta}_3$	0.180***	-0.016***	-0.353**	-0.099*	-0.014***	-0.378**	-0.129	-0.012***	-0.353*
Panel B : DM block									
$treat_{ij\tau}$	0.137**	0.007***	0.259***	0.258***	0.006***	0.311***	0.185**	0.005**	0.293**
$post_{ij\tau}$	-0.010	0.033***	0.139	0.182	0.038***	0.140	0.456	0.056***	-0.078
$\hat{\beta}_3$	0.167**	-0.015***	-0.284***	-0.139**	-0.013***	-0.315***	-0.154*	-0.011***	-0.292**
Panel C : Least Developed EMU Economies									
$treat_{ij\tau}$	0.301**	-0.009**	0.162	0.749***	-0.043**	0.772*	0.760*	-0.000	0.000
$post_{ij\tau}$	-0.043	0.028***	0.158	0.179	0.028***	0.168	0.196	0.030*	0.065
$\hat{\beta}_3$	0.250	0.020***	-0.395***	-0.352***	0.027***	-0.551***	-0.301**	0.029*	-0.618***

* p<0.10, ** p<0.05, *** p<0.01, OLS results, Columns 1, 2 and 3: Results refer to the use of the first control group of the 11 OECD economies. Columns 4, 5 and 6: Results refer to the use of the second control group of the six European economies. Column 7, 8 and 9: Results refer to the use of the third control group of the three European economies. Results in columns 1, 4 and 7 refer to the dependent variable measured as the correlation coefficient between the cyclical components of real GDP. The cyclical component is obtained by applying the HP filter with a structural break in 1999. Results in columns 2, 5 and 8 refer to the dependent variable measured as in Alesina et al. (2002) and is explained in the text.
Results in columns 3, 6 and 9 refer to the dependent variable measured as the correlation coefficient between the predicted residuals from a VAR with GDP and money growth rates. The regressions include dummies for common border, common language, common colonial relationship, RTA membership, the log of bilateral distance and size measures like the log of GDP per capita and area for each country separately in each pair. Finally, country fixed effects are included in all the specifications.

These results are in line with the findings of Bayoumi and Eichengreen (1993) about the different nature of shocks between a core group of economies (Germany and its neighbours) and the periphery countries. Our findings indicate that the common currency has led, on average, to a smaller increase in the member countries' output correlations compared to that of non-members. The negative treatment effect is stronger in the case of the least developed member economies (viewed as the periphery in Eichengreen) compared to the effects on the core and DM blocks. This could be explained by the fact that the less developed economies entered the EU at a later stage compared to the core group. This might indicate that even though these economies were subjected to the same group of reforms as the core economies, this was for a shorter period compared to the core group. These results could reflect differences in economic structures that might cause idiosyncratic shocks in these economies compared to the core group countries.

In the next robustness check, the treatment group is decomposed in the country level. We split the treatment group into the individual countries that compose it and we run regressions having one country's correlations with all the other countries in the treatment group. For instance, we consider initially only the correlations of Austria with all the other 10 countries in the treatment group, then only the correlations of Belgium with the other 10 countries in the treatment group and so on. In this way it can be observed whether the sign and magnitude of the treatment effect differ across countries. The results are summarized in Table 3, where only the treatment effects are reported. Austria, Germany, Italy, Netherlands and Ireland do not seem to experience significantly higher output correlations compared to the non-members in the control groups. The results for the rest of the countries are mixed depending on the measure of the output correlations used. Belgium and Luxembourg are faced with a lower increase in output correlations compared to non-members, even though they are considered to be part of the core group of countries. For the rest of the countries, the effects are mainly insignificant when the group of the 11 OECD economies is considered. The effects are negative mainly when the treatment group is compared with the two control groups that consist of other European economies that did not adopt the euro. The majority of the effects remain insignificant for the second measure of business cycle correlations as in Alesina et al. (2002).

The results on the individual country members indicate a group of at least four countries (Austria, Germany, Italy, Netherlands) that support the story of core and periphery country groups. The effect of the adoption of a common currency is insignificant for these countries according to our results. There are core countries like Belgium, Luxembourg and France that faced either a decline or no decline at all in their correlations, depending on the measure used. Finally, the results for the less developed economies are mixed. Ireland seems to experience similar patterns in output correlations with the rest of the members before and after the euro adoption. Spain and Portugal face negative effects mainly when compared with the last two control groups and when the first and third measures of our dependent variable are used.

The third robustness check focuses on the method used to extract the cyclical components from the real GDP data. In the first case, a second order random walk for the trend and a first order stochastic cyclical component are assumed. In other words, we have an HP filter with a specific model for the cycle. We have already mentioned the benefits of such a model over the simple HP filter. In the second case, a first order random walk for the trend and a first order stochastic cycle are assumed. We change the assumption for the stochastic process of the trend, as there is evidence that the GDP series might be an I(1) and not an I(2) process as imposed by the classic HP filter (Nelson and Plosser, 1982). We also specify a structural break at around the introduction of the euro in 1999.

The results are presented in Table 4. Panel A of Table 4 shows the results for the HP filter with a specific model for the cycle. Each of the three columns corresponds to each of the three control groups. These results indicate that the treatment effect is insignificant. The $treat_{ij\tau}$ dummy is positive and significant in all the three cases, indicating that the members experienced higher output correlations regardless of the euro membership. Panel B of the same table, shows the results for the I(1) process assumed for the trend. The treatment effect remains insignificant and the $treat_{ij\tau}$ dummy is highly significant.

These results are in line with the second measure results of Table 4, that revealed an insignificant effect. On the other hand, they are not in line with the results on the other two measures employed in Table 4, which showed a negative and significant effect. The main conclusion is that the results depend on the model assumed for the trend and the cycle.

Table 3: Business Cycle Correlations and the Euro Effect :
Individual Economies

Variables	OECD11	OECD11	OECD11	EU6	EU6	EU6	EU3	EU3	EU3
Austria	0.103	-0.003	0.056	-0.170	-0.001	0.040	-0.180	- 0.001	0.067
Belgium		-0.007*	-0.470***		-0.006	-0.477***		-0.003	-0.451***
Finland	0.008	0.004	-0.100	-0.236*	0.006**	-0.096	-0.242	0.010***	-0.080
France	0.105	-0.008**	-0.305***	-0.120*	-0.007	-0.307**	-0.165*	-0.005	-0.300**
Germany	0.225***	-0.004	0.158	-0.004	-0.002	0.159	-0.048	-0.001	0.161
Ireland	0.100	0.009*	-0.023	-0.017	0.010*	0.013	-0.019	0.014	0.015
Italy	0.094	-0.005	-0.175	-0.141	-0.004	-0.173	-0.177	-0.002	-0.153
Luxembourg		-0.028***			-0.027***			-0.028***	
Netherlands	0.179***	-0.005	-0.129	-0.065	-0.002	-0.124	-0.085	0.001	-0.089
Portugal	0.073	0.007*	-0.061	-0.227**	0.009**	-0.089	-0.234**	0.011**	-0.057
Spain	0.135	0.000	-0.357***	-0.173*	0.002	-0.386***	-0.159	0.004	-0.380**

* p<0.10, ** p<0.05, *** p<0.01, OLS results, Columns 1, 2 and 3: Results refer to the use of the first control group of the 11 OECD economies. Columns 4, 5 and 6: Results refer to the use of the second control group of the six European economies. Column 7, 8 and 9: Results refer to the use of the third control group of the three European economies. Results in columns 1, 4 and 7 refer to the dependent variable measured as the correlation coefficient between the cyclical components of real GDP. The cyclical component is obtained by applying the HP filter with a structural break in 1999. Results in columns 2, 5 and 8 refer to the dependent variable measured as in Alesina et al. (2002) and is explained in the text.
Results in columns 3, 6 and 9 refer to the dependent variable measured as the correlation coefficient between the predicted residuals from a VAR with GDP and money growth rates. The regressions include dummies for common border, common language, common colonial relationship, RTA membership, the log of bilateral distance and size measures like the log of GDP per capita and area for each country separately in each pair. Finally, country fixed effects are included in all the specifications.

Table 4: Robustness Checks: Alternative Assumptions for the Trend and the Cycle

Variables	OECD11	EU6	EU3
Panel A: HP with a model for the cyclical component.			
$treat_{ij\tau}$	0.347**	0.568***	1.105***
$post_{ij\tau}$	0.894***	1.595***	1.526***
$\hat{\beta}_3$	-0.013	-0.062	0.331***
Panel B: Random Walk Trend with a model for the cyclical component.			
$treat_{ij\tau}$	0.631***	0.574**	0.511
$post_{ij\tau}$	-0.469**	-0.700**	-0.127
$\hat{\beta}_3$	0.115	-0.241	0.322

* p<0.10, ** p<0.05, *** p<0.01, OLS results, Column 1: Results refer to the use of the first control group of the 11 OECD economies. Column 2: Results refer to the use of the second control group of the six European economies. Column 3: Results refer to the use of the third control group of the three European economies. Results in Panel A refer to the dependent variable measured as the correlation coefficient between the cyclical components of real GDP. The cyclical component is obtained by applying the HP filter with a structural break in 1999 and assuming a separate model for the cycle. Results in Panel B refer to the dependent variable measured as the correlation coefficient between the cyclical components of real GDP. The cyclical component is obtained by applying the TCF filter with a structural break in 1999 and assuming that the trend follows a random walk process and a separate model for the cycle. The regressions include dummies for common border, common language, common colonial relationship, RTA membership, the log of bilateral distance and size measures like the log of GDP per capita and area for each country separately in each pair. Finally, country fixed effects are included in all the specifications.

6 Conclusions

In this paper we studied empirically the effect of currency union formation on the convergence of business cycles for the countries that adopted the euro in 1999. We try to solve the endogeneity between business cycle correlations and currency union membership by employing a Difference in Difference estimator. We study the case of EMU, as the already existing literature focuses its analysis on currency unions that are composed of small economies adopting the currency of a larger economy. Finally, we use an amended version of the HP filter to account for a potential structural break at around 1999, when detrending the real GDP series to get a cyclical measure for the calculations of business cycles correlations. Finally, we use two alternative measures based on recent papers in the literature.

Our main finding is that the effect of the common currency adoption is negative and significant for two out of the three measures for business cycle correlations employed in the current study. This is the case when we focus on the more homogeneous control groups consisting of European economies that did not adopt the euro. The third measure for output correlations adopted by Alesina et al. (2002) indicates an insignificant effect, in line with the results of Alesina et al. (2002). The negative result seems to be more in line with Krugman's (1993) argument that currency unions create specialization in production and shocks might become country specific shocks. This is in contrast with most of the literature on business cycles determinants which infers that there is a positive effect of specialization on business cycles correlations. These studies analyze OECD economies and suggest that this is evidence that there is more intra-industry trade taking place in Europe. Therefore, according to these studies, it is difficult to conclude that there is, to any great degree, production specialization in Europe. Frias et al. (2000) found that specialization patterns in European economies have not altered dramatically after the introduction of the internal market in Europe in 1992.

On the other hand, employing the third measure for output correlations adopted by Alesina et al. (2002) indicates an insignificant effect. This is in line with the results of Alesina et al. (2002) and Barro and Tenreyro (2007), who find no effect of currency unions on output correlations. These studies focus on currency unions among smaller economies and not on a currency union among more developed economies like the EMU. In light of these studies, the insignificant treatment effect found in this study, even though not in all the models, is somewhat in line with them. It means that there is no evidence that EMU members became on average more correlated with their partners in the euro-zone, with whom trade barriers were lowered due to the formation of the union.

Separating the treatment group into the core group and the least developed group, the negative effect is higher among the least developed economies. The separation of the treatment group at the country level indicated no effect on the business cycle correlations of most of the core group countries. The effect for the least developed economies is less robust, with the exemption of Ireland, which seems to experience no differences in its output correlations before nor after the euro. These results taken together support the story of Bayoumi and Eichengreen (1993) that there exist two different groups of countries within Europe, one with relatively more correlated shocks compared to the other. The less developed economies might face less correlated cycles as their economic structure differs to that of the core group. This could point towards Krugman's (1993) argument that currency unions lead to specialization in production.

The results depend heavily on the assumptions underlying the filtering procedure. When the trend is modelled as a first or second order random walk with a stochastic first order cycle, the results are uniform across cases and control groups. This provides some idea about what the implications of the filtering procedure adopted are for our results.

In this paper, much attention was given to the different factors for choosing the control groups in order to eliminate as far as possible differentiable effects of different variables on the two groups. However, it must be acknowledged that there might be some remaining factors that could affect the two groups in different ways. Moreover, we cannot say to what extent the treatment variable is not endogenous with respect to other things happening at the same time as the introduction of the euro. The best that could be achieved was to control for time invariant unobserved characteristics via the inclusion of country FE. We try to control this complication by choosing carefully the control groups. A potential solution is to use a smaller time window before and after the year 1999, to isolate the effect of the treatment (if any) and not general changes in other factors. Finally, a more comprehensive look at which process would be more appropriate for the filtering of the data is required. This could be done by model selection criteria available in applying the Kalman Filter on different models assumed for the trend and the cycle.

References

[1] Abadie, A., 2005. *Semiparametric Difference-in-Differences Estimators*, Review of Economic Studies, 72(1), 1-19.

[2] Alesina, A., Barro R.J. and S. Tenreyro, 2002. *Optimal Currency Areas*, NBER Working Paper No. 9072, National Bureau of Economic Research, Inc.

[3] Ashenfelter, O. and D. Card, 1985. *Using the Longitudinal Structure of Earnings to Estimate the Effects of Training Programs*, Review of Economics and Statistics, 67(4), 648-660.

[4] Barro, R.J. and S. Tenreyro, 2007. *Economic Effects of Currency Unions*, Economic Inquiry, Western Economic Association International, 45 (1), 1-23.

[5] Baxter, M. and M. Kouparitsas, 2004. *Determinants of Business Cycle Co Movement: a Robust Analysis*, NBER Working Paper No. 10725, National Bureau of Economic Research, Inc.

[6] Bayoumi, T. and B. Eichengreen, 1993. *Shocking Aspects of European Economic Unification*, in Adjustment and Growth in the European Monetary Union, ed. F Torres, F Giavazzi, 193-229. Cambridge: Cambridge University Press.

[7] Berger, H. and V. Nitsch, 2008. *Zooming out: the Trade Effect of the Euro in Historical Perspective*, Journal of International Money and Finance, 27, 1244-1260.

[8] Besley, T. and A. Case, 1994. *Unnatural Experiments? Estimating the Incidence of Endogenous Policies*, NBER Working Paper No. 4956, National Bureau of Economic Research, Inc.

[9] Blanchard, O.J. and D. Quah, 1989. *The Dynamic Effects of Aggregate Demand and Supply Disturbances*, American Economic Review, American Economic Association, 79 (4), 655-673.

[10] Card, D., 1990, *The Impact of the Mariel Boatlift on the Miami Labour Market*, Industrial and Labor Relations Review, 44, 245257.

[11] Card, D., 1992, *Do Minimum Wages Reduce Employment? A Case Study of California, 19871989*, Industrial and Labor Relations Review, 46, 3854.

[12] Card, D. and A.B. Krueger, 1994. *Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania*, American Economic Review, 84, 772793.

[13] Cogley, T. and J.M. Nason, 1995. *Effects of the Hodrick-Prescott Filter on Trend and Difference Stationary Time Series: Implications for Business Cycle Research*, Journal of Economic Dynamics and Control, 19(1-2), 253-278.

[14] Eichengreen, B., 1990. *One Money for Europe: Lessons from US Currency and Customs Union*, Economic Policy, 10, 118-187.

[15] Eichengreen, B., 1991. *Is Europe an Optimal Currency Area?*, NBER Working Paper No. 3579, National Bureau of Economic Research, Inc.

[16] Eichengreen, B., 1993. *European Monetary Unification*, Journal of Economic Literature, 1321-1357.

[17] Engel, C. and A.K. Rose, 2002. *Currency Unions and International Integration*, Journal of Money Credit and Banking, 34 (4), 1067-1089.

[18] Fielding, D. K. Shields, 2005. *The Impact of Monetary Union on Macroeconomic Integration: Evidence from West Africa*, Economica, London School of Economics and Political Science, 72 (288), 683-704.

[19] Frankel, J. and A. Rose, 1998. *The Endogeneity of the Optimum Currency Area Criteria*, Economic Journal, 108, 1009-1025.

[20] Frankel, J. and A.K. Rose, 2000. *Estimating the Effect of Currency Unions on Trade and Output*, NBER Working Paper No. 7857, National Bureau of Economic Research, Inc.

[21] Frias, I., Iglesias A. and I. Neira, 2000. *Regional Specialization and Trade Patterns in Europe*, Economic Development, 46, University of Santiago de Compostela, Faculty of Economics and Business. Econometrics.

[22] Goncalves, C.E.S., Rodrigues M. and S. Tiago, 2009. *Correlation of business cycles in the euro zone*, Economics Letters, Elsevier, 102 (1), 56-58.

[23] Guay, A. and P. St-Amant, 1997. *Do the Hodrick-Prescott and Baxter-King Filters Provide a Good Approximation of Business Cycles?*, Cahiers de Recherche CREFE / CREFE Working Paper No. 53, CREFE, Universit du Qubec Montral.

[24] Harvey, A.C. and A. Jaeger, 1993. *Detrending, Stylized Facts and the Business Cycle*, Journal of Applied Econometrics, 8, 231-248.

[25] Harvey, A.C., 1989. *Forecasting, Structural Time Series Models and the Kalman Filter*, Cambridge University Press, Cambridge.

[26] Hodrick, R. and E. Prescott, 1980. *Post-War US Business Cycles: An Empirical Investigation*, Working Paper, Carnegie-Mellon University, 205.

[27] Inklaar, R., Jong-a-Pin R. and J. De Haan, 2005. *Trade and Business cycle synchronization in OECD countries: A reexamination*, CESinfo Working Paper, No 1546.

[28] Krugman, P., 1990. *Increasing Returns and Economic Geography*, NBER Working Paper No. 3275, National Bureau of Economic Research, Inc.

[29] Krugman, P. (1993). *Lessons of Massachusetts for EMU*, in F. Giavazzi and F. Torres, eds., The Transition to Economic and Monetary Union in Europe, Cambridge University Press, New York, 241-261.

[30] Lane, P.R., and G.M. Milesi-Ferretti, 2006. *The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004*, The Institute for International Integration Studies Discussion Paper Series iiisdp 126, IIIS

[31] Meyer, B.D., 1994. *Natural and Quasi-Experiments in Economics*, NBER Technical Working Papers No. 0170, National Bureau of Economic Research, Inc.

[32] Micco, A., Stein E. and G. Ordonez, 2003. *The Currency Union Effect on Trade: Early Evidence from EMU*, Economic Policy, 37, 317-556.

[33] Mundell, R.A., 1961. *A Theory of Optimum Currency Areas*, American Economic Review, 51, 657-665.

[34] Mohr, M., 2005. *A Trend-Cycle(-Season) Filter*, Working Paper Series 499, European Central Bank.

[35] Mohr, M., 2005, *A Trend-Cycle(-Season) Filter: Programme Code for Eviews, Excel, and MatLab*, Econometrics 0508005, EconWPA.

[36] Nelson, C.R. and C.I. Plosser, 1982. *Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications*, Journal of Monetary Economics, 10, 139-162.

[37] Persson, T., 2001. *Currency Unions and Trade: How Large is the Treatment Effect?*, Economic Policy, 33, 433-448.

[38] Rose, A.K., 2000. *One Money, One Market: Estimating the Effect of Common Currencies on Trade*, Economic Policy 30, 7-46.

[39] Rose, A.K., 2004. *Do We Really Know That the WTO Increases Trade?*, American Economic Review, 13 (4), 682-698.

[40] Santos Silva, M.C.J. and S. Tenreyro, 2010. *Currency Unions in Prospect and Retrospect*, Annual Review of Economics 2010, forthcoming.

7 Appendix A

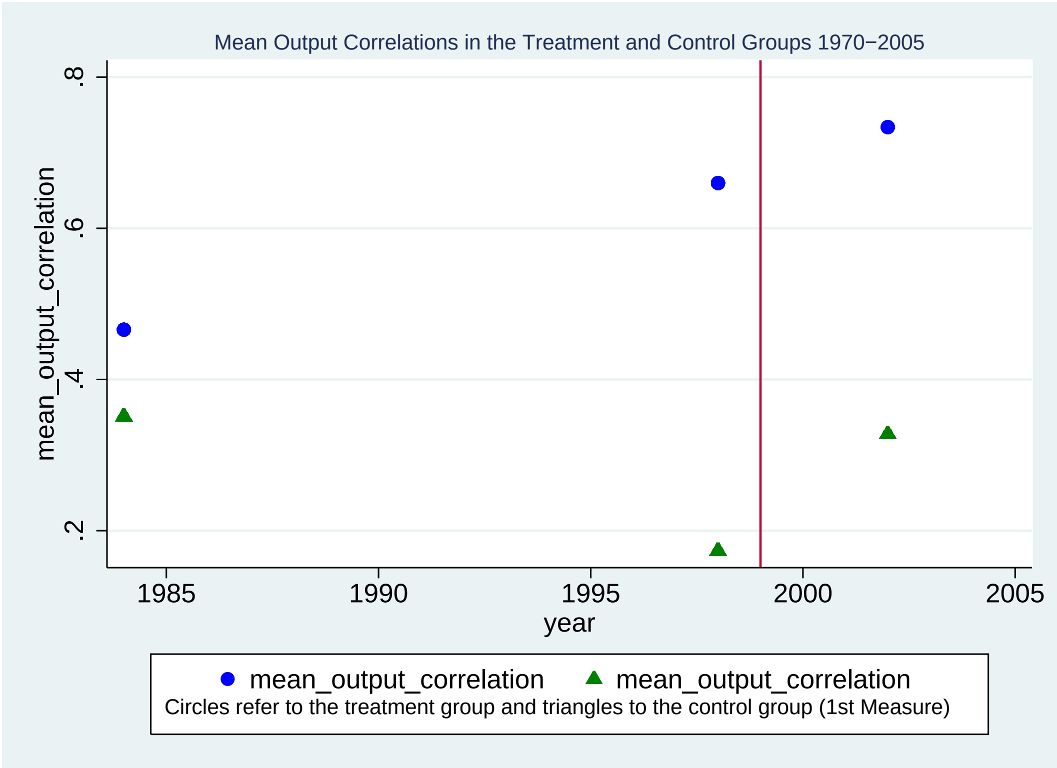

Figure 1: Mean Output Correlations in the Treatment and Control Groups 1970-2005 (1st Measure)

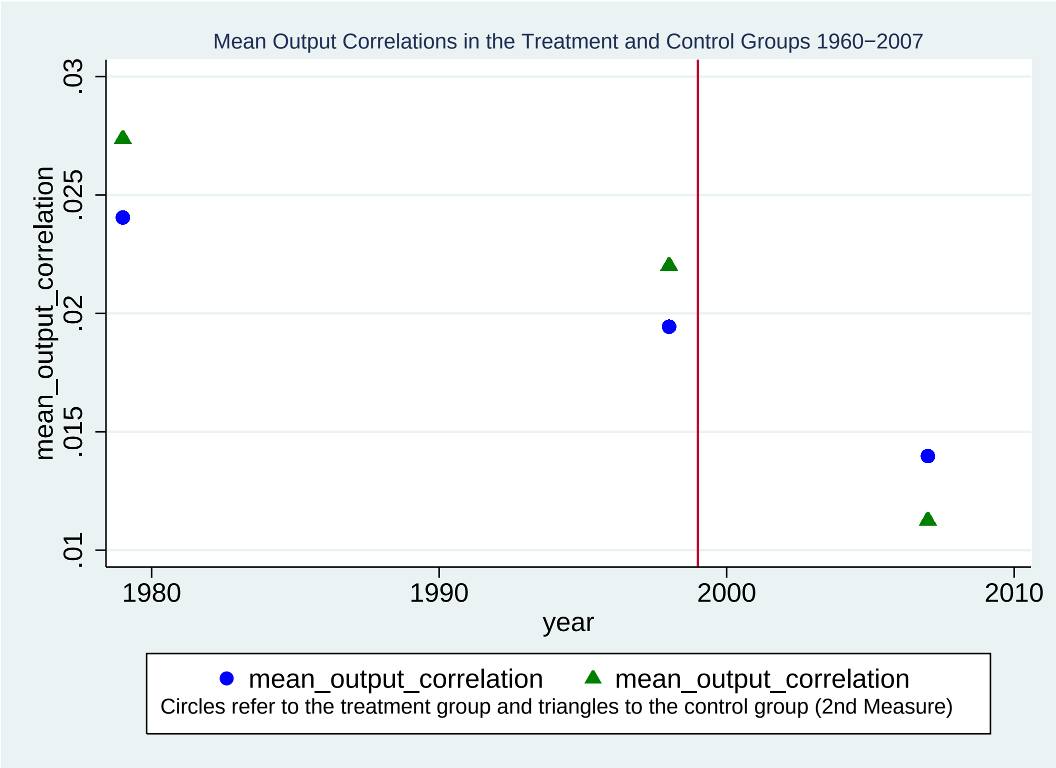

Figure 2: Mean Output Correlations in the Treatment and Control Groups 1960-2007 (2nd Measure)

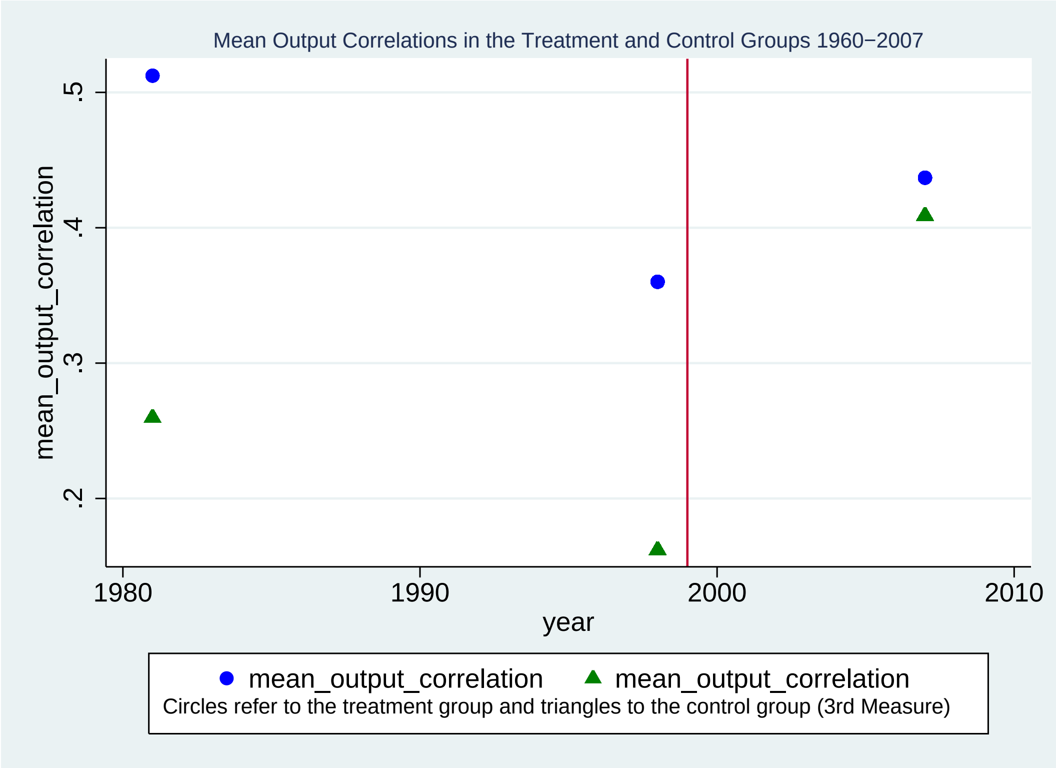

Figure 3: Mean Output Correlations in the Treatment and Control Groups 1970-2005 (3rd Measure)

Table 5: Mean Inflation Rates

Country	Pre-treatment	Post-treatment	Whole period
Australia	5.95	3.24	5.53
Austria	4.08	1.57	3.69
Belgium	4.41	1.81	4.00
Canada	5.26	2.50	4.77
Denmark	6.36	2.09	5.70
Finland	6.90	1.35	6.03
France	5.66	1.39	5.00
Germany	3.37	0.57	2.80
Iceland	22.17	3.86	19.32
Ireland	7.69	3.85	7.10
Italy	8.88	2.51	7.89
Japan	4.18	-1.74	3.26
Luxembourg	4.59	2.23	4.22
Netherlands	4.33	2.77	4.08
New Zealand	7.73	2.37	6.89
Norway	5.32	5.06	5.28
Portugal	11.00	3.32	9.80
Spain	9.12	3.89	8.31
Sweden	6.26	1.45	5.51
Switzerland	3.71	0.81	3.25
United Kingdom	7.20	2.36	6.44
United States	4.21	2.13	3.88
Treatment group	6.45	2.30	5.79
Control group	7.14	2.19	6.36

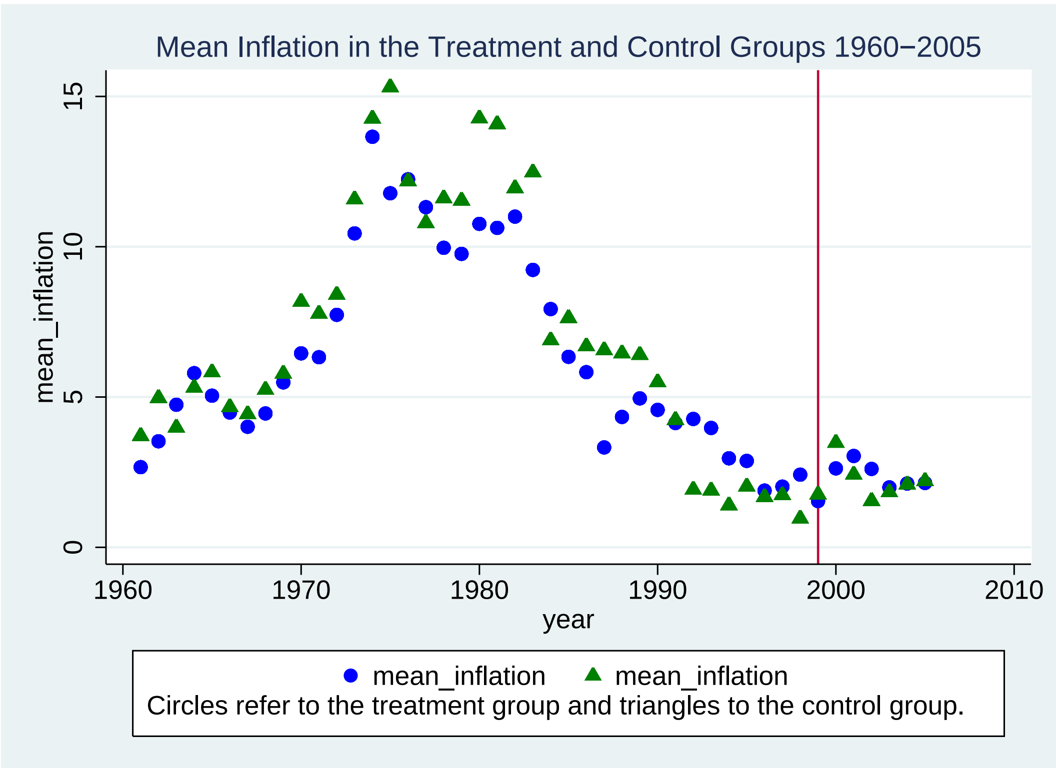

Figure 4: Mean Inflation in the Treatment and Control Groups 1960-2005

Table 6: Mean government expenditure to GDP

Country	Pre treatment	Post treatment	Whole period
Australia	16.57	18.11	16.78
Austria	17.02	18.15	17.20
Belgium	19.69	22.29	20.09
Canada	20.47	19.35	20.32
Denmark	22.86	25.93	23.33
Finland	18.29	21.69	18.80
France	20.09	23.35	20.58
Germany	20.27	18.97	20.01
Iceland	16.98	24.34	18.10
Ireland	16.77	14.71	16.50
Italy	17.38	19.24	17.66
Japan	13.17	17.51	13.74
Luxembourg	14.32	16.14	14.59
Netherlands	21.56	23.26	21.82
New Zealand	18.20	17.68	18.11
Norway	18.39	21.12	18.81
Portugal	13.55	19.90	14.52
Spain	13.32	17.38	13.93
Sweden	24.79	27.29	25.17
Switzerland	10.01	11.56	10.22
United Kingdom	19.49	20.05	19.58
United States	15.10	16.92	16.68
Treatment group	17.40	19.62	17.75
Control group	17.98	20.10	18.29

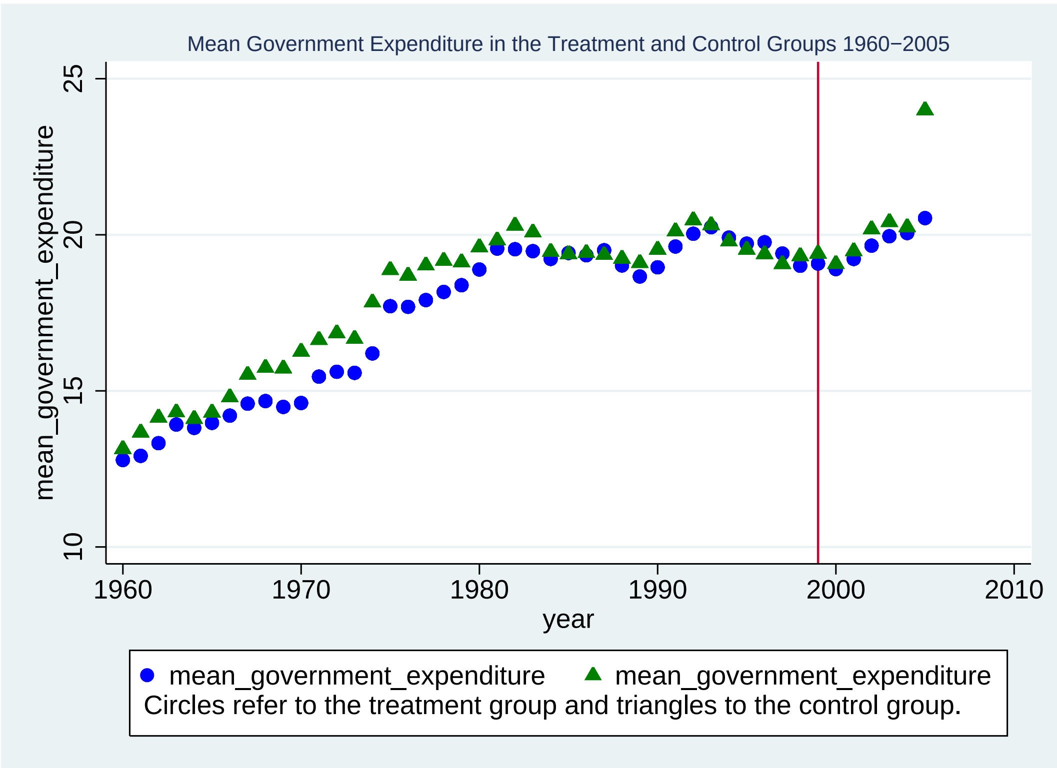

Figure 5: Mean Government Expenditure in the Treatment and Control Groups 1960-2005

Table 7: Mean budget deficits as percentages of GDP.

Country	Pre treatment	Post treatment	Whole period
Australia	-1.384251	0.4715628	-0.9651965
Austria	-3.33913	-1.728571	-2.963333
Belgium	-7.745833	-0.4857143	-6.106452
Canada	7.562651	3.471122	6.607961
Denmark	-1.670833	1.857143	-0.8741935
Finland	1.591667	3.628572	2.051613
France	-2.7875	-2.642857	-2.754839
Germany	-3.126019	-2.500392	-2.984749
Iceland	-1.316667	1.157143	-0.7580645
Ireland	-5.857978	1.186995	-4.267178
Italy	-10.26779	-3.035735	-8.634748
Japan	-5.858236	-13.47779	-7.57878
Luxembourg	2.333333	2.428571	2.375
Netherlands	-7.416193	-1.148529	-6.000915
New Zealand	-2.744963	2.920121	-1.42311
Norway	-1.292482	2.935273	-0.5635583
Portugal	-7.488669	-2.419702	-6.344063
Spain	-3.930703	-0.353329	-3.122909
Sweden	-4.525494	0.9031827	-3.439759
Switzerland	-0.5234752	-0.2352481	-0.4583917
United Kingdom	-3.408333	-1.014286	-2.867742
United States	-3.132255	-0.9436057	-2.638044
Treatment group	-4.776196	-0.6427901	-3.796897
Control group	-1.694206	-0.2765053	-1.381974

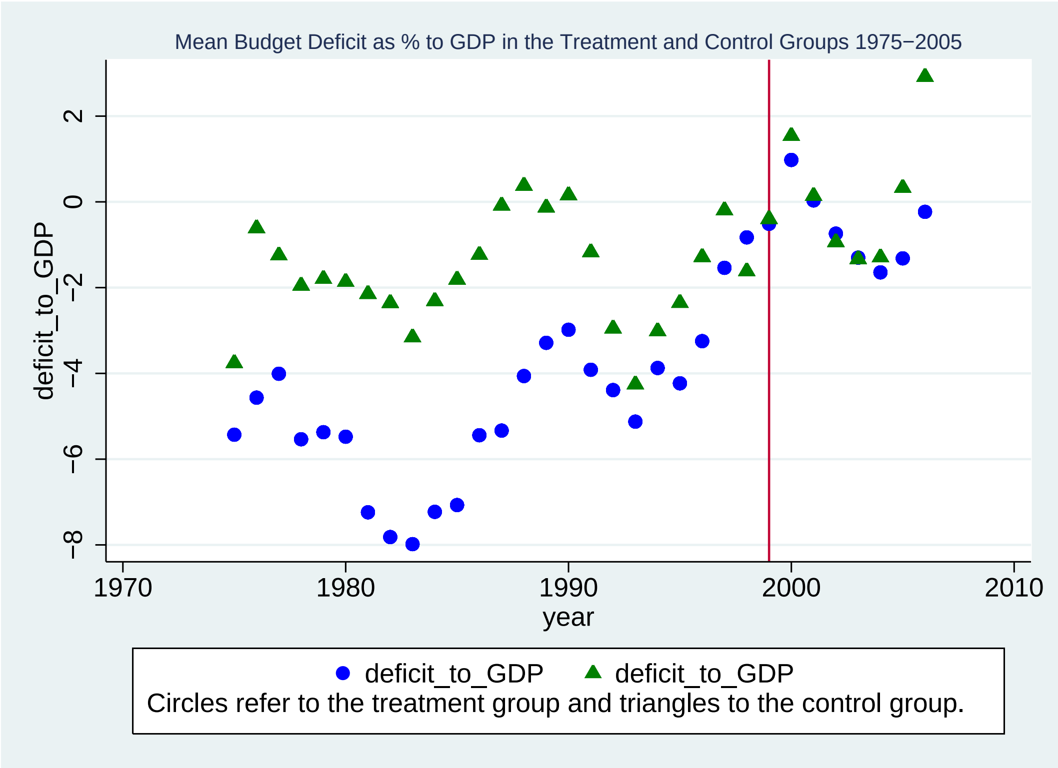

Figure 6: Mean Government Deficit in the Treatment and Control Groups 1975-2005

Table 8: Mean openness.

Country	Pre treatment	Post treatment	Whole period
Australia	32.07	40.96	33.59
Austria	67.76	91.50	71.83
Belgium	123.97	160.07	130.16
Canada	54.63	79.64	58.92
Denmark	67.70	85.32	70.72
Finland	55.66	70.32	58.18
France	42.01	52.69	43.84
Germany	44.11	66.22	47.90
Iceland	71.07	76.39	71.98
Ireland	105.86	167.12	116.36
Italy	42.21	52.75	44.01
Japan	21.63	21.09	21.54
Luxembourg	197.80	270.50	210.26
Netherlands	105.85	125.04	109.14
New Zealand	55.16	63.18	56.54
Norway	74.36	71.51	73.87
Portugal	60.22	69.84	61.87
Spain	35.72	57.18	39.40
Sweden	61.12	82.57	64.80
Switzerland	66.31	82.60	69.10
United Kingdom	52.32	55.49	52.86
United States	18.57	24.57	19.60
Treatment group	80.11	107.56	84.81
Control group	52.27	62.12	53.96

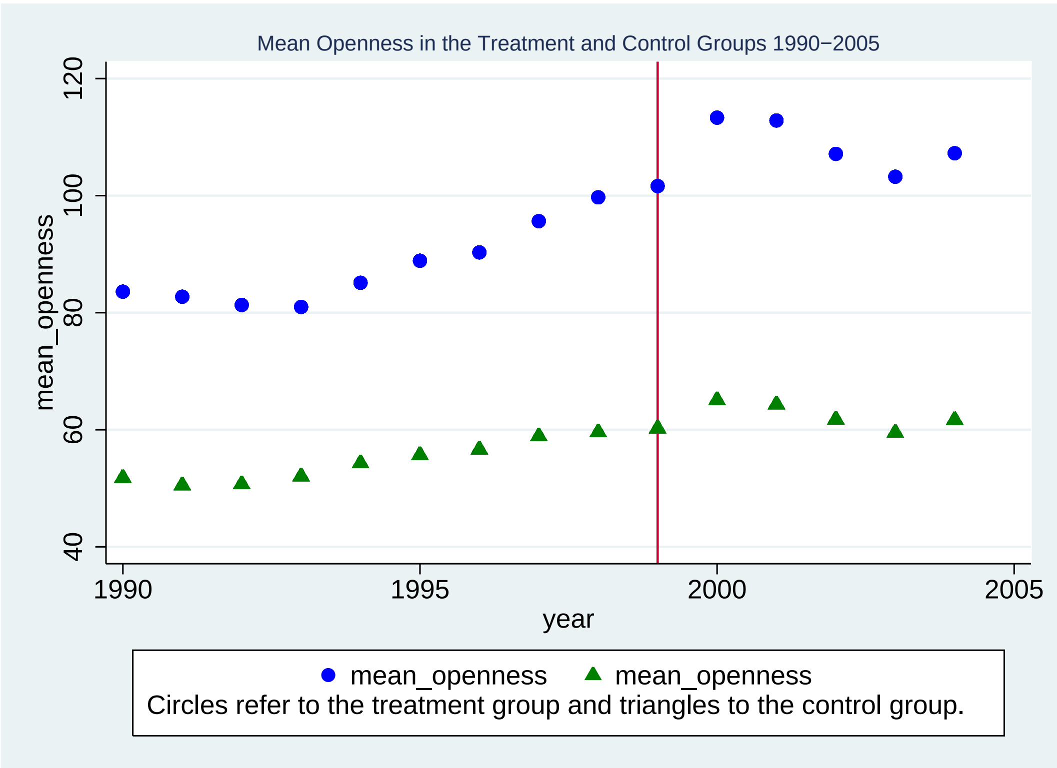

Figure 7: Mean Openness in the Treatment and Control Groups 1990-2005

Table 9: Mean agriculture shares to GDP.

Country	Pre treatment	Post treatment	Whole period
Australia	5.47	3.68	5.15
Austria	4.71	1.98	4.16
Belgium	2.51	1.19	2.25
Canada	3.75	2.33	3.57
Denmark	4.60	2.25	4.13
Finland	7.16	3.39	6.40
France	4.67	2.65	4.26
Germany	2.07	1.15	1.89
Iceland	11.03	8.26	10.51
Ireland	11.55	2.95	10.04
Italy	5.14	2.63	4.64
Japan	3.57	1.73	3.25
Luxembourg	1.84	0.62	1.59
Netherlands	4.01	2.38	3.69
New Zealand	8.84	8.52	8.81
Norway	4.00	1.87	3.57
Portugal	15.70	3.46	13.24
Spain	6.93	3.90	6.33
Sweden	3.94	1.77	3.51
Switzerland	2.24	1.48	1.97
United Kingdom	2.13	1.03	1.91
United States	2.67	1.20	2.41
Treatment group	6.03	2.38	5.31
Control group	4.87	2.81	4.50

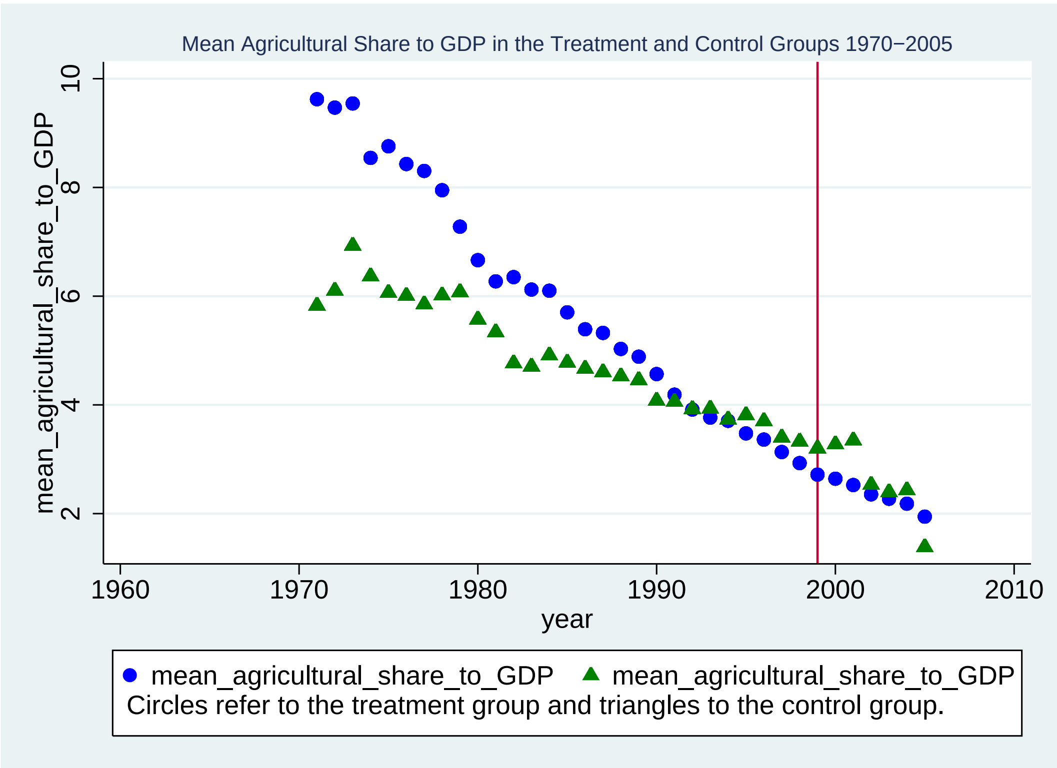

Figure 8: Mean Agricultural Share to GDP in the Treatment and Control Groups 1970-2005

Table 10: Mean industrial shares to GDP.

Country	Pre treatment	Post treatment	Whole period
Australia	34.05	26.44	32.71
Austria	34.32	30.47	33.55
Belgium	33.34	25.60	31.79
Canada	33.98	32.31	33.77
Denmark	26.63	25.39	26.38
Finland	35.13	31.42	34.39
France	29.36	21.94	27.88
Germany	38.74	29.54	36.90
Iceland	32.11	24.93	30.76
Ireland	35.22	40.54	36.16
Italy	34.58	27.75	33.21
Japan	39.58	31.23	38.11
Luxembourg	28.65	17.81	26.48
Netherlands	30.22	24.30	29.04
New Zealand	30.94	25.19	30.39
Norway	36.27	40.00	30.02
Portugal	29.63	26.44	28.99
Spain	34.73	29.20	33.63
Sweden	31.66	27.92	30.91
Switzerland	31.32	28.89	30.45
United Kingdom	37.89	26.67	35.64
United States	30.42	22.98	29.11
Treatment group	33.08	27.56	31.99
Control group	33.30	28.48	32.42

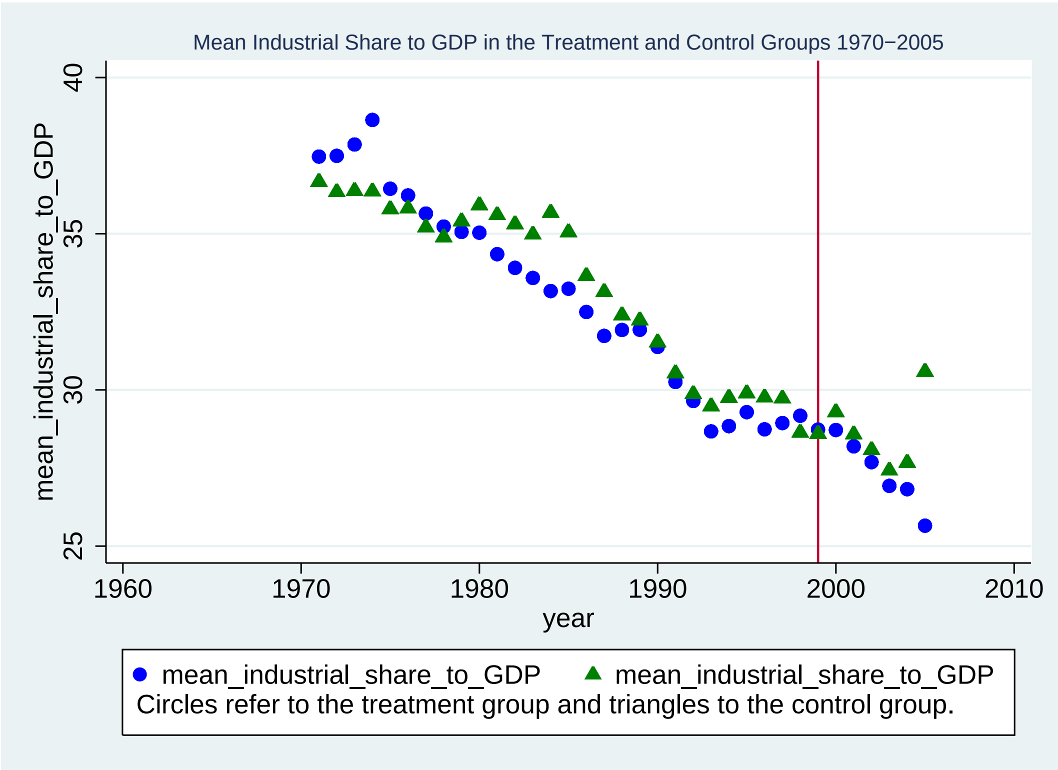

Figure 9: Mean Industrial Share to GDP in the Treatment and Control Groups 1970-2005

Table 11: Mean services to GDP shares

Country	Pre treatment	Post treatment	Whole period
Australia	60.48	69.88	62.14
Austria	60.97	67.55	62.30
Belgium	64.14	73.21	65.96
Canada	62.27	65.37	62.66
Denmark	68.77	72.37	69.49
Finland	57.71	65.19	59.21
France	65.96	75.41	67.85
Germany	59.19	69.31	61.21
Iceland	56.86	66.80	58.73
Ireland	53.22	56.51	53.80
Italy	60.28	69.63	62.15
Japan	56.84	67.04	58.64
Luxembourg	69.51	81.57	71.92
Netherlands	65.77	73.32	67.28
New Zealand	60.21	66.28	60.80
Norway	59.72	58.13	59.41
Portugal	54.68	70.10	57.76
Spain	58.33	66.90	60.05
Sweden	64.40	70.30	65.58
Switzerland	66.45	69.62	67.58
United Kingdom	59.98	72.29	62.44
United States	66.91	75.81	68.48
Treatment group	60.89	70.06	62.70
Control group	61.83	68.71	63.08

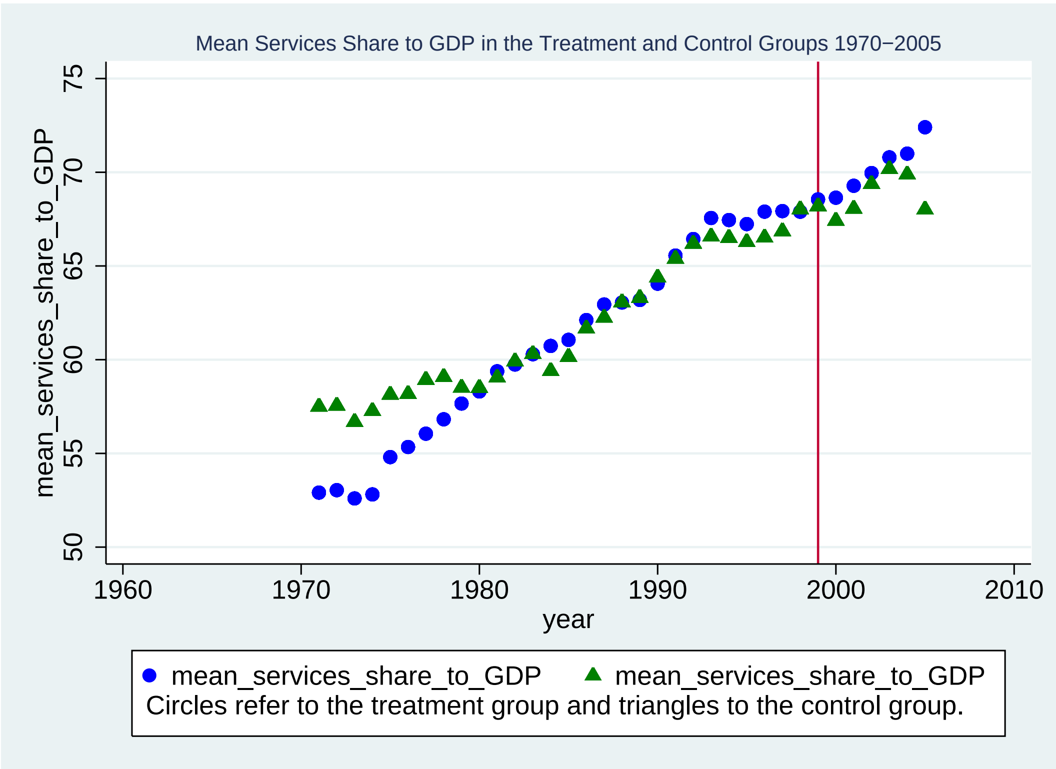

Figure 10: Mean Services Share to GDP in the Treatment and Control Groups 1970-2005

Table 12: Mean Net Foreign Asset Positions as percentages to GDP.

Country	Pre treatment	Post treatment	Whole period
Australia	-0.34	-0.58	-0.38
Austria	-0.09	-0.20	-0.11
Belgium	0.06	0.47	0.13
Canada	-0.32	-0.10	-0.28
Denmark	-0.31	-0.15	-0.28
Finland	-0.28	-0.81	-0.37
France	0.003	0.06	0.01
Germany	0.09	0.05	0.08
Iceland	-0.40	-0.74	-0.45
Ireland	-0.38	-0.05	-0.32
Italy	-0.05	-0.12	-0.06
Japan	0.09	0.31	0.12
Luxembourg		0.96	0.95
Netherlands	0.11	-0.16	0.06
New Zealand	-0.54	-0.86	-0.60
Norway	-0.16	0.39	-0.06
Portugal	-0.26	-0.54	-0.31
Spain	-0.13	-0.35	-0.17
Sweden	-0.14	0.02	-0.11
Switzerland	0.89	1.24	0.95
United Kingdom	0.05	-0.07	0.03
United States	-0.004	-0.20	-0.04
Treatment group	-0.09	-0.08	-0.089
Control group	-0.11	-0.07	-0.10

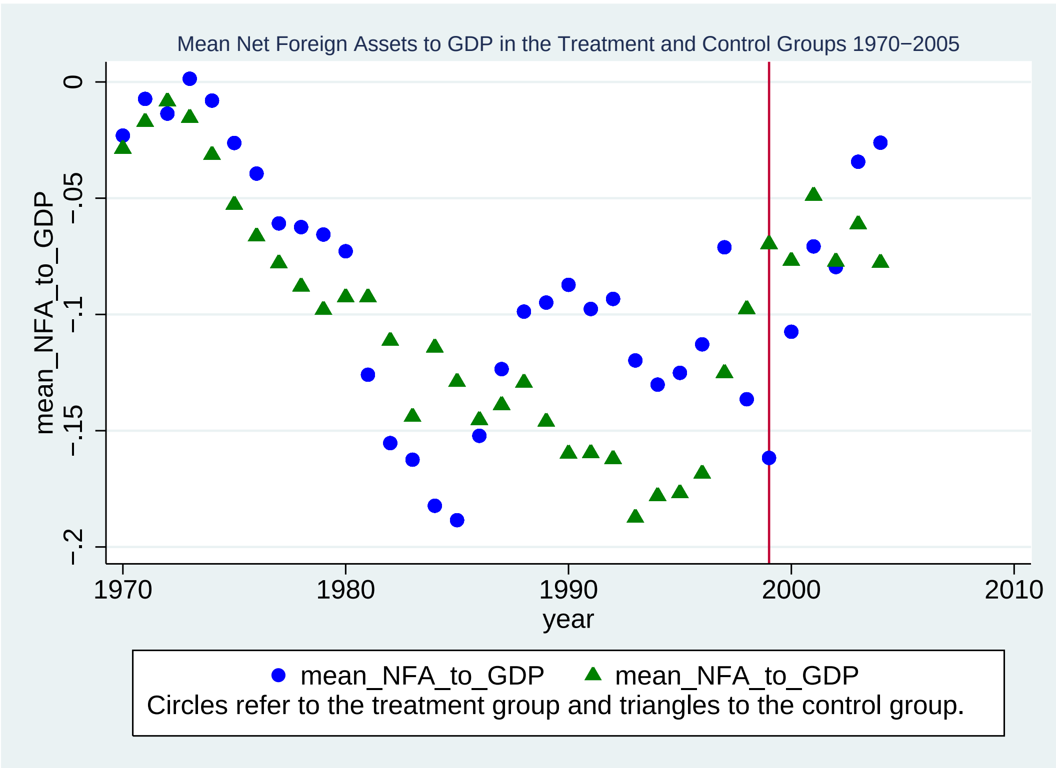

Figure 11: Mean Net Foreign Assets to GDP in the Treatment and Control Groups 1970-2005