# Winners and Losers from the €uro*

Pedro Gomis-Porqueras† Deakin University

Laura Puzzello‡ Monash University

First Draft: December 18, 2013
This Draft: November 5, 2014

**Abstract**

This paper estimates the effect of having joined the monetary union on the income per capita of six early adopters of the euro using the synthetic control method. Our estimates suggest that while the income per capita of Belgium, France, Germany and Italy would have been higher without the euro, that of Ireland would have been considerably lower. The Netherlands is estimated as well off without the euro. In addition, we use the insights from the literature on the economic determinants of the costs and benefits of monetary unions to explain these income effects. We find that early euro adopters with a business cycle more synchronized to that of the union, and more open to intra-union trade and migration lost less or gained more from the euro. A key role in the transmission of post-euro income losses across union members has been played by the integration of capital markets.

**JEL Codes**: C21; C23; E65; F33; N14
**Keywords**: Monetary Union; Synthetic Control Method; Per Capita Income; euro.

*We are especially grateful to David Hummels for thoughtful discussions at the early stages of this project. We thank Silvio Contessi, Oscar Mitnik, Wang Sheng Lee, Konstantinos Theodoridis and seminar participants at Monash University, Indiana University, University of Oregon, the National University of Singapore, University of Melbourne, Deakin University and La Trobe University for helpful comments. All remaining mistakes are our own.

†Address: Deakin University, School of Accounting, Economics and Finance, Burwood, VIC 3125; email: p.gomisporqueras@deakin.edu.au; phone: +61-3-9252-7832.

‡Address: Monash University, Department of Economics, Caulfield Campus, Caulfield East, VIC 3145; e-mail: laura.puzzello@monash.edu; phone: +61-3-9903-4517.

# 1 Introduction

In the wake of the economic and financial crisis of 2008, several members states of the eurozone were confronted with sovereign debt crisis.[1] These crises have raised some questions regarding the viability of the European Economic and Monetary Union (EMU) and the future of the euro. Policymakers and academics have been reassessing the perceived benefits and costs of joining a monetary union as well as considering new structures going forward to improve economic governance.[2]

This paper contributes to the debate by providing estimates on the effect of the euro on the income per capita of six early adopters of the single currency before the global financial and eurozone crises took place. Joining a currency union implies a trade-off. Most of the insights related to the costs of monetary unions are from the literature on optimum currency areas (OCA) initiated by Mundell (1961). The biggest cost a country bears once it joins a monetary union is the lost ability to use the monetary policy to accomodate external shocks. However, if a country faces shocks similar to those of other union members, this policy loss is not too onerous. In fact, in this case the monetary policy at the union level would often be in line with the optimal one at the national level. Another important insight from the OCA literature is that countries might face lower costs from joining a monetary union if by doing so they gain access to additional shock absorbers, through greater mobility of production factors within the union or a system of fiscal federalism. Further, a country's labor market conditions, its flexibility and similarity to those of other countries in the union, affect the effective costs of monetary unions. Joining a currency union can also benefit a country as currency conversion costs and exchange rate uncertainty with other union members are eliminated. Given that these cost savings increase with the extent to which a country trades with other members of the union, countries more open to intra-union trade reap more of the benefits of the monetary union.

Before the adoption of the euro, the consensus among economists was that the costs of the single currency would outweight the benefits for most of the countries involved. Even though the euro has been around for more of a decade, no direct evidence has been brought in this regard. Our paper fills this gap.

Our analysis rests on two different but interrelated exercises. First, we estimate who lost and who gained, in real income per capita terms, from the adoption of the euro during the pre-crises period. The countries we analyse are: Belgium, France, Germany, Ireland, Italy and the Netherlands. We focus on countries' real income per capita because this is an informative indicator of welfare likely to reflect the net benefits of having joined

[1] Véron (2011) argues that the interdependence between sovereign credit and banking systems has been at the heart of the crisis since sovereign debt of euro area countries are held in large quantities by euro area banks.

[2] On December 9, 2011 the European Council meeting with all 17 members of the eurozone outlined a new intergovernmental treaty to put strict caps on government spending and borrowing, with penalties for countries deemed to violate the limits. In June 2012 the European Council adopted a report setting out "four essential building blocks" for the future EMU.

the EMU. We use the synthetic control method introduced by Abadie and Gardazeabal (2003, AG henceforth), and further developed by Abadie, Diamond and Hainmueller (2010, ADH) to obtain our estimates. This method allows us to estimate the income per capita EMU's members would have experienced had they kept their independent monetary policy by exploiting data from the early 70's. In particular, the methodology uses the data before the introduction of the euro to find, for each EMU's member, a convex combination of similar countries not in the EMU (*synthetic control*). The exact weights assigned to countries in the synthetic control are determined by an algorithm that minimizes the difference in the relevant economic characteristics between the chosen EMU's member and its synthetic counterpart. The comparison of the evolution of the income per capita of euro adopters with that of the corresponding synthetic controls after the introduction of the euro allows us to determine the winners and losers from the euro.[3]

Our findings suggest that Belgium, France, Germany and Italy have lost from adopting the euro. More specifically, their annual income per capita would have been, on average, between 7.7 and 17.2 percentage points higher had they not adopted the euro. In contrast, both the Netherlands and Ireland are estimated to have been better off by the euro adoption, with Ireland having experienced an annual income per capita, on average, 23.7 percent higher than it would have been without the euro. We conduct placebo studies reassigning the euro adoption either to countries in the control groups or back to 1987 to verify the significance of our estimates. All our estimates are statistically significant with the exception of the income gains of the Netherlands.

The second exercise of the paper consists of relating the synthetic estimates of the losses and gains from the euro to the economic determinants of the costs and benefits of monetary unions. This exercise has two advantages. First, it is a simple way to further validate the significance of our synthetic estimates by verifying their economic content. Second, it provides useful insights on the economic consequences of adopting the single currency for prospective members of the EMU.

Consistently with the literature predictions, we find that greater synchronization of a country's business cycle with that of other union members, and greater openess to intra-union trade or migration lowered the costs or increased the gains from the euro. Greater rigidity in labor markets and differences in labor market institutions implied greater losses from the euro. Finally, we find evidence that deeper financial market integration played a key role in the transmission of income losses post-euro across EMU's members. Further, these results are driven by cross-country differences in the economic characteristics of the six early adopters we consider. Our results are relevant for prospective members because they help both predicting the country-specific net cost of adopting the euro and identifying which economic factors should be adjusted to tilt the balance in favor of a positive outcome.

In addition to the theoretical literature on currency unions, this paper relates to a growing

[3]Because the methodology requires a reasonable number of years pre- and post-euro we focus only on those countries that joined the monetary unification project and adopted the euro early.

literature trying to quantify the net economic benefits of monetary unions. Using a stochastic dynamic general equilibrium framework, Carre and Collard (2002) find that following a 1% permanent domestic technology (fiscal) shock, domestic households should be given a 0.38% (0.14%) permanent rise in consumption to be compensated for their loss in utility as a regime of flexible exchange rates is chosen in place of a monetary union. Devereux, Engel and Tille (2003), using a New Keynesian model, find that the benefit of introducing the euro for europe and the U.S. is equivalent to, respectively, a 15% and 5% reduction in the standard deviation of monetary shocks worldwide. For countries that did not join the EMU, Ferreira-Lopes (2010) finds that consumers in Sweden and the UK are willing to give up part of their consumption in order to retain an economy where the monetary policy is conducted at a national level.

As mapping the estimated net benefits of monetary unions from quantitative studies to our results is not obvious, the paper that is most closely related to ours is the empirical study by Frankel and Rose (2002). Their work establishes the main channel through which currency unions increase income growth is trade. More specifically, two are their main findings. First, being part of a currency union triples trade with other union members. Second, a one percent increase in a country's overall trade increases income per capita by at least a one-third of a percent. Combining these key results, Frankel and Rose predict that non-EMU's members (Denmark, UK and Sweden) would experience an increase in income per capita of about 20% by joining the monetary union. In contrast to Frankel and Rose (2002), our estimated gains and losses from the euro are not out-of-sample predictions but they are obtained after having constructed appropriate counterfactuals. Further, our results seem to suggest that the UK benefitted from not adopting the euro. In fact, the UK contributes to all our synthetic controls taking on higher weights in the synthetic controls corresponding to bigger losers from the euro (France and Italy) and lower weights in the synthetic controls corresponding to the non-worse off by the euro (Ireland and the Netherlands).

The rest of the paper is organized as follows. Section 2 briefly summarizes the history of the euro. Section 3 discusses the synthetic method and our estimates on the income gains and losses from the euro. Section 4 summarizes the insights from the literature on the economic determinants of the costs and benefits of monetary unions, which are then used to explain our synthetic income estimates. Section 5 concludes.

# 2 A Brief History of the €uro

In the early seventies member countries of the European Community (France, West Germany, Italy, Belgium, Luxembourg, the Netherlands, UK, Denmark and Ireland) committed to form an economic and monetary union.[4] The initial process of integration was discontinuous, with the most effective steps taken toward the formation of a monetary union being:

[4]The UK, Denmark and Ireland joined in 1973, two years after the founding members.

the introduction of the European Currency Unit (ECU)[5] and the Exchange Rate Mechanism (ERM), and the adoption of the Single European Act. The ERM, by limiting fluctuations in the value of member countries' currencies, successfully increased the monetary, exchange rate and price stability in member states. The Single European Act, by adding the 'single market' to the list of objectives of the community, emphasized the necessity of a single currency. Greece joined the European Community in 1981, Spain and Portugal in 1986. In 1988, the 'Delors committee' was appointed to propose the necessary stages for the realization of the EMU. Three were the stages proposed, the first two would lay down the institutional foundation for the adoption, in Stage Three, of a stable single currency.

During Stage One (1989-1993), the Maastricht Treaty (officially called Treaty on European Union) was signed, entering into force on November 1, 1993. The treaty established the economic and legal conditions countries must satisfy in order to adopt the single currency. Importantly, the economic requirements therein specified include: a high degree of price stability, sustainability of the government financial position, the observance of the ERM bands for at least two years prior to the single currency adoption, and the convergence of long-run interest rate levels. In accordance with the treaty, Denmark and the UK were given the option of retreating from the last stage of the EMU.

In Stage Two (1994-1998), the European Monetary Institute was established to increase coordination of monetary policies across member countries, and to prepare for the introduction of the euro and the European Central Bank (ECB). The European Monetary Institute also monitored member states' progress in fulfilling the conditions for the adoption of the single currency. In the meanwhile, countries adopted the Stability and Growth Pact, further enforcing the budgetary rules set by the Maastrict Treaty. Denmark and the UK exercised their right not to participate in Stage Three of the EMU in December 1992 and October 1997, respectively.[6] Despite having opted out of the monetary union, Denmark joined the ERM permanently in 1999. In 1995, Austria, Finland and Sweden joined the European Union.[7] In May 1998 the birth of the euro was officially announced, giving life to the biggest currency union of all times. In fact, only Greece and Sweden had not met the conditions for adopting the euro, and the eleven constituent members accounted for 19.4 percent of world GDP and 18.6 percent of world trade, internal trade excluded. On June 1, 1998 the ECB formally replaced the European Monetary Institute.

[5]The value of the ECU was defined as a fixed combination of the values of the member countries' currencies. The exchange rate ECU\USD, for example, was determined as the (fixed) weighted average of the exchange rates of each of the member countries' currencies with the US dollar. The ECU mainly served as a unit of account of the European Community and was used only in some international financial transactions.

[6]The debate on the participation of UK to the EMU centered around the following issues: (1) whether the UK and the eurozone had converged sufficiently to make a single monetary policy desirable; (2) whether the UK economy was sufficiently flexible to join a common currency; and (3) how the adoption of the euro would affect: the position of the City of London as europe's predominant financial capital, investment, employment and growth more generally.

[7]Sweden never joined the ERM. In 2003, the Swedish people rejected the adoption of the euro in a referendum.

In Stage Three (1999-) exchange rates between participating member countries' currencies and the euro were fixed irrevocably, and the ECB officially took over the responsibility of conducting the unified monetary policy. The introduction of the euro was completed with the cash changeover on January 1, 2002. Greece joined the eurozone in 2001. To date, the eurozone consists of 18 countries.[8] Table 1 summarizes the key dates and political developments in the making of the eurozone.

# 3 Estimating Income Gains and Losses from the €uro

## 3.1 On the Synthetic Control Method

In order to estimate the effect of the euro on the income per capita of candidate countries that joined the EMU, we use the synthetic control method proposed by AG (2003), and further developed in ADH (2010). The intuition behind this methodology is to measure the economic effect of an intervention or shock on a unit which can be thought as a region, state or country. In order to do so, one, first, has to find a convex combination of similar but unaffected units (*synthetic* control) that best fits relevant economic characteristics of the affected unit. Then, one compares the post-intervention economic evolution of the synthetic control to the one observed for the affected unit.

ADH rationalize the syntethic control method using traditional regression frameworks. Formally, suppose that we observe $J+1$ units, the first unit of which experiences an intervention at time $1 < T_0 < T$. Assume that the intervention does not affect, neither directly nor indirectly, the remaining $J$ units, then these can be used as a control group. Let $Y_{it}$ indicate the observed value of the outcome of interest for the $i$-th unit at time $t = 1, 2, ..., T$, and $Y_{it}^N$ be the outcome that would be observed for unit $i$ at time $t$ without the intervention. As a result, we have that $Y_{it}^N = Y_{it}$ for all $i \neq 1$. The estimate of interest is the intervention effect as denoted by $\alpha_{1t} = Y_{1t} - Y_{1t}^N$ at time $t = T_0 + 1, ..., T$, during which $Y_{1t}^N$ is not observed. Assume that $Y_{it}^N$ is represented by the following factor model:

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \epsilon_{it} \tag{1}$$

where $\delta_t$ is an unknown common factor, $Z_i$ is a ($r$x1) vector of observed covariates unaffected by the intervention, $\theta_t$ represents a (1x$r$) vector of unknown parameters, $\lambda_t$ denotes an unknown common factor with factor loadings, $\mu_i$, varying across units, and $\epsilon_{it}$ represents transitory shocks with mean zero for all $i$. ADH show that if one finds a vector of non-negative weights that sum to one, $W^* = (w_2^*, w_3^*, ..., w_{J+1}^*)$, such that the following conditions

[8] Countries belonging to the eurozone are: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain.

hold:

$$\sum_{j=2}^{J+1} w_j^* \overline{Y_j^k} = \overline{Y_1^k} \quad \text{for} \quad k = 1, ...K, \qquad \text{and} \qquad \sum_{j=2}^{J+1} w_j^* Z_j = Z_1 \tag{2}$$

where $\overline{Y_i^k}$ is the $k$-th linear combination of $i$'s pre-intervention outcomes, then $Y_{1t}^N \rightarrow \sum_{j=2}^{J+1} w_j^* Y_{jt}$ as the number of observed pre-intervention periods increases. As a consequence, an unbiased estimate of the intervention effect is given by:

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}. \tag{3}$$

The conditions in equation (2) can hold exactly only if $(Y_{11},\ Y_{12},\ \ldots,\ Y_{1T_0},\ Z_1')$ belongs to the convex hull of $(Y_{21},\ Y_{22},\ \ldots,\ Y_{2T_0},\ Z_2')$, $\ldots$, $(Y_{J+11},\ Y_{J+12},\ \ldots,\ Y_{J+1T_0},\ Z_{J+1}')$. This rarely occurs in practice. Thus, the synthetic control approach provides a relatively simple procedure to find $W^*$ that approximately satisfies the conditions in equation (2).

Formally, let $X_1$ be a $((r + K)\text{x}1)$ vector that contains information on $K$ linear combinations of pre-intervention outcomes and $r$ outcome predictors for unit 1. Let also $X_0$ denote a $((r + K)\text{x}J)$ matrix which collects the same pre-intervention economic variables for each of the $J$ unaffected units. Then, the synthetic approach consists of finding the vector of weights, $W^*$, that minimizes some distance in the pre-intervention characteristics between unit 1 and the $J$ control units. More precisely, $W^*$ minimizes the following metric: $\sqrt{(X_1 - X_0W)'V(X_1 - X_0W)}$, where $V$ is some $((r + K)\text{x}(r + K))$ diagonal and positive semidefinite matrix. This minimization problem provides a solution for $W^*$ that is function of the elements of the matrix $V$. These elements are in turn chosen so that $W^*(V^*)$ minimizes the pre-intervention Mean Square Prediction Error (MSPE) of the outcome of interest: $\frac{1}{T_0}\sum_{t=1}^{T_0}\left(Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}\right)^2$. The elements in $V$ are non-negative weights assigned to each of the pre-intervention characteristics in the matrices $X$, which are normalized to sum to one for identification purposes. In a nutshell, the synthetic method estimates the unobserved counterfactual as a weighted average of the control units' outcomes, with weights being chosen to best match the pre-intervention characteristics of the affected unit.

Even though the synthetic control method has the flavor of comparative case studies, where researchers compare units affected by an intervention to one or more unaffected units, it addresses two of their major shortcomings. First, in comparative case studies, researchers choose their control units on the basis of relatively subjective measures of affinity with the affected unit. In contrast, the synthetic method is a data-driven method that finds suitable comparison groups and makes explicit the similarities between the affected unit and its synthetic control. Second, in comparative case studies there is uncertainty about how good of a job the control units do at replicating the evolution of the outcome of interest were the affected unit not treated. Instead, inference on the fit of the synthetic control is

possible through placebo experiments. A way of implementing these tests is to reassign the intervention to each of the control units, and estimate the intervention effect in each case using the synthetic estimator. If the estimated intervention effect for the control units is comparable or larger than the one estimated for the unit actually exposed to it, the latter cannot be taken as significant. Alternatively, one can reassign the intervention to an earlier time period, and estimate the corresponding intervention effect using the synthetic estimator. If the estimated intervention effect when the treatment date is set early is comparable or larger than the one estimated using the effective intervention date, the latter cannot be taken as significant. The inference from these tests is always exact and it becomes more informative as the number of control units or time periods increases.

An important advantage of the synthetic control estimator over traditional panel estimators is that it is identified under weaker conditions.[9] As implied by the model in (1), the effect of the unobserved individual heterogeneity does not have to be time invariant, and the covariates and unobserved heterogeneity do not have to be independent of the error term.

The synthetic control method has been used in a number of recent papers. AG pioneer it by quantifying the Basque country's income losses from the terroristic activity of the 70's. ADH apply this method to measure the effect of the passage of Proposition 99 on per capita cigarettes consumption in California. Multi-country studies exploiting the synthetic control approach include Billmeier and Nannicini (2013) and Cavallo et al. (2013), that analyse the effects on economic growth of openness to international markets and large natural disasters, respectively. More closely related to our study, the synthetic control method has been used by Manasse et al. (2013) to examine the effect of the euro adoption on five indicators of the Italian economy, including per-capita GDP[10], and Saia (2014) to determine the effect of the non-adoption of the euro on the European bilateral trade flows of the UK.

## 3.2 Data and Sample

We conduct our analysis on six EMU members: Belgium, France, Germany, Italy, Netherlands, and Ireland.[11] We use annual country-level data from the year a country joined the EMU till 2007 as to not include the global financial and eurozone crises.[12] Even though the creation of the euro was officially announced in 1998, most EMU countries took actions to meet the Maastricht requirements before that. To account for anticipation effects we

[9] An additional advantage of the synthetic estimator over regression estimators is that it does not allow for extrapolation (Abadie et al., 2014), which can lead to large biases in the context of treatment models (King and Zeng, 2005).

[10] Specifically, Manasse et al. (2013) consider the effect of the euro on Italy's: bilateral trade, inflation, government bonds yields, labor productivity and real per capita GDP.

[11] We considered Luxembourg as well. But, because Luxembourg was one of the richest countries in the world during our sample period, we did not find an appropriate set of control countries.

[12] We do not consider the post-crises period for two reasons. First, the global financial crisis might have caused structural changes in the economies most hit by it. This implies that the synthetic control unit's economic evolution might not be anymore representative of that of the corresponding EMU member. In addition, the effects of the global financial crisis were compounded by the eurozone crisis in europe, implying that treated and control countries in our sample were exposed to different types of shocks after 2007.

consider 1995 as the treatment date.[13] Thus, for all the EMU members in our sample we have a pre-intervention period of 26 years, except for Ireland whose pre-intervention period is 23 years. Since our study ends in 2007, this implies a post-intervention period of more than a decade, which is quite standard in the literature.

For each EMU member we restrict the control group to countries with similar levels of income per capita during the pre-treatment period. We do so to avoid interpolation biases which might arise when regions in the control group are very different in their economic characteristics (ADH, 2010). More precisely, among all possible control units, countries that make it to an EMU member's control group are only those whose income per capita during the pre-treatment period diverges from that of the EMU member by on average 40%. We further limit our control group to countries that have never diverged more than 50% in a given year, except at most in 7 instances.[14] Table 2 lists for each EMU member the sample period and control countries.[15] Belgium, France and Germany share the same control group, which differs from that of the Netherlands beacause it excludes Switzerland. Ireland and Italy's control groups share some of the countries with the other EMU's member control groups but include lower income countries like Gabon and Trinidad and Tobago.

Our outcome of interest, $Y_{jt}$, is the real GDP per capita. The real GDP per capita data we use are from the Penn World Tables version 7.1 (PWT 7.1), they are PPP-adjusted and measured in 2005 International dollars. As in ADH (2014), the pre-euro characteristics in $X_{it}$ include the following predictors of economic growth: per capita real GDP, inflation rate, industry share of value added, investment share of GDP, secondary education and trade openness.[16] Table 3 reports the data source for each predictor and, for each EMU member, the pre-intervention periods over which predictors are averaged. The choice of the pre-intervention periods over which we average predictors does not affect qualitatively the results we discuss in the following section and is made so as to minimize the pre-intervention MSPE of the estimated specification.

[13] Our results are not sensitive to moving the treatment date to 1998, 1996 or years immediately following national elections after 1992.

[14] Seven years correspond to about one-fourth of the sample period. Without this restriction Trinidad and Tobago adds to the control group of Belgium, France and Germany, and Gabon and Bahrain add to Italy's control group. Our results are robust to these alternative control groups. More in general, easing the selection rule would not affect substantially our control groups. That is because many potential control countries were subject to large shocks or lack data on growth predictors during the sample period.

[15] Japan would be in the control group of all EMU's members but we excluded it for two reasons. First, in the nineties, it experienced the asset price bubble whose burst contributed to the lost decade. Second, the Kobe earthquake in 1995 caused a persistent and widening drop in the GDP of the Hyogo Prefecture (DuPont and Noy, *forthcoming*), which accounted for 3.8%-4.1% of Japan's total GDP between 1995 and 2006. Canada and Sweden would belong to the control group all EMU's members with the exception of Ireland. We have excluded them because they experienced profound structural shocks during our sample period. Denmark would belong to the control group of only Belgium, France, Germany and Italy. We have excluded it because by entering the ERM in 1999 it has *de facto* lost the ability to conduct independent monetary policy. The inclusion of Canada, Denmark and Sweden in the relevant control groups does not affect our results but would make inference more precise.

[16] Our results are robust to the use of additional growth predictors like fertility rate, population growth and government consumption share.

## 3.3 Results

The first row of Table 4 lists the countries that contribute with a positive weight to the synthetic control unit of each of the EMU's members in our sample. Each synthetic unit we obtain is a convex combitation of four to six countries. The UK, Barhain, Gabon, Trinidad and Tobago, and Switzerland take on positive weights whenever they belong to an EMU's member control group. In contrast, New Zealand consistently takes on a zero weights. The fact that UK belongs to some extent to each of the EMU's members synthetic control is particularly interesting as the UK is one of the countries that could have adopted the euro but decided against it. Table A1 compares the pre-treatment characteristics of each member with those of its synthetic control. In general, the synthetic control matches the characteristics of the treated country quite closely and better than just the simple or population average in the control group.

Figure 1 shows the trends in real GDP per capita of each EMU's member and its synthetic counterpart from the beginning of the sample period until 2007. The real GDP per capita of each EMU's member is tracked very well by the the real GDP per capita of its synthetic counterpart until 1995. This is further confirmed by the values of the root MSPE (RMSPE) and pre-euro gaps in income per-capita reported in the second and third row of Table 4, respectively. The average gap in per capita incomes during the pre-euro period amounted to less than one percent of the relevant EMU's member per capita income for all the EMU's members but Ireland. Even though Ireland's real GDP per capita is not tracked by its synthetic counterpart as closely as that of the other EMU's members, the pre-treatment percentage gap is estimated to be less than 2 percent, on average.[17]

As shown in Figure 1, the trends in real per capita GDPs of each EMU's member and its synthetic counterpart diverge after 1995. The fourth row of Table 4 summarizes the average gaps in income per-capita of each EMU's member and its synthetic control during the post-intervention period. Belgium, France, Germany and Italy are estimated to have lost from adopting the euro. More specifically, their income per capita would have been on average between 7.7 and 17.2 percentage points higher had they not adopted the euro. In contrast, both the Netherlands and Ireland are estimated to have gained from adopting the euro, with Ireland having experienced a real income per capita, on average, 23.7 percent higher than it would have been without the euro.[18]

A helpful measure to gauge the size of the income gap post-intervention relative to the estimated gap pre-intervention is the ratio of post- to pre-intervention RMSPEs. The first column of Table 5 reports the ratio corresponding to each of the EMU's members' estimates.

[17] We have constructed alternative control groups for Ireland to improve the fit during the pre-euro period. The fit improves, without changing our results, if Oman, Puetro Rico, Suriname and Seychelles are included to the control group. The inclusion of these countries, however, implies dropping secondary education attainment as a predictor due to the lack of data. For consistency with all the other specifications we do not report these results, which are available upon request.

[18] When Oman, Puetro Rico, Suriname and Seychelles are included in Ireland's control group this estimate is as large as 34.3 percent.

With the exception of the Netherlands, the post-1995 RMSPE is at least 5.89 times the pre-1995 RMSPE. The Netherlands has a low post- to pre-intervention RMPSE ratio mostly driven by the small estimated income gains post-1995.

Interestingly, our estimates seem to suggest that the UK benefitted from not adopting the euro. The UK contributes to the synthetic control units of all EMU's members, taking on higher weights in the synthetic control units corresponding to bigger losers from the euro (France and Italy) and lower weights in the synthetic controls corresponding to the countries that gained from the euro (Ireland and the Netherlands).

In order to determine the significance of our estimates, the first set of placebo tests we conduct consist of reassigning the euro adoption to a year different from 1995. To conduct these tests, we reestimate each model for the case when the euro adoption is reassigned to 1987. We use the same control groups and lag the predictors to minimize economic differences with the relevant EMU's country during the pre-treatment period. Figure 2 shows the trends in real GDP per capita of each EMU's member and its synthetic counterpart from the beginning of the sample period until 1995, when the treatment year is moved to 1987. For all countries except the Netherlands, the estimated income gaps post-1987 do not appear large relative to the income gaps pre-1987. More importantly, glancing over Figures 1 and 2 the estimated intervention effect when the treatment date is set to 1987 appears much smaller than the one estimated using the effective intervention date. To verify that is the case, Table 5 reports, for each EMU's member, the ratio of post- to pre-treatment RMSPEs when the intervention is assigned to 1987 next to the same ratio when the intervention year is 1995. With the exception of the Netherlands, all other EMU's members have a much lower ratio of RMPSEs when the treatment is assigned to 1987 instead of 1995. Put it another way, for these countries our 1987 placebo euro adoption does not have a sizeable effect. This provides evidence in favor of the fact that our estimates in Figure 1 do pick up the effect of the euro adoption on the income per capita of Belgium, France, Germany, Ireland and Italy.[19] In contrast, the results for the Netherlands imply that the estimated gains from the euro adoption in Figure 1 might not be significant.

In addition we conduct placebo tests that consist of reassigning the euro adoption to any of the countries in the control group of the relevant EMU member, and applying the synthetic control method to obtain intervention effects for countries that did not adopt the euro. If the estimated effect of the euro for a EMU's member is greater than any of the synthetic estimated effects for its control countries, we take the estimated EMU's member loss or gain as significant. To compare estimated intervention effects across units, Figure 3 reports the ratios of the post- to pre-euro RMSPEs for each EMU's member and the corresponding control countries. Belgium's post-euro RMSPE is about 6 times larger than its pre-euro RMSPE. This ratio is higher than any of the post- to pre-euro RMSPEs ratios obtained for Belgium's control countries. In other words, if one were to pick a country at

[19] We obtain similar conclusions if we move the euro adoption year to 1985 and 1989.

random from Belgium's sample, the probability of observing a ratio as high as the one of Belgium would be 1/9, i.e., 0.11. These probabilities are reported in the last row of Table 4 by EMU's member. All the remaining EMU's members except the Netherlands, turn out to have post- to pre-euro RMSPEs ratio that are far higher than the ones found for their control countries. This supports the significance of our estimates of the euro effect on the income per capita of Belgium, France, Germany, Ireland and Italy.

The placebo in-space results for the Netherlands, instead, imply that if one were to pick a country at random from its sample, the probability of observing a ratio as high as the one of the Netherlands would be 3/10, or 0.3. The estimated gains from the euro for the Netherlands cannot be taken as significant.

The next section explores the economic content of our estimated gains and losses, providing us with an additional tool to verify the significance of our estimates.

## 3.4 Discussion

A key assumption for the identification of the synthetic estimator is that endogeneity is not due to reverse causation. In the context of our application, this is equivalent to ruling out the possibility that countries adopted the euro because they expected it would spur their future economic growth. If synthetic estimates of the intervention effect were endogenous, our estimated gaps in the cases when the treated unit does better than the synthetic unit would be upward biased, while all the remaining estimated gaps would be downward biased. Having said that, we are not overly concerned with the endogeneity of our estimates as the literature suggests that euro adopters gave up their national currencies mainly for political reasons.[20] In fact, economic accounts of the costs and benefits of adopting the euro in the nineties agree that the EMU was not an optimal currency area, it would lead to economic losses for all countries involved and was to be understood mainly as a political phenomenon (Feldstein, 1997; Eichengreen and Frieden, 1993, 2000).[21] In other words, even though economic considerations were part of the political discussions at the national level, they were not the main reason behind a country's decision to adopt the euro.

Alternative explanations for the creation of the EMU come from the political science literature that studies the process of European integration.[22] The most prominent theory, functionalism, sees the EMU as the result of the process of integration and one of the steps toward deeper political integration. As European countries integrated their goods and capital markets, stable exchange rates at the cost of monetary autonomy became essential. In particular, the functionalist framework considers the process of integration as a sequence of agreements, where each integration phase opens the doors to next one with the costs of

[20] In contrast, we believe economic considerations were at the heart of the decision of the UK and Denmark to opt-out of the EMU. That explains why we do not estimate the income effects of their decision not to adopt the euro in this paper.

[21] We refer the reader to Lane (2006) who provides a more recent account of the real effects of the EMU.

[22] Sadeh and Verdun (2009) provide a review of the literature on the explanations behind the creation of the EMU. Spalaore (2013) provides a political guide on the European integration for economists.

exit increasing exponentially after each step is taken. This functionalist view was especially influential among supranational politicians that contributed to the makings of the EMU. It is not surprising that functionalist arguments appeared in official documents emphasizing the need of a single currency.

Another important assumption of the synthetic method is that the intervention implemented in the treated unit does not affect directly or indirectly the outcomes of the control units. Changes in trade patterns with non-EMU members brought about by the euro might be of concern in this respect. In fact, changes in bilateral trade reflect in changes in a country's trade, which can ultimately affect growth. The existing literature estimates that the euro increased trade between EMU members and non-EMU members ranges from 0% and 9%.[23] Combining the average estimate of 4.5% with the average share of control units' trade with EMU members included in our sample, 3.07%, we find that the euro increased trade of a control unit by 0.14%, on average.[24] Going a step further and taking this estimate together with Frankel and Rose's (2002) estimate that a one percent increase in trade increases a country's income per capita growth by one third of a percent, we calculate the euro effect on a control unit's growth to be approximately 0.05%. This effect is not sizeable, and becomes smaller if one considers that the literature finds no significant effect of the euro on trade with the UK and Denmark (Flam and Nordström, 2006), which are the countries with the highest trade shares with EMU members in our sample. Furthermore, more recent studies find no significant effect of the euro on trade with either other EMU members or non-EMU members (Silva and Tenreyro, 2010; Mancini-Griffoli and Pauwels, 2006).[25] In sum, we believe the adoption of the euro has not substantially affected the income growth of the control units.

# 4 Explaining the Aggregate Effects of the €uro

In this section we exploit the insights of the literature on currency unions to evaluate how our synthetic estimates of the gains and losses from the euro relate to the economic determinants of the costs and benefits of monetary unions. This type of exercise allows us to further verify the economic content and significance of our synthetic estimates.

## 4.1 Costs and Benefits of Monetary Unions

In a series of seminal papers by Mundell (1961), Ingram (1962) and McKinnon (1963), these authors investigate the key characteristics that define an OCA. An important insight of this

[23] We refer the reader to Micco et al. (2003) and Flam and Nordström (2006) for more on these estimates.

[24] Incidentally, 4.5% is the estimated effect Micco et al. (2003) obtain from a dynamic panel model.

[25] One might also be concerned about the euro effect on foreign direct investments (FDI) with non-EMU members. However, Carkovic and Levine (2005) find no effect of FDI on a country's growth. This implies that even if bilateral FDI between treated and control units were affected by the euro, that would not have affected the income growth of the control units.

early literature is that when a country gives up its currency and joins a monetary union, it is essentially abandoning its autonomous monetary policy. As a result, this country imposes a cost on itself in its ability to respond to external shocks. The more likely a country is to be hit by asymmetric shocks, the less likely it is that it will benefit from having a common currency.[26]

Other than the nature of shocks, Mundell (1961) emphasizes the importance of labor mobility. He argues that in order to better absorb external shocks there should be a high degree of labor mobility among the countries in a monetary union. Allowing this factor of production to be mobile across countries helps, through migration, to manage external shocks that put pressure in local labor markets. A related mechanism is that induced by wage flexibility. If workers in the country hit by negative shocks are willing to accept lower wages, then the adverse effects of unemployment can be weakened by making it cheaper for firms to hire workers. Wage flexibility then lowers both the incentives of workers to emigrate and the need of exchange rate adjustments in the face of shocks.

In the same spirit as labor mobility, Ingram (1962) argues that financial integration could reduce the need for exchange rate adjustments as it may cushion temporary adverse disturbances through capital inflows/outflows. In particular, through borrowing from surplus areas or decumulating net foreign assets in depressed ones, countries in the monetary union with integrated financial markets can have better risk sharing arrangements. This multi-country insurance scheme allows the smoothing of both temporary and permanent shocks.[27] Thus, having free capital mobility reduces the need to alter real factor prices and the nominal exchange rate between countries in response to external shocks.

Apart from factor inputs, McKinnon (1963) emphasizes the role of international trade in determining the costs of joining a monetary union. He argues that the higher the degree of openness, the more changes in international prices of tradables transmit to the aggregate price level. As a result, the systematic use of monetary policy, by changing the currency value, reflects in greater price variability in more open economies. As price variability implies costs, giving up independent monetary policy is less costly for more open economies.

Further, labor market institutions play a key role in determining a country's response to shocks common to union members. For instance, a supply shock might have very different effects on domestic wages and prices depending on the response of labor unions to it. Wages and prices might change dramatically in economies with intermediate level of labor union centralization, but not much in countries with extremely centralized or decentralized labor unions (Bruno and Sachs, 1985; Calmfors and Driffils, 1988). This implies, that a country

[26] Alesina and Barro (2002) formalize the importance of asymmetric shocks and price rigidities and show the adoption of another country's currency trades off the benefits of commitment to price stability against the loss of an independent stabilization policy. This trade-off depends on co-movements of disturbances, on distance, trading costs, and on institutional arrangements. Within the same spirit, Gali and Monacelli (2008) show that in the presence of country-specific shocks and nominal rigidities, the policy mix that is optimal from the viewpoint of the union as a whole requires that inflation be stabilized at the union level by the common central bank, whereas fiscal policy has a country-specific stabilization role.

[27] This is the case as long as output is imperfectly correlated with these shocks.

might find it costly to join a monetary union where other members have very different labor institutions. In fact, the different response in wages and prices in face of a common shock might be difficult to correct once the exchange rate is fixed.

Finally, the literature on OCA stresses the role of monetary and fiscal policies. In particular, Fleming (1971) notes that when inflation rates between countries are low and similar, terms of trade will tend also to remain fairly stable. This synchronicity of inflation rates among trading countries then reduces the need for nominal exchange rate adjustments to respond to external shocks. Moreover, once in a monetary union, the level of seigniorage is also collectively determined by the common central bank. The latter is expected to put a limit on the extent of deficit monetization by member states as suggested by the unpleasant monetarist arithmetic of Sargent and Wallace (1981). The government's budget constraint forces a deep interconnection between monetary and fiscal policies in each of the countries that adopt a common currency. Consequently, members of the monetary union must strictly adhere to fiscal discipline. More recently, Chari and Kehoe (2007) show the desirability of fiscal constraints in monetary unions depends critically on whether the monetary authority can commit to following its policies. If it can commit, then debt constraints can only impose costs. If it cannot commit, then fiscal policy has a free-rider problem, and debt constraints may be desirable.[28]

The criteria for an OCA are likely to be endogenous. For instance, the introducion of a common currency spurs trade among union members. If trade within the union is mostly intra-industry, integration in the goods market increases the similiraties in union members' production structures and their exposure to similar shocks, de facto bringing the currency union closer to being optimal (Frankel and Rose, 1998; Alesina et al., 2003; Barro and Tenreyro, 2007).[29]

Focusing on the benefits of monetary unions, these include the reduction of both transaction costs and the uncertainty related to exchange rate fluctutations. By joining a currency union, a country abates the costs of coverting domestic money in other members' currencies, and it increases price transparency and competition within the union. The reduction in exchange rate uncertainty increases the welfare of risk-averse consumers and firms. More importantly, fixing the exchange rate with main economic partners brings to zero the probability of large movements in the exchange rate, which typically create large adjustment costs as firms close down and factors of production must be reallocated.[30] All these benefits tend to be larger for economies that are more open to other countries of the union. The elimination of transaction costs is greater the more countries trade with other union members.

[28]These authors then provide a new lens to view the Maastricht treaty and the stability and growth pact.

[29]This view is supported by the European Commission in the context of the EMU. Krugman (1993), instead, argues that increased trade within a monetary union might lead to increased concentration of production at the country level. This, by increasing differences in union members' production structures, increases the incidence of asymmetric shocks within the union.

[30]In the context of the European Union, Germany faced large adjustment costs following the depreciations of the Italian lira and Spanish peseta in the ninities.

Similarly, the elimination of exchange rate uncertainty benefits firms and consumers more the more business they conduct within the union.

## 4.2 Empirical Approach

In order to understand the aggregate effects of the euro we use the insights from the literature reviewed in section 4.1 and estimate the following model:

$$\frac{Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}}{Y_{1t}} = \beta_0 + \beta_1 X_{1t}^{emu} + \beta_2 I_{1t}^{emu} + \beta_3 SEP_{1t} + \beta_4 \Delta LI_{1t}^{emu} + \beta_5 (d_{1t} - d_M) + \epsilon_{1t} \quad (4)$$

where the dependent variable is the synthetic estimate of the income per capita gap for treated country 1 as a percentage of its income per capita observed at time $t = 1995, ..., 2007$. This variable takes on positive values for EMU's members that are estimated to have gained from the euro and negative values for countries that have lost from the euro. The variable $X_{1t}^{emu}$ measures the extent of business cycle syncronization, trade openess or labor mobility of country 1 with the founding eleven EMU's members at time $t$. $I_{1t}^{emu}$ captures country 1's capital integration in the union and it measures the share of 1's international portfolio allocated to the founding EMU's members in $t$. $SEP_{1t}$ is country 1's strictness of employment protection as a proxy for wage flexibility in $t$. $\Delta LI_{1t}^{emu}$ captures diferences in labor market institutions, and it is calculated as the difference in wage bargaining coordination between 1 and the founding EMU's members at time $t$. Finally, we control for $(d_{1t} - d_M)$, which is the deviation of the country 1's debt to GDP ratio at time $t$, $d_{1t}$, from the Maastrict limit, $d_M$, to account for the desirability of fiscal contraints. $\epsilon_{1t}$ is an error term with standard properties.

According to the insights of the literature on the costs and benefits of currency unions we expect the estimate of $\beta_1$ to be positive. Greater syncronization of a country's business cycle with that of other union members reduces the cost of giving up independent monetary policy. Greater openness to migration within the union increases a country's gain from the access to partners' labor markets and reduces the losses associated to a fixed exchange rate. Greater trade openness toward other union partners increases the benefits and lowers the costs of the adoption of a unique currency. When we estimate the model in (4), we include one of these factors at the time. We do so as these covariates are not independent from each other or they are highly correlated with each other. For instance, trade and migration openness are very highly correlated, which makes identification an issue. Trade has been shown to increase partners' business cycle correlation, if we put both variables in the same specification the interpretation of results is compromised.

The estimated coefficient of $\beta_2$ could be positive or negative depending on whether union members on average gained or lost in income per capita terms after the introduction of the euro. Suppose that, on average, the founding EMU's members experienced losses post-euro, these losses would be borne to a larger extent by those union members having a larger share

of their international portfolio invested in other union members. In this case, the estimate of $\beta_2$ would be negative indicating that greater losses or smaller gains accrued to those members with capital markets more integrated with the union.

We use the strictness of employment protection to capture the extent of a country's labor market rigidity. Less rigid labor markets allow a country to cope better with external shocks and to lose less from joining a monetary union. Thus, the expected sign of $\beta_3$ is negative. We take the difference in wage bargaining coordination of a member relative to other EMU's members to account for differences in labor market institutions. Because countries might find it costly to join a monetary union where other members have very different labor institutions, we expect the estimate for $\beta_4$, to be negative. Finally, a negative estimate for $\beta_5$, following Chari and Kehoe (2007), would imply that fiscal discipline is desirable.

Our dependent variable consists of estimated values. While this does not affect our estimated coefficients from model (4)it implies a loss of efficiency. Typically, when the dependent variable is a regression estimate the corresponding standard errors from the first stage are used as weights to improve the estimator efficiency in the second stage. This approach is unfortunately unavailable to us because the synthetic method does not provide us with standard errors for our estimates. We do report Efron (HC3) robust standard errors to correct for the heterosckedasticity potentially arising because we do not observe the true income effects of the euro.

## 4.3 Data

The data we use in this section are at the country level and span the period 1995-2007. We take our synthetic estimates of income per capita gaps for our six EMU's members to construct the dependent variable in equation (4). This implies that the total number of observations available for our analysis is 78 (6 countries by 13 years).

In order to calculate the business cycle correlation of each of the six EMU's members with the union, we use quarterly data on the real GDP for all the founding EMU's countries from the OECD database. We focus on business cycle fluctuations by first expressing the output data in natural logarithms and then de-trending the resulting series using the Hodrick-Prescott filter (using a smoothing paramenter of 1600). For each EMU's member we calculate the bilateral business cycle correlations with other union countries in a given year, on a rolling fashion, based on the quarterly output fluctuations in that year and the previous three years.[31] The average of all these bilateral correlations is our measure of a country's business cycle syncronization with the union in a given year.

A country's openess to intra-EMU trade is constructed using data from the OECD Bilateral Trade Database and GDP values from the World Development Indicators (WDI).

[31] All the results in table 6 are robust if our business cycle syncronization measure is based on the quarterly output fluctuations in that year and the previous four or nine years. The variation in the resulting measure is higher the shorter is the time horizon over which we calculate business cycles correlations.

Our measure of a country's labor mobility in the union is based on its openness to immigrants from the founding 11 EMU's countries, i.e., the share of immigrants from EMU's members in total population. To calculate this measure for Germany, Italy, Belgium and the Netherlands we use the Ortega-Peri dataset (2013).[32] For Ireland and France, we use immigration data from the Central Statistics Office StatBank and the INED, respectively.[33] Population data are from the WDI. We focus on immigration openness because of data availability. However, using data on 15 OECD countries from the Ortega-Peri dataset we find that countries open to immigration from OECD countries tend to be open to emigration to the same set of countries.[34] This gives us confidence that our measure of openess to immigration captures the extent of a country's integration in the union labor market.

Data on the proportion of a country's international portfolio holdings allocated to founding EMU's partners are from the IMF's Coordinated Portfolio Investment Survey.[35] Data on the strictness of employment protection are from the OECD. Information on wage bargaining coordination for all EMU's members are taken from the database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts (ICTWSS; Visse, 2013). Finally, debt to GDP data are from the European Commission Annual Macroeconomic database (AMECO).

## 4.4 Results

Table 6 summarizes the estimates for different specifications of the model in equation(4). We report standardized beta coefficients so we can directly compare the effects of our covariates on the synthetic income per capita gap. HC3 standard errors are in parentheses. Conventional standard errors are in square brackets. We report both set of standard errors because in finite sample the maximum of the two is the best measure of precision (Angrist and Pischke, 2009).[36]

The specification in column (1) considers the business cycle syncronization effect on our six EMU's members income gains or losses from the euro. The same specification omits the debt to GDP deviation variable as fiscal policy affects a country's exposure to idiosyncratic shocks and its business syncronization with the union. Our results are consistent with the theory and imply that a one standard deviation increase in the symmetry of countries' business cycle relative to the union decreases the costs or increases the gains from the euro by

[32]The data for Italy are only available till the year 2000. We bring forth the series to 2007 applying the average growth rate of immigration from EMU members to Italy during 1995-2000.

[33]The Irish data are available at the EU13 level (with the exclusion of Ireland and the UK). To obtain immigration flows from the founding members we, first, calculate the average proportion of immigrants from Denmark, Greece and Sweden that entered Italy, Germany, Belgium and the Netherlands by year from the Ortega-Peri dataset. We, then, use these averages to deflate the Irish data. We apply a similar methodology to the French data as they are available at the EU14 level.

[34]The correlation between immigration and emigration population shares is 0.75 in the data.

[35] Data are available for 1997, 2001-2007. We interpolate the data between 1997 and 2001. To bring back the series to 1995 we use the observed country-specific average growth rates in portfolio shares.

[36]Our results are robust to the clustering of standard errors by country cell accounting for the small number of clusters. Results are available upon request to the authors.

0.16 of a standard deviation. All the remaining estimated coefficients are negative. We find that increasing shares of a country's international portfolio invested in the union decrease gains from adopting the euro. This finding is consistent with capital markets working as an insurance system as losses from the euro are redistributed across its members. Finally, greater rigidity in labor markets or difference in labor institutions imply greater losses from the euro.

In column (2) we replace the syncronization variable with the intra-EMU trade openess measure. We further control for the debt to GDP deviation measure. Results are again consistent with the theory, increases in trade openess toward members of the union reduce the costs of giving up monetary policy or increases the benefits from the adoption of the single currency. The estimated effect on the trade variable is likely capturing more than just the effect of intra-EMU trade openess as more open countries have a more syncronized business cycle relative to the union and are also more open to migration with other union partners. The negative estimate on the debt to GDP measure suggests that fiscal discipline is desirable for countries joining a monetary union. All the remaining coefficients are significant and take the same signs as in column (1).

Column (3) focuses on the effect of labor mobility, captured by immigration openness toward union members, on the gains from the euro. Because this measure is highly correlated with the characteristics of the labor market in the host country, the specification we estimate does not include labor market related variables. A one standard deviation increase in immigration openness increases the gains from joining the union by 0.59 of a standard deviation. As in the case of trade openness, this effect should be interpreted as the results of more than a country's integration in the union labor market. All the remaining effects are negative and consistent with the specifications estimated in columns (1) and (2).

Interestingly, glancing over the first three columns of table 6 it appears that the factor that affects the most the income effects of the euro is the integration of capital markets. In fact, a one standard deviation increase in the share of a country's international portfolio invested in the union decreases the gains from adopting the euro by between 0.51 and 0.72 of a standard deviation.

Because most of the variation in our variables is cross-sectional in nature, in columns (4)-(6), we re-estimate the specifications in columns (1)-(3) adding year fixed effects. The results are robust to the addition of the year fixed effects.[37] This suggests the results in column (1)-(3) are mainly driven by cross-country differences in the economic characteristics of the six EMU's members in our sample.

The results in table 6 are essentially unchanged if one replaces the synthetic estimates of the income gains for the Netherlands with zeros.[38] We take this as further evidence of the statistical non-significance of the estimated gains from the euro for the Netherlands.

[37]The exception in this respect is the coefficient on the debt to GDP deviation whose magnitude shrinks or becomes insignificant.

[38]Results are available upon request to the authors.

All the results in table 6 are consistent with the predictions of the literature. This shows that our synthetic estimates reflect commonly recognized determinants of the economic costs and benefits of monetary union, confirming their significance.

# 5 Conclusions

The euro was introduced more than a decade ago, but so far no direct evidence exists on whether the adopters have benefitted or lost, in economic terms, from it. Our paper fills this gap in the literature performing two interrelated exercises.

First, we estimate the income per capita EMU's members would have experienced had they kept their independent monetary policy using the synthetic control method. This allows us to identify winners and losers from the euro. Our estimates suggest that the income per capita of Belgium, France, Germany and Italy would have been higher without the euro, while that of Ireland would have been considerable lower. Our evidence suggests the Netherlands has been as well off with the euro as it would have been without it.

Second, we relate the synthetic estimates of the income effects of the euro to the economic determinants of the costs and benefits of monetary unions. This second exercise is particularly interesting because, in addition to a simple way of verifying the economic content of our synthetic estimates, it provides useful insights for prospective members of the EMU. Consistent with the theory of currency unions, we find that early euro adopters with a business cycle more syncronized to that of the union, and more open to intra-union trade and migration experienced lower losses or greater benefits from the euro. Our evidence also suggests that a key role in the transmission of post-euro income losses across union members has been played by the integration of capital markets. These results are of relevance for prospective members of the EMU as they suggest intra-union trade and migration openness as well as targeted investments within the union are key to increase the chances of winning from the euro.

# References

**Abadie, A. and J. Gardeazabal**, "The Economic Costs of Conflict: A Case Study of the Basque Country," *American Economic Review*, (2003), 93(1): 113-132.

**Abadie, A., A. Diamond, and J. Hainmueller**, "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program," *Journal of the American Statistical Association*, (2010), 105(490): 493-505.

**Abadie, A., A. Diamond, and J. Hainmueller**, "Comparative Politics and the Synthetic Control Method," *American Journal of Political Science*, (2014), doi: 10.1111/ajps.12116.

**Alesina, A. and R. Barro**, "Currency Unions," *Quarterly Journal of Economics*, (2002), 117(2): 409-436.

**Barro, R. and J. W. Lee**, "A New Data Set of Educational Attainment in the World, 1950-2010." *Journal of Development Economics*, (forthcoming).

**Billmeier, A. and T. Nannicini**, "Assessing Economic Liberalization Episosdes: A Synthetic Control Approach," *Review of Economics and Statistics*, (2013), 95(3), 983-1001.

**Bruno, M. and J. Sachs**, "Economics of Worlwide Stagflation," Oxford: Basil Blackwell, (1985).

**Calmfors, L. and J. Driffill**, "Bargaining Structure, Corporatism and Macroeconomic Performance," *Economic Policy*, (1988), 6: 13-61.

**Carkovic, M., and R. Levine**, "Does Foreign Direct Investment Accelerate Economic Growth?", In Moran, T.H., E. M. Graham, and M. Blomstrom, (eds.), Does Foreign Direct Investment Promote Development, (2005), Washington , DC: Institute for International Economics.

**Carre, M. and F. Collard**, "Monetary union: A Welfare Based Approach," *European Economic Review*, (2003), 47(3): 521-552.

**Cavallo, E., S. Galiani, I. Noy, and J. Pantano**, "Catastrophic Natural Disasters and Economomic Growth," *Review of Economics and Statistics*, (2013), 95(5): 1549-1561.

**Chari, V. and P. Kehoe**, "On the Need for Fiscal Constraints in a Monetary Union," *Journal of Monetary Economics*, (2007), 54(8): 2399-2408.

**Ching, S. and M. Devereux**, "Mundell Revisited: a Simple Approach to the Costs and Benefits of a Single Currency Area," *Review of International Economics*, (2003), 11(4): 674-691.

**Devereux, M., C. Engel and C. Tille**, "Exchange Rate Pass-Through And The Welfare Effects Of The euro," *International Economic Review*, (2003), 44(1): 223-242.

**DuPont, W. and I. Noy**, "What happened to Kobe? A Reassessment if the Impact of the 1995 Earthquake in Japan," *Economic Development and Cultural Change*, (forthcoming).

**Eichengreen, B. and J. Frieden**, "The Political Economy of European Monetary Unification: An Analytical Introduction," *Economics and Politics*, (1993), 5(2): 85-104.

**Feldstein, M.**, "The Political Economy of the European Economic and Monetary Union: Political Sources of an Economic Liability," *Journal of Economic Perspectives*, (1997), 11(4):23-42.

**Ferreira-Lopes, A**, "In or out? The welfare costs of EMU membership," *Economic Modelling*, (2010), 27(2): 585-594.

**Flam, H., and H. Nordström** "Trade Volume Effects of the euro: Aggregate and Sector Estimates," Institute for International Economic Studies, unpublished, (2003).

**Fleming J.**, "On Exchange Rate Unification," *Economic Journal*, (1971), 81: 467-88.

**Frankel, J. and A. Rose**, "The Endogeneity of the Optimum Currency Area Criteria," *Economic Journal*, (1998), 108(449):1009-1025.

**Frankel, J. and A. Rose**, "An Estimate Of The Effect Of Common Currencies On Trade And Income," *Quarterly Journal of Economics*, (2002), 117(2):437-466.

**Galí, J. and T. Monacelli**, "Optimal Monetary and Fiscal Policy in a Currency Union," *Journal of International Economics*, (2008), 76(1): 116-132.

**Ingram, J.**, "The Case for the European Monetary Integration." Princeton University, Essays in International Finance, (1973), No. 98.

**Kenen, P.**, "The Optimum Currency Area: An Eclectic View", In Mundell and Swoboda, (eds.), Monetary Problems of the International Economy, (1969), Chicago: University of Chicago Press.

**King, G., and L. Zeng**, "The Dangers of Extreme Counterfactuals." *Political Analysis*, (2006), 14, 131-159.

**Lane, P.R.**, "The Real Effects of European Monetary Union," *Journal of Economic Perspectives*, (2006), 20(4): 47-66.

**Manasse, P., Nannicini T., and A. Saia**, "Gli effetti dell'euro sull'economia italiana ," Linkiesta, (2013).

**Mancini-Griffoli, T., and L. Pauwels**, "Is there a euro Effect of Trade? An Application of End-of-Sample Structural Break Tests for Panel Data," HEI manuscript, (2006).

**McKinnon, Ronald I.**, "Optimum Currency Areas," *American Economic Review*, (1963), 52:717-725.

**Micco, A., E. Stein, and G. Ordõnez**, "The Currency Union Effect on Trade: Early Evidence from EMU," *Economic Policy*, (2003), 18(37): 315-356.

**Mundell, R.**, "A Theory of Optimum Currency Areas," *American Economic Review*, (1961), 51(4): 657-665.

**Ortega, F. and G. Peri**, "The Effect of Income and Immigration Policies on International Migration," *Migration Studies*, (2013), 1: 28.

**Sadeh, T., and A. Verdun** , "Explaining europe's Monetary Union: A Survey of the Literature," *International Studies Review*, (2009), 11: 277-301.

**Saia A.**, "Choosing the Open Sea: The Cost to the UK of Staying Out of the euro," mimeo, (2014).

**Sargent, T. and N. Wallace**,"Some Unpleasant Monetarist Arithmetic," *Quarterly Review*, Federal Reserve Bank of Minneapolis.

**Silva, S. and S. Tenreyro**, "Currency Unions in Prospect and Retrospect," *Annual Review of Economics*, (2010), 2(1):51-74.

**Sousa, J.**, "The Currency Union Effect on Trade is Decreasing Over Time," *Economics Letters,* (2012), 117(3): 917-920.

**Spalaore, E.**, "What is European Integration Really About? A Political Guide for Economists," *Journal of Economic Perspectives*, (2013), 27(3): 125-144.

**Véron, N.**, "The European Debt and Financial Crisis: Origins, Options". Congressional Testimony Submitted to the US Senate Committee on Banking, Housing, and Urban Affairs: Subcommittee on Security and International Trade and Finance.

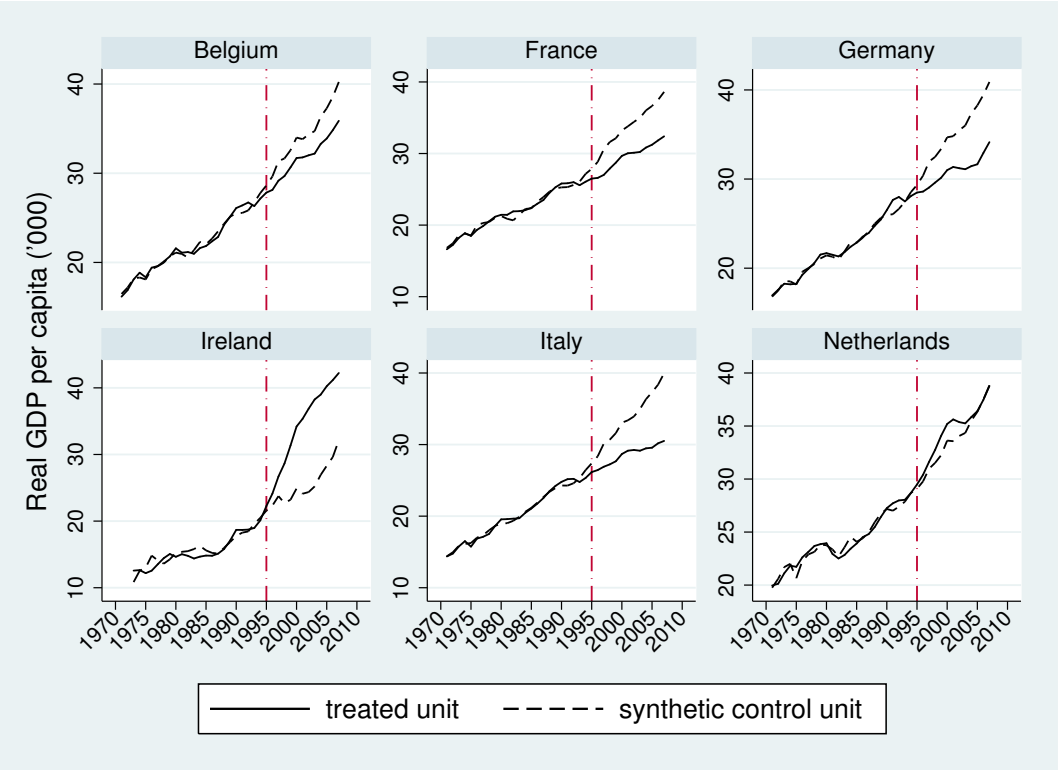


Figure 1: Real GDP per capita: Treated vs. synthetic control unit

**Note.** The vertical line stands in correspondence of 1995, our treatment year.

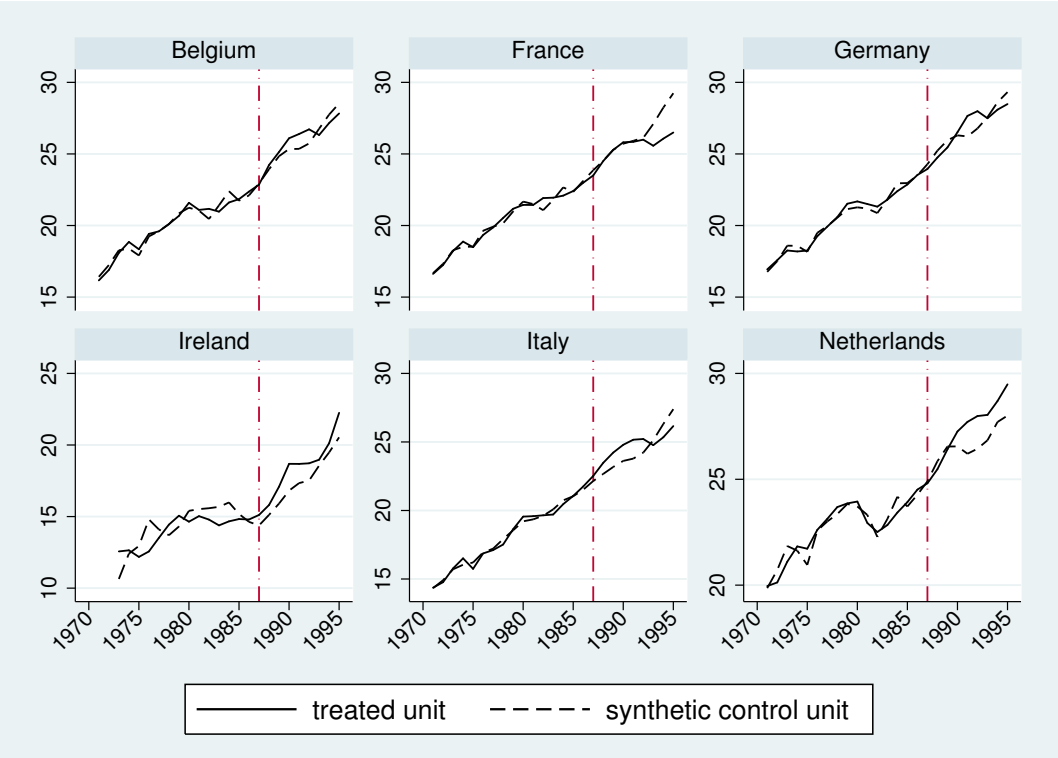


Figure 2: Results of placebo in time tests

**Note.** The vertical line stands in correspondence of 1987, which is the year we reassign the treatment to.

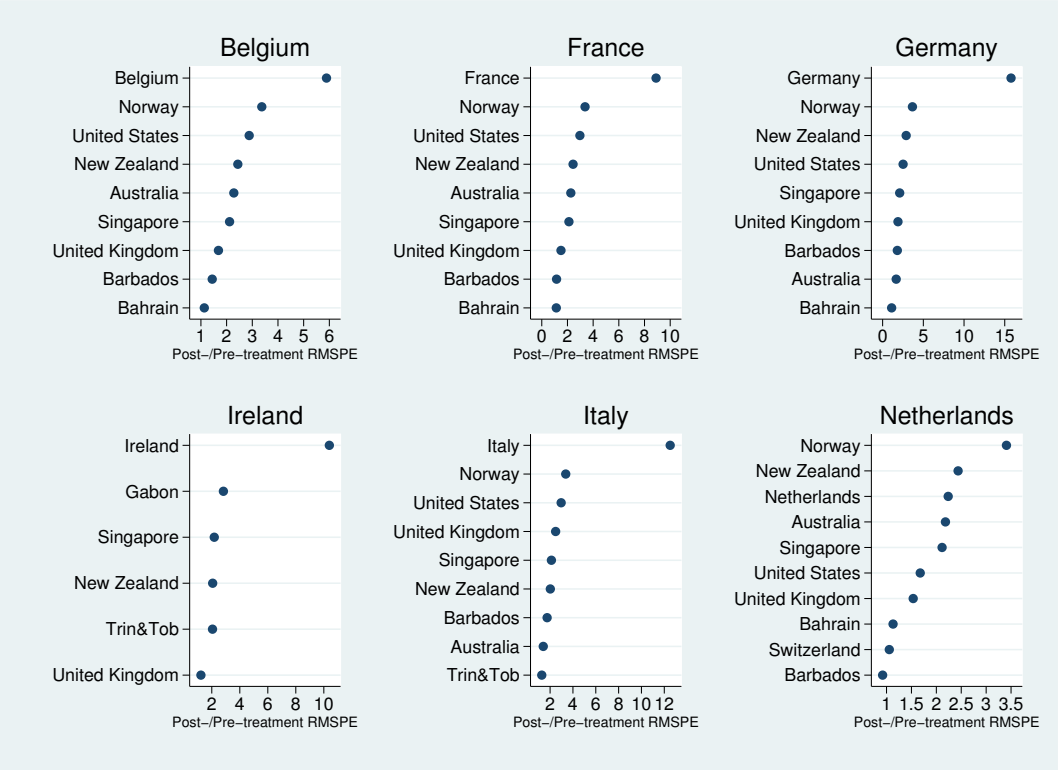


Figure 3: Results of placebo in space tests

Table 1: Key Dates in the Making of the Eurozone

| Year | Political Developments |
|---|---|
| 1971 | France, West Germany, Italy, Belgium, Netherlands, Luxembourg (European Community, EC) commit to form an economic and monetary union. |
| 1973 | Denmark, Ireland and the UK join the EC. |
| 1981 | Greece joins the EC. |
| 1986 | Portugal and Spain join the EC. |
| 1991 | The Maastrict Treaty transforms EC into the European Union (EU) and sets the criteria for the adoption of the common currency. |
| 1992 | Denmark opts out the European Monetary Union (EMU). |
| 1995 | Austria, Finland and Sweden join the EU. |
| 1997 | The UK opts out the EMU. |
| 1998 | The European Central Bank is created. Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain fix their exchange rates with the euro. |
| 2001 | Greece joins the eurozone. |
| 2003 | Sweden voters reject the adoption of the euro in a referendum. |
| 2004 | Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta Poland, Slovakia, and Slovenia join the EU. |
| 2007 | Slovenia joins the eurozone. |
| 2008 | Cyprus and Malta join the eurozone. |
| 2009 | Slovakia joins the eurozone. |
| 2011 | Estonia joins the eurozone. |
| 2014 | Latvia joins the eurozone. |

Table 2: Sample Period and Control Group by EMU member

| EMU Member | Sample Period | Control Group |
|---|---|---|
| Belgium | 1971-2007 | Australia, Bahrain, Barbados, UK, Norway,New Zealand, Singapore, USA |
| France | 1971-2007 | Australia, Bahrain, Barbados, UK, Norway, New Zealand, Singapore, USA |
| Germany | 1971-2007 | Australia, Bahrain, Barbados, UK, Norway, New Zealand, Singapore, USA |
| Ireland | 1973-2007 | Gabon, UK, New Zealand, Singapore, Trinidad and Tobago |
| Italy | 1971-2007 | Australia, Barbados, UK, Norway, New Zealand, Singapore, Trinidad and Tobago, USA |
| Netherlands | 1971-2007 | Australia, Bahrain, Barbados, UK, Norway, New Zealand, Singapore, Switzerland, USA |

Table 3: Predictors: Data Sources and Periods of Averaging by EMU member

| **Predictor** | **Source** | **Belgium** | **France** | **Germany** | **Ireland** | **Italy** | **Netherlands** |
|---|---|---|---|---|---|---|---|
| Real GDP per capita | PWT 7.1 | 1971-1975 | 1971-1980 | 1971-1980 | 1973-1980 | 1971-1980 | 1971-1975 |
| | | 1976-1985 | 1981-1985 | 1981-1990 | 1981-1990 | 1981-1985 | 1976-1980 |
| | | 1986-1994 | 1986-1994 | 1991-1994 | 1991-1994 | 1986-1994 | 1981-1985 |
| | | | | | | | 1986-1990 |
| | | | | | | | 1991-1994 |
| Inflation rate, GDP deflator | WDI | 1991-1994 | 1991-1994 | 1991-1994 | 1981-1994 | 1986-1990 | 1991-1994 |
| Industry share of value added | WDI | 1986-1994 | 1971-1980 | 1981-1985 | 1986-1994 | 1981-1994 | 1976-1994 |
| Investment to GDP | WDI | 1991-1994 | 1986-1994 | 1991-1994 | 1976-1985 | 1986-1990 | 1971-1994 |
| Secondary Education | Barro-Lee | 1991-1994 | 1971-1994 | 1991-1994 | 1973-1980 | 1981-1994 | 1991-1994 |
| Trade Openness | WDI and CEPII | 1986-1994 | 1986-1994 | 1986-1994 | 1986-1990 | 1986-1994 | 1986-1994 |

Note. Investment to GDP is: Gross capital formation as a percentage of GDP. Secondary Education is the percentage of total population aged 25+ that has attained secondary schooling (Barro and Lee, *forthcoming*). Trade Openness is: total trade in goods and services as a percentage of GDP. WDI stands for World Development Indicators, and CEPII for Centre d'Études Prospectives et d'Informations Internationales.

Table 4: Summary of Results-Synthetic Estimation

| | **Belgium** | **France** | **Germany** | **Ireland** | **Italy** | **Netherlands** |
|---|---|---|---|---|---|---|
| Control countries with positive weights | Bahrain (0.106)<br>Barbados (0.092)<br>UK (0.292)<br>Norway (0.128)<br>Singapore (0.215)<br>USA(0.166) | Bahrain (0.123)<br>Barbados (0.034)<br>UK (0.561)<br>Norway (0.282) | Australia (0.122)<br>Bahrain (0.105)<br>UK (0.284)<br>Norway (0.134)<br>Singapore (0.154)<br>USA (0.201) | Gabon(0.31)<br>UK (0.109)<br>Singapore(0.422)<br>Trinidad and Tobago (0.159) | UK (0.557)<br>Norway (0.194)<br>Singapore(0.116)<br>Trinidad and Tobago (0.089)<br>USA (0.044) | Bahrain (0.156)<br>UK (0.208)<br>Singapore (0.137)<br>USA (0.288)<br>Switzerland (0.212) |
| RMSPE | 446.87 | 482.71 | 286.72 | 910.93 | 442.98 | 481.17 |
| Difference RGDP p.c. pre-intervention (% of EMU member's RGDP p.c.): $\mu, [sd]$ | 0.062<br>[1.982] | -0.059<br>[2.176] | -0.071<br>[1.316] | -1.826<br>[6.578] | -0.335<br>[2.082] | -0.135<br>[2.112] |
| Difference RGDP p.c. post-intervention (% of EMU member's RGDP p.c.): $\mu, [sd]$ | -7.656<br>[2.416] | -13.663<br>[3.917] | -13.171<br>[5.561] | 23.677<br>[10.265] | -17.253<br>[7.855] | 2.451<br>[2.018] |
| $P(\frac{R^c_{post}}{R^c_{pre}}) \geq P(\frac{R^{cemu}_{post}}{R^{cemu}_{pre}})$ | 1/9 | 1/9 | 1/9 | 1/6 | 1/9 | 3/10 |

Note. R stands for Root Mean Square Prediction Error, $c$ refers to any country in the relevant control group, and $c_{emu}$ is the EMU member for which the results are being reported in the relevant column. $\mu$ and $sd$ indicate the mean and the standard deviation of the estimated gap.

Table 5: Ratio of post- to pre- intervention RMSPEs

| | **Intervention Year** | |
|---|---|---|
| | **1995** | **1987** |
| Belgium | 5.890 | 1.764 |
| France | 8.900 | 4.092 |
| Germany | 15.775 | 2.647 |
| Ireland | 10.394 | 1.116 |
| Italy | 12.517 | 3.782 |
| Netherlands | 2.238 | 3.585 |

Table 6: Explaining the Aggregate Effects of the Euro

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Business cycle syncronization with EMU 11 | 0.1558*** | | | 0.3510** | | |
| | (0.0352) | | | (0.0899) | | |
| | [0.0399]** | | | [0.0851]*** | | |
| Openess to Trade with EMU 11 | | 0.4147*** | | | 0.4373*** | |
| | | (0.0328) | | | (0.0289)*** | |
| | | [0.0310]*** | | | [0.0284]*** | |
| Immigration from EMU 11, % of population | | | 0.5941*** | | | 0.6323*** |
| | | | (8.7143)*** | | | (7.9729) |
| | | | [8.3888]*** | | | [7.4208]*** |
| Share of Int'l portfolio invested in EMU 11, $I_{1t}$ | -0.5155*** | -0.5168*** | -0.7161*** | -0.5527*** | -0.5810*** | -0.8456*** |
| | (0.0007) | (0.0004) | (0.0005) | (0.0006) | (0.0005) | (0.0007) |
| | [0.0007]*** | [0.0006]*** | [0.0005]*** | [0.0007]*** | [0.0006]*** | [0.0006]*** |
| Strictness of Employment Protection, $SEP_{1t}$ | -0.6110*** | -0.3624*** | | -0.6430*** | -0.3550*** | |
| | (0.0204) | (0.0172) | | (0.0177) | (0.0164) | |
| | [0.0173]*** | [0.0138]*** | | [0.0171]*** | [0.0126]*** | |
| $\Delta$ in wage bargaining coordination, $\Delta LI_{1t}^{emu}$ | -0.2308*** | -0.2467*** | | -0.2977*** | -0.2619*** | |
| | (0.0240) | (0.0185) | | (0.0249) | (0.0174) | |
| | [0.0289] *** | [0.0188]*** | | [0.0293]*** | [0.0175]*** | |
| Debt to GDP deviationfrom limit, $(d_{1t} - d_M)$ | | -0.3868*** | -0.2230*** | | -0.3419*** | -0.1204* |
| | | (0.0002) | (0.0003) | | (0.0002) | (0.0004) |
| | | [0.0002]*** | [0.0003]*** | | [0.0002]*** | [0.0003]** |
| Year fixed effects | No | No | No | Yes | Yes | Yes |
| $R^2$ | 0.7647 | 0.9021 | 0.8592 | 0.8212 | 0.9327 | 0.9106 |
| $N$ | 78 | 78 | 78 | 78 | 78 | 78 |

Note. The dependent variable is the synthetic estimate of the income per capita gap for the treated country as a percentage of its observed income per capita, $\frac{Y_{1t}-\sum_{j=2}^{J+1} w_j^* Y_{jt}}{Y_{1t}}$. Standardized beta coefficients are reported, with HC3 standard errors in parentheses and conventional standard errors in square brackets. ***, **, * indicate significance at the 1, 5 and 10 percent level, respectively.

# A Appendix

Table A1 provides a comparison of the means of the predictors for each EMU member and its synthetic control. The results show each EMU's member's characteristic is well matched by its synthetic counterpart. In general, the synthetic control matches characteristics of the treated country more closely than just the simple or population average value in the control group.[39] A recurrent exception is trade openness. This happens when Singapore, an important shipping and processing center with very high trade to GDP ratios, takes on a positive weight in the synthetic control of not as open EMU's members.

Table A1: Economic Growth Predictor Means before the Euro: Treated vs. Synthetic

| **Panel A.** Results for Belgium, France and Germany | | | | | | |
|---|---|---|---|---|---|---|
| **Predictor** | **Belgium** | **Synthetic Belgium** | **France** | **Synthetic France** | **Germany** | **Synthetic Germany** |
| RGDP p.c. (I) | 17668.0 | 17649.4 | 19178.1 | 19323.6 | 19216.8 | 19210.5 |
| RGDP p.c. (II) | 20825.3 | 20782.7 | 21958.9 | 21513.9 | 23409.1 | 23403.5 |
| RGDP p.c. (III) | 25254.0 | 25230.9 | 25064.1 | 25156.7 | 27807.0 | 27174.5 |
| Inflation rate | 3.1 | 2.3 | 1.9 | 2.3 | 3.7 | 2.3 |
| Investment rate | 20.4 | 20.7 | 19.4 | 20.0 | 22.9 | 20.9 |
| Industry VA (%) | 30.2 | 32.1 | 33.2 | 40.0 | 39.3 | 38.4 |
| Secondary Ed | 46.5 | 43.9 | 26.9 | 34.7 | 41.1 | 45.4 |
| Trade Openness | 126.0 | 125.9 | 42.8 | 73.7 | 47.3 | 101.1 |
| **Panel B.** Results for Ireland, Italy and Netherlands | | | | | | |
| **Predictor** | **Ireland** | **Synthetic Ireland** | **Italy** | **Synthetic Italy** | **Netherlands** | **Synthetic Netherlands** |
| RGDP p.c. (I) | 13449.8 | 13553.0 | 16683.9 | 16753.6 | 20947.9 | 20939.6 |
| RGDP p.c. (II) | 15518.3 | 15951.5 | 20091.9 | 20008.0 | 23447.7 | 23175.2 |
| RGDP p.c. (III) | 19121.7 | 19198.0 | 24139.2 | 24085.8 | 23126.7 | 23655.4 |
| RGDP p.c. (IV) | | | | | 25693.3 | 25843.9 |
| RGDP p.c. (V) | | | | | 28108.4 | 27742.7 |
| Inflation rate | 5.9 | 4.6 | 6.9 | 5.2 | 2.3 | 2.4 |
| Investment rate | 24.4 | 38.7 | 21.8 | 22.0 | 22.3 | 24.2 |
| Industry VA (%) | 34.8 | 34.7 | 33.1 | 36.0 | 31.2 | 35.2 |
| Secondary Ed | 35.5 | 16.0 | 40.0 | 38.1 | 63.6 | 42.9 |
| Trade Openness | 107.8 | 184.6 | 38.0 | 87.1 | 106.2 | 104.0 |

[39] Results are available upon request to the authors.