

**THE IMPACT OF THE EURO  
ON EURO AREA GDP PER CAPITA**

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Cristina Fernández <sup>(\*)</sup> and Pilar García Perea <sup>(\*)</sup>

BANCO DE ESPAÑA

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## **Abstract**

This paper poses the following question: what would euro area GDP per capita have been, had the monetary union not been launched? To this end we use the synthetic control methodology. We find that the euro did not bring the expected jump to a permanent higher growth path. During the early years of the monetary union, aggregate GDP per capita in the euro area rose slightly above the path predicted by its counterfactual; but since the mid-2000s, these gains have been completely eroded. Central European countries – Germany, the Netherlands and Austria – did not seem to obtain any gains or losses from the adoption of the euro. Ireland, Spain and Greece registered positive and significant gains, but only during the expansionary years that followed the launch of the euro, while Italy and Portugal quickly lagged behind the GDP per capita predicted by their counterfactual. We test the robustness of the synthetic estimation not only to the exclusion of any particular country from the *donor pool* but also to the omission of each of the selected determinants of GDP per capita and to the reduction of the dimensions in the optimisation programme, namely the number of GDP determinants.

**Keywords:** treatment effects, synthetic control method, monetary union.

**JEL Classification:** C33 E42 F15 O52.

## Resumen

Este artículo aborda la siguiente pregunta: ¿cuál habría sido el PIB per cápita del área del euro si no se hubiese creado la unión monetaria? Para intentar contestarla, utilizamos la metodología de control sintético [Abadie y Gardeázabal (2003) y Abadie *et al.* (2010)]. Nuestros resultados señalan que el euro no trajo consigo el salto esperado hacia una senda de crecimiento mayor del PIB per cápita. Durante los primeros años de la unión monetaria, el PIB per cápita del área avanzó ligeramente por encima de la senda predicha por su contrafactual; pero desde mediados del 2000 estas ganancias desaparecieron completamente. Los países de Europa central —Alemania, Países Bajos y Austria— siguieron una pauta muy similar a la del agregado. Sin embargo, entre los países de la periferia obtenemos resultados heterogéneos. Irlanda, España y Grecia registraron ganancias positivas y significativas, aunque solo durante los años de expansión inmediatamente posteriores al lanzamiento del euro. Por su parte, Italia y Portugal registraron desde el primer momento una senda de PIB per cápita inferior a la prevista por sus contrafactuales. En el estudio se comprueba la robustez de la estimación sintética no solo a la exclusión de países de la *bolsa de donantes*, sino también tanto a la exclusión como a la reducción del número de variables explicativas del PIB per cápita.

**Palabras clave:** evaluación de programas, método de control sintético, unión monetaria.

**Códigos JEL:** C33, E42, F15, O52.

## 1 Introduction

The European Monetary Union (EMU) is the most ambitious step to have been taken as part of the long process of European integration. As the so-called Five Presidents' Report<sup>1</sup> recently stated, the euro is more than just a currency. *"It is a political and economic project and it only works as long as all members gain from it"*. Thus, in the recently renewed process of enhancing its design, it is crucial to evaluate the effective gains that the euro has brought for each of the member states.

In the years prior to the launching of the euro area, many voices<sup>2</sup> recalled that the euro area did not satisfy the conditions identified in the theory of Optimal Currency Areas (OCA) for a welfare-improving monetary union. Belonging to a monetary union means giving up control of monetary policy, which may become a key instrument in the presence of asymmetric shocks. As mentioned by Mundell (1961), the costs of losing the monetary instrument will be all the lower the higher wage flexibility is, the higher labour mobility is or, as De Grauwe (2013) recalled more recently, whenever the monetary union is also embedded in a budgetary union. However, it was also thought that launching a monetary union would entail undoubted benefits via the increase in trade and investment. The Delors Report (1989) and the One Market One Money Report<sup>3</sup>, which greatly influenced the adoption of the euro, considered that the main welfare improvement ingredient was expected to result from the elimination of exchange rate risk, which had traditionally been one of the main sources of uncertainty characterising Europe (De Grauwe P, 2012). This, together with the expected reduction of interest rates, led the Commission to conclude that the adoption of the euro would move the euro area to a durable higher growth path.

Has this prediction come true? Figure 1 displays the average euro area yearly growth rate of per capita GDP, employment and inflation for the period before (1990-1998) and the period after the adoption of the euro in 1999, divided into two sub-periods: 1999-2007 and 2008-2011. We also depict yearly growth rates of the three variables for Japan, the United States and the United Kingdom. From the cross-country comparison, the chart points out that the euro area has achieved significant progress in terms of generating employment and reducing inflation. However, in terms of the GDP per capita growth rate, aggregate data for the euro area does not seem to follow the expected path: "a jump to a permanent higher growth path". Moreover, when looking at the Great Recession period, the euro area has undergone a contraction in terms of GDP per capita and employment greater than that registered in the United States and Japan.

This paper attempts to shed some light on whether the euro had a significant impact on the GDP growth rate of the euro area. The question we seek to answer is what euro area GDP per capita would have been had the monetary union not been launched. The question is not new in the economic literature. Drake and Mills (2010), using data since 1980, decompose euro area GDP into trend and cyclical components through the "optimal approximation" band pass filter developed by Christiano and Fitzgerald (2003). The GDP trend they obtained, both under the assumption that it evolves as a deterministic function or as a stochastic process, suggests that the adoption of the euro appears to have reduced the

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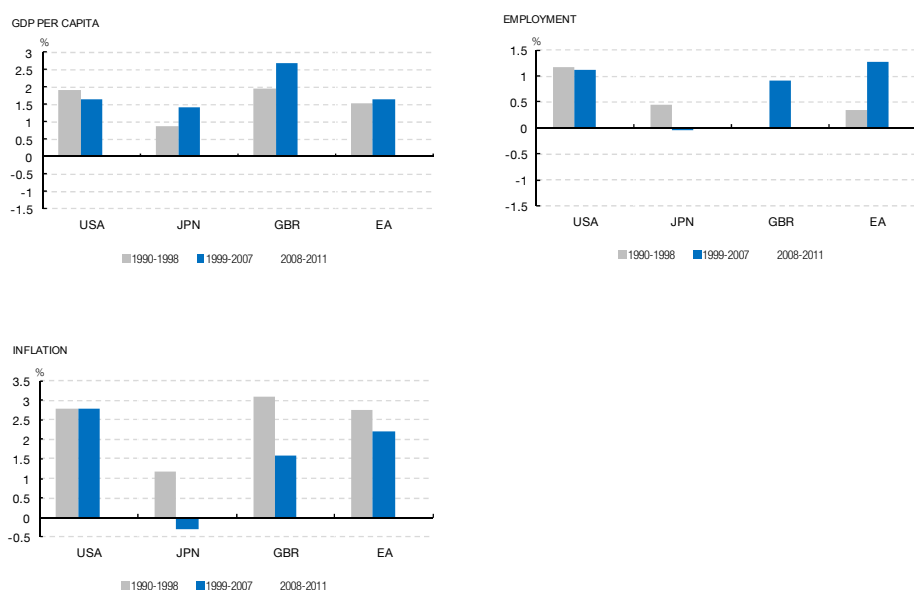
1. Completing Europe's Economic and Monetary Union (2015).

2. Eichengreen (1990) and De Grauwe and Heens (1993), among others.

3. Commission of the European Communities (1990).

trend rate of growth of the Eurozone economies, both *ex ante*, during the Maastricht nominal convergence phase, and *ex post*, during the period from 2001 to 2006. Following a different approach, Giannone, Lenza and Reichlin (2010) also pose the question of whether the observed growth path in the EMU years could have been expected on the basis of the past distribution and conditioning on external developments. To capture external developments, they choose the US, the other large common-currency area in the world, as the counterfactual of the euro area<sup>4</sup>. After estimating a VAR for the period 1970-1998, they conclude that for each year since the inception of EMU, euro area growth is not significantly different from what is expected on the basis of the pre-EMU economic structure and the US business cycle. However, from 2001 to 2005, growth in the euro area is always on the lower side of the confidence bands.

**Figure 1: GDP Per capita, employment and inflation**



**Source:** Eurostat, ECB and Banco de España.

This article examines the impact of the introduction of the euro in terms of real GDP per capita, as in Giannone, Lenza and Reichlin et al (2010), but using the synthetic control methodology that was first introduced in the economic literature by Abadie and Gardeazabal (2003). We build a counterfactual that closely reproduces euro area GDP per capita during the years before the *intervention*. The counterfactual is defined as a linear combination of countries of the *donor pool* that minimises the differences with the *treated unit* in a set of relevant covariates and past realisations of the outcome variable during the pre-intervention period. In this spirit, it becomes a key condition that countries that belong to the *donor pool* should look similar in terms of development to countries that belong to the euro area, and also that they do not turn out to be affected by the launching of the monetary union. Hence, the difference between the GDP per capita of the treated country (i.e. the euro area) and the counterfactual (i.e. the synthetic) from the year of the intervention onwards allows us to quantify the impact of the monetary union.

<sup>4</sup> The choice of US output as a conditioning variable is motivated by the findings that the dynamic correlation between US and euro area growth is robust and has been stable over time.



Abadie and Gardeazabal (2003) used this approach to assess the impact of the terrorist conflict on GDP per capita in the Basque Country. More recently, this methodology has also been applied to quantify the effects of the large-scale tobacco control programme that California implemented in 1998 (Abadie et al, 2010), to evaluate the economic impact of the 1990 German reunification on West Germany (Abadie et al, 2015), to investigate the impact of economic liberalisation on real GDP per capita in a worldwide sample of countries (Billmeier and Nannicini, 2013) and to measure the impact of private sector reforms, such as the adoption of the one-stop shop, on GDP per capita (Gathani et al, 2013). In the context of the European Union, Campos et al (2014) resort to the synthetic control methodology to analyse the growth gains from the European Union for its member countries, while Mäkelä (2014) addresses the question of whether the monetary union has affected its members' sovereign risk premiums.

Our main result is in line with that obtained previously in the literature: the adoption of the monetary union in the euro area did not produce the expected permanent increase in the GDP per capita growth rate. However, when we step down to the country-level details, we observe very different patterns. Firstly, central European countries -Germany, the Netherlands and Austria- did not seem to obtain any gains or losses from the adoption of the euro. Secondly, among countries from the periphery, Ireland, Spain and Greece registered positive and significant gains throughout the years of expansion that followed the launching of the euro area but up to the debt crisis, while Italy and Portugal quickly lagged, despite the expansionary cycle, behind the GDP per capita predicted by their counterfactual.

The euro area was designed as an additional step in the process of European integration. It was thought it would bring further increases in intra-area trade that would boost GDP growth, mainly because of the stability of the exchange rates, as well as an endogenous demand for structural reforms that would also propel convergence within the euro area. The demand for structural reforms should have endogenously emerged from the need to design sufficiently flexible economies to face shocks without the use of the exchange rate. However, perhaps because of the arrival of China on the world trade stage and the resultant increase in the international fragmentation of production, intra-area trade did not rise. Neither did the boost for a consistent strategy to implement productivity enhancing reforms arrive, in a context where the previously inflationary member countries benefited from the favourable financing conditions. The broad reduction in long term interest rates favored the recently so called *reform anesthesia* that propelled the divergences among member countries. Then, the initial welfare gains that the euro brought did not consolidated in the long run, leading the European project to a risky cliff.

Looking forward, it is crucial that all member countries benefit from the joint-venture and this is only possible if the euro area keeps on giving steps towards a stronger convergence via structural enhancing productivity reforms and an improvement of the European governance. This spirit is shared by recent ECB research that attributes this lack of convergence to the notably weak institutions, structural rigidities, weak productivity growth and insufficient policies to address asset price booms (ECB, 2015). Also, the Five Presidents' Report has called for "*further steps, both individually and collectively, to compensate for the national adjustment tools that countries gave up on entry*" in order for all members to gain from the euro.

The rest of the paper is structured as follows. The next section explains the synthetic control methodology. Section 3 displays the results that we obtain, devoting special attention to their robustness. Section 4 discusses a plausible interpretation of our results, while section 5 concludes.

## 2 The synthetic control methodology

Assume that there is a sample of  $J+1$  units (in our case, countries) and unit  $j=1$  is our unit of interest (in our case, the euro area), while units  $j=2$  to  $j=J+1$  are the potential comparisons. The literature usually refers to unit  $j=1$  as the “treated unit”, i.e. the unit exposed to the event or intervention of interest, while units  $j=2$  to  $j=J+1$  are referred to as the “donor pool”, i.e. the group of potential comparison units. In order to be able to construct a reliable synthetic control, the donor pool has to fulfil three characteristics. First, it has to be restricted to countries with some similarity in observable characteristics in order to prevent interpolation biases; second, countries should not undergo structural shocks to the outcome variable during the sample period of the study; and third, their outcome should not be affected by the intervention implemented in the treated unit<sup>5</sup>.

Suppose that all units are observed during  $t=1, \dots, T$  periods, in such a way that the time span includes a positive number of pre-intervention periods,  $T_0$ , and a positive number of post-intervention periods,  $T_1$ , with  $T = T_0 + T_1$ .

Let  $Y_{jt}$  be our variable of interest, namely GDP per capita, which would be observed for country  $j$  at time  $t$  in the absence of the intervention. Let  $Y_{1t}^I$  be the outcome that would be observed for the treated country after being exposed to the intervention, that is, in periods  $T_0+1$  to  $T$ . Let  $\alpha_{1t} = Y_{1t}^I - Y_{1t}$  be the effect of the intervention for the treated country at time  $t$ . Then, under the general model:

$$\begin{aligned}
 Y_{it}^I &= \delta_t + \alpha_{it}D_{it} + v_{it} \\
 Y_{it}^{NI} &= \delta_t + v_{it} \\
 v_{it} &= \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it}
 \end{aligned}
 \tag{1}$$

where  $\delta_t$  is an unknown common factor,  $Z_i$  is a vector of observed covariates not affected by the intervention, and where unobserved confounders,  $\lambda_t \mu_i$ , are allowed to change over time; Abadie, Diamond and Hainmueller (2010) show<sup>6</sup> that if there is a vector of weights  $W=(w_2, \dots, w_{J+1})'$  with  $0 \leq w_j \leq 1$  and  $w_2 + \dots + w_{J+1} = 1$ <sup>7</sup>, such that:

$$\sum_{j=2}^{J+1} w_j^* Y_{j1} = Y_{1,1} , \dots , \sum_{j=2}^{J+1} w_j^* Y_{jT_0} = Y_{1,T_0}
 \tag{2}$$

and

$$\sum_{j=2}^{J+1} w_j^* Z_j = Z_1
 \tag{3}$$

5. Assumption of no interference across units (Rosenbaum, 2007). We will further discuss in section 3 how this assumption may bias our results.

6. Abadie, Diamond and Hainmueller (2010) argue that if the number of pre-intervention periods in the data is large, matching on pre-intervention outcomes helps control for the unobserved factors affecting the outcome of interest as well as for the heterogeneity of the effect of the observed and unobserved factors on the outcome of interest.

7. These assumptions prevent extrapolation biases.

We can define, as long as the number of pre-intervention periods is large enough, the following estimator for  $\alpha_{1t}$ :

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

Therefore, the synthetic control is defined as a weighted average of the units in the donor pool and can be represented by a  $J \times 1$  vector of weights  $W^* = (w_2, \dots, w_{J+1})'$ .

In practice, the optimal vector of weights  $w^*$  must satisfy conditions (2) and (3). Let  $X_1$  be a  $(k \times 1)$  vector containing the values of pre-intervention characteristics of the treated unit that we aim to match as closely as possible, and let  $X_0$  be the  $k \times J$  matrix collecting the values of the same variables for the units in the donor pool. The difference between the pre-intervention characteristics of the treated unit and a synthetic control is given by the vector  $X_1 - X_0 W$ . We select the synthetic control  $W^*$  that minimises the size of this difference. That is to say:

$$\sum_{m=1}^k v_m (X_{1m} - X_{0m} W)^2,$$

where  $X_{1m}$  is the value of the  $m$ -th variable for the treated unit,  $X_{0m}$  is a  $1 \times J$  vector containing the values of the  $m$ -th variable for the units in the donor pool and  $v_m$  is a weight that reflects the relative importance that we assign to the  $m$ -th variable when we measure the discrepancy between  $X_1$  and  $X_0 W$ . The choice of  $v$  influences the mean square error of the estimator. We choose  $v$  among positive definite and diagonal matrices such that the mean squared prediction error of the outcome variable is minimised for the pre-intervention periods (Abadie and Gardeazabal, 2003).

$$\min_v \sum_{t=1}^{T_0} \left( Y_{1t} - \sum_{j=2}^{J+1} w_j(v) Y_{jt} \right)^2$$

There are several advantages to using this econometric approach. First of all, unlike the difference-in-difference approach, we do not choose who the comparison group is, since weights assigned to each of the members of the donor pool are data-driven. Second, once the synthetic unit is defined, we can follow growth performance over time without limiting the analysis to an average effect estimator. And finally, unlike linear regression models, the synthetic control methodology avoids extrapolation outside the support of the data.

### 3 Estimating the impact of the euro on euro area GDP per capita

#### 3.1 The donor pool and variable selection

We use yearly country-level data for the period 1970-2013. The euro was adopted in 1999 so we will have a pre-intervention period of 29 years. However, our benchmark estimation will rely on a shorter pre-intervention period –1992 to 1998 – in order to isolate our preferred estimation from the potential benefits derived from the European integration process that took place during the 1970s in countries from northern and central Europe, and during the 1980s in southern European countries. In 1992, the European Union launched the Single Market and countries, for the first time, delegated economic policy functions to the European level.

In order to construct the donor pool we disregard countries that are at a very different stage of development, such as those from Asia, Africa or South America, since we want to avoid extrapolation biases. Moreover, we exclude countries that might potentially be affected by the consolidation of the euro area. That is why we exclude countries from the European Union, in particular the United Kingdom, Denmark and Sweden, since they voluntarily opted not to join the euro area. Finally, we also exclude eastern European countries that joined the euro or the EU at a later date. Therefore, we finally have 11 OECD countries in the donor pool: Australia, Canada, Switzerland, Iceland, Japan, Korea, Mexico, Norway, New Zealand, Turkey and the United States. However, we are aware that our donor pool may still not be fully sterilised since the euro process may have had spillover effects on non-member countries. We will let the model operate and, once results are obtained, we will discuss the potential biases that may arise.

All the variables that we use are obtained from the OECD database. The variable of interest, GDP per capita,  $Y_{it}$ , is PPP-adjusted and measured in 2005 US Dollars<sup>8</sup>. Measuring our variable of interest in levels gives us the opportunity to check whether the adoption of the euro had a divergent long-run growth path or whether we faced a step effect that built up over time given the lags of the economy (Billmeier and Nancini, 2013). For the set of characteristics we use standard economic predictors: share of public and private consumption in GDP, share of investment in GDP, share of exports and imports in GDP, average years of education<sup>9</sup> and the ratio of people aged 65 and above relative to the population aged between 16 and 64 years old (which we call the dependency ratio), in order to control for the demographic structure of the economy. We have also worked with variables to take into account country price dynamics and R&D investment, but the fit did not improve so we have not included them in our final specification.

Finally our definition of the euro area includes eleven countries. These are all the countries that met the euro convergence criteria in 1998<sup>10</sup>, excluding Luxembourg, and adding Greece, which did not qualify until two years later. Despite this slight difference in timing, we will consider 1999 as the intervention date when examining the euro area aggregate.

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**8.** We consider real per capita GDP PPP-adjusted because this facilitates international comparisons on the levels of economic activity. We follow the OECD recommendation of deflating per capita GDP by the PPP of a fixed year. It has both the advantage of using a price structure that is consistently updated and of protecting against the variance from one year to another of PPP calculations (see Lequiller and Blades, 2014).

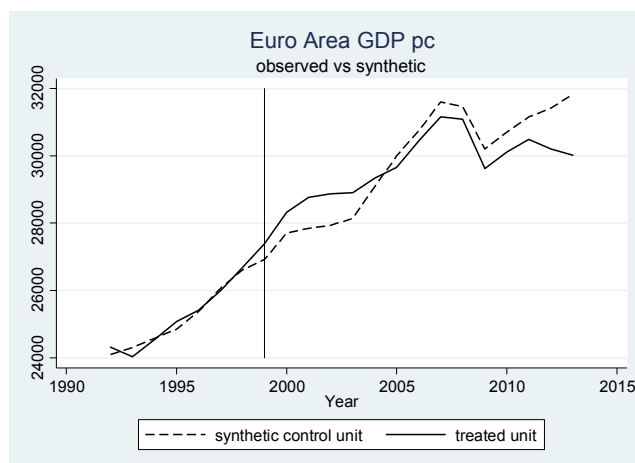
**9.** We obtain this variable from the Barro and Lee (2014) dataset.

**10.** Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain.

### 3.2 Results

One of the advantages of the synthetic control methodology is that results can be displayed easily in one chart that needs little clarification. This chart is depicted in Figure 2: it displays euro area GDP per capita and its synthetic counterpart for the years 1992 through 2013. The synthetic euro area almost exactly reproduces observed GDP per capita during the pre-intervention period. Moreover, this close fit is not only limited to the variable of interest but also to most of the GDP determinants (see Table 1).

**Figure 2:** Euro area GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1992-1998)



**Table 1:** Means of GDP per capita and of its determinants before the adoption of the euro (1992-1998)

	EURO AREA	SYNTHETIC EURO
GDP PER CAPITA	25152.40	25127.65
PRIVATE CONSUMPTION (SHARE OF GDP)	0.57	0.57
PUBLIC CONSUMPTION (SHARE OF GDP)	0.21	0.16
INVESTMENT (SHARE OF GDP)	0.20	0.20
EXPORTS (SHARE OF GDP)	0.26	0.27
IMPORTS (SHARE OF GDP)	0.25	0.24
AVERAGE YEARS OF EDUCATION	8.56	9.01
DEPENDENCY RATIO	25.47	20.30

**Source:** OECD and Banco de España.

**Note:** The average of each variable for the 1992-1998 period is shown.

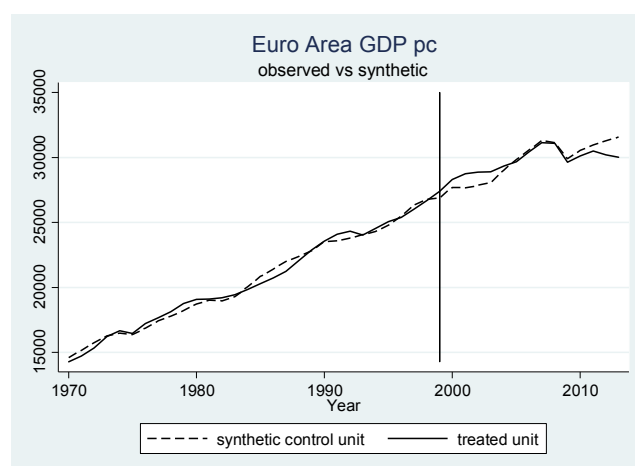
The estimation of the impact of the euro on GDP per capita of the euro area is given by the difference between the observed GDP per capita and the synthetic counterpart since 1999. Our estimation shows that, after the adoption of the euro, the area's GDP per capita is 2.7% higher on average than it would have been, had the euro not been launched. However, these initial gains did not last and they completely disappear before the mid-2000s. Results show that between 2004 and 2007, euro area GDP per capita is 0.7% lower on average than it could have been, if the euro project had not been implemented. That is, our finding seems to sum up the previous evidence in Drake and Miller (2010) and Giannone et al. (2010) suggesting that the adoption of the euro did not bring the expected jump to a durable higher

growth path. In fact, in the year prior to the start of the Great Recession, euro area GDP per capita fell slightly below the level predicted by the counterfactual. In the following section we perform different exercises to show the robustness of the result: slight initial gains from the adoption of the euro that did not last.

### 3.3 Robustness of the results

On the benchmark specification we opted for a short pre-treatment period mainly in order to isolate the gains from adopting the euro from the gains of European integration. Therefore, the first exercise to assess the robustness of the result depicted in Figure 2 is to consider a longer pre-treatment period: from 1970 to 1998. Figure 3 shows that results remain fairly stable. As in our benchmark estimation, the synthetic GDP per capita reproduces that of the euro area during the pre-treatment period. Regarding the expected role of the euro, we find that results are qualitatively and quantitatively very similar to those obtained in the benchmark scenario: there is an early stage where the monetary union has a positive impact on its GDP per capita, but from the mid-2000s onwards the gains completely vanished.

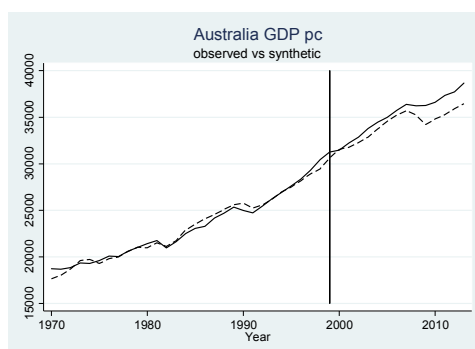
**Figure 3:** Euro area GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1970-1998)



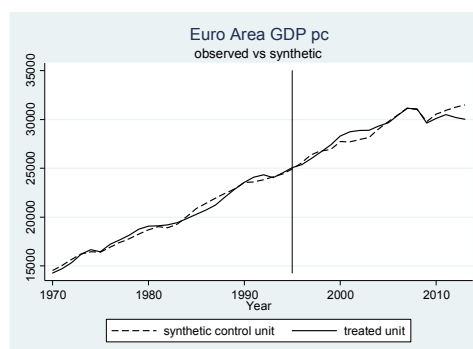
To further assess whether we could attribute to the adoption of the euro the difference between the changes observed in GDP per capita and its synthetic counterpart, we perform two placebo exercises. In the first, we check whether the treatment had any effect on a country, Australia, which does not belong to the euro area. Results are reported in Figure 4. In the second exercise we assume instead that the treatment took place in a different year, 1995. In this case we are somewhat limited because the 1980s and the 1990s were decades of continuous developments in European economic integration. Results of this placebo exercise are reported in Figure 5.

In both cases we obtain a good match between the GDP per capita of the country treated and the counterfactual during the pre-treatment years. Besides, as we were expecting, no differences emerge between the variables after the treatments. This evidence backs the idea that the differences observed in Figure 2 can be attributed to the adoption of the euro and are not potentially reflecting the lack of predictive power of the synthetic control.

**Figure 4:** Placebo intervention in 1999. Australia GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1970-1998)



**Figure 5:** Placebo intervention in 1995. Euro area GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1970-1994)



At this point we illustrate the country and the variable weights, i.e. the  $W$  and the  $v$  that we obtain from the estimation of the synthetic euro area GDP per capita. In Table 2 we display the weight that countries in the donor pool ultimately receive in each of the three counterfactuals for the euro area we have shown so far (Figure 2, Figure 3 and Figure 5). Switzerland and Turkey turn out to be the countries that receive more weight across the three counterfactuals, up to 50%, while Iceland, Japan, Norway and New Zealand make up the other 50%.

**Table 2:** Synthetic weights of countries in the donor pool

	Preferred synthetic (pre-treatment period: 1992-1998)	Long synthetic (pre-treatment period: 1970-1998)	1995 Placebo synthetic (pre-treatment period: 1970-1994)
AUS	0	0	0
CAN	0	0	0.10
CHE	0.34	0.23	0.20
ISL	0.17	0.06	0.01
JAP	0.09	0.15	0.19
KOR	0	0	0
MEX	0	0	0
NOR	0.07	0.20	0.20
NZL	0.13	0	0
TUR	0.20	0.33	0.31
USA	0	0.04	0

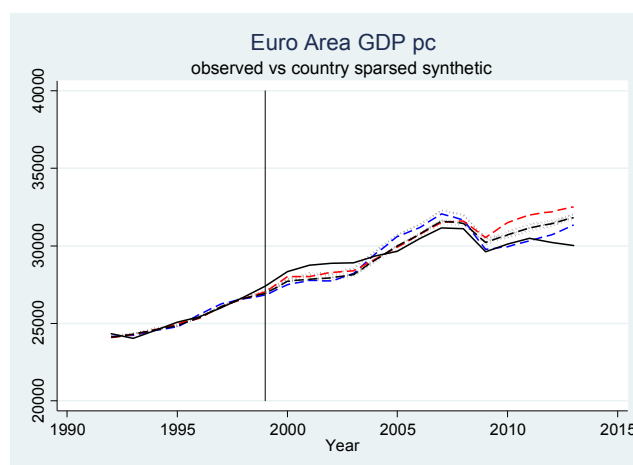
**Table 3:** Synthetic weights of variables

	Preferred synthetic (pre-treatment period: 1992-1998)	Long synthetic (pre-treatment period: 1970-1998)	1995 Placebo synthetic (pre-treatment period: 1970-1994)
GDP PER CAPITA	99.94%	61.17%	81.72%
PRIVATE CONSUMPTION (SHARE OF GDP)	0.01%	0.18%	0.03%
PUBLIC CONSUMPTION (SHARE OF GDP)	0.00%	0.00%	0.00%
INVESTMENT (SHARE OF GDP)	0.00%	1.35%	0.01%
EXPORTS (SHARE OF GDP)	0.00%	36.55%	18.17%
IMPORTS (SHARE OF GDP)	0.01%	0.19%	0.01%
AVERAGE YEARS OF EDUCATION	0.02%	0.50%	0.06%
DEPENDENCY RATIO	0.02%	0.06%	0.00%

As we pointed out in the previous section, a major concern arising from this approach is that the construction of the euro area may potentially have a positive or a negative effect not only on its member countries but also on the countries included in the donor pool. If this were the case, the assumption of non-interference across units would no longer apply and we would not be able to construct a proper counterfactual. The estimated gap would then be a lower bound, in the case of positive spillovers, or an upper bound, in the case of negative spillovers.

To tackle this issue we first repeat, for every single country in the donor pool, the placebo exercise reported in Figure 4 for Australia. Results, reported in Figure A1 of the Appendix, show no clear sign of either positive or negative spillovers among those countries for which we can construct a reliable counterfactual. Also, we assess whether Figure 2 is sensitive to the exclusion of any particular country from the sample or any particular variable from the estimation. With this purpose we first iteratively re-estimate the baseline model to construct a synthetic euro area omitting in each iteration one of the countries that received a positive weight in our preferred estimation. Figure 6 displays the result. As expected, results seem to be fairly robust to the exclusion of any particular country from our donor pool and the observed euro area GDP per capita always lies below its counterfactual from mid-2000 onwards.

**Figure 6:** Euro area GDP per capita. Observed vs. synthetic estimation. Synthetic estimation calculated by removing countries from the donor pool one by one



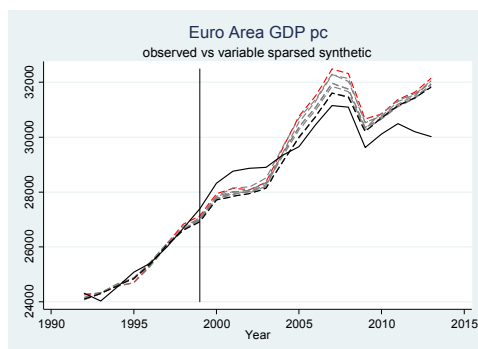
**Note:** The solid black line is the observed euro area GDP per capita, the dashed black line is the preferred synthetic estimation, the dashed blue line is the synthetic estimation without Switzerland and the dashed red line is the synthetic estimation without Iceland.

Now, as a final robustness check, Figure 7 and Figure 8 present the same exercise as that above but testing, first, the sensitivity of the synthetic estimation to the omission of each of the selected determinants of GDP per capita (Figure 7) and, second, to the reduction of the dimensions in the optimisation program, i.e. from eight to two (Figure 8). Again, the results seem to be fairly stable. In almost all the counterfactuals we obtain the same result as in Figure 2: the adoption of the euro seemed to bring some initial small gains, albeit short-lived, which eroded before the mid-2000s. The only exceptions are the green and red line in Figure 8 which display the synthetic control when we only take into account two or three



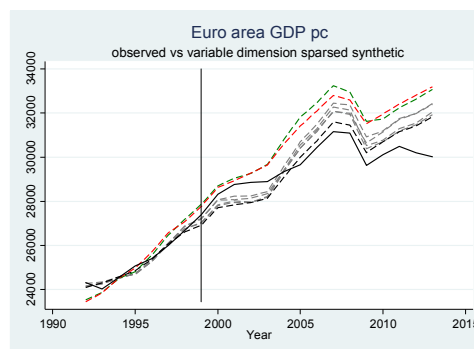
dimensions<sup>11</sup> to be matched during the pre-intervention period. However, in these two cases, the vector of weights obtained does not seem to match euro area per capita GDP before 1999, invalidating them as a reliable counterfactual.

**Figure 7:** Euro area GDP per capita. Observed vs. synthetic estimation. Synthetic estimation calculated by removing GDP determinants one by one



**Note:** The solid black line is the observed euro area GDP per capita, the dashed black line is the preferred synthetic estimation and the dashed red line is the synthetic estimation removing per capita GDP as a determinant.

**Figure 8:** Euro area GDP per capita. Observed vs. synthetic estimation. Synthetic estimation calculated by reducing the number of GDP determinants



**Note:** The solid black line is the observed euro area GDP per capita, the dashed black line is the preferred synthetic estimation and the dashed red line is the synthetic estimation with only two determinants and the dashed red line is the synthetic estimation with three dimensions.

### 3.4 The effect on individual member countries

The results we have obtained so far point to a negligible impact of the adoption of the euro on GDP per capita of the euro area aggregate. However, the effect for individual countries is heterogeneous and also changes over time. In this section we intend to address the question of the degree to which certain countries have benefited from the adoption of the euro. That is, for each country our research question now becomes: “*what would, for example, Austrian GDP per capita have been, had the euro area not been created?*” We have grouped countries into two categories: central European countries and peripheral ones. Figures 9 and 10 display the results comparing the changes observed in each country’s GDP per capita and its counterfactual, while Table A1 documents the weights that each country of the donor pool receives within each counterfactual and Table A2 assesses the goodness of fit for each of the variables that we consider during the pre-intervention period.

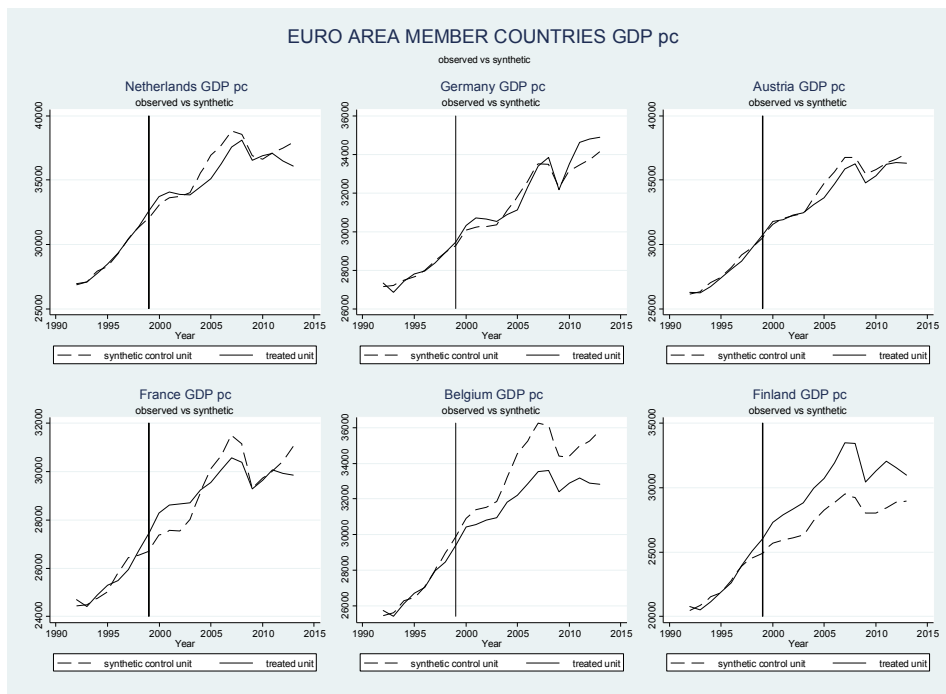
When looking at the central European countries we undoubtedly find that for three of them, the Netherlands, Germany and Austria, the adoption of the euro did not result in any gains or losses and, as a result, did not bring the expected jump in GDP per capita. These results hold when we extend the pre-intervention period to 1970-1998 (see Figure A2 of the Appendix). Unfortunately, given the common structure we have considered in terms of variables and countries in the donor pool, the counterfactual for French GDP per capita is not as good as might have been desirable. Nevertheless, we find that France registered the same result as the euro area aggregate: slight initial gains that did not last, were soon erased and

<sup>11</sup>. When optimizing over two dimensions we take into account GDP per capita and share of exports, while when we optimize over three dimensions we also add the share of investment.

turned into losses. Regarding Belgium and Finland we find two opposite patterns. While Finland would seem to be benefitting from the adoption of the euro, Belgian GDP per capita would be below its counterfactual.

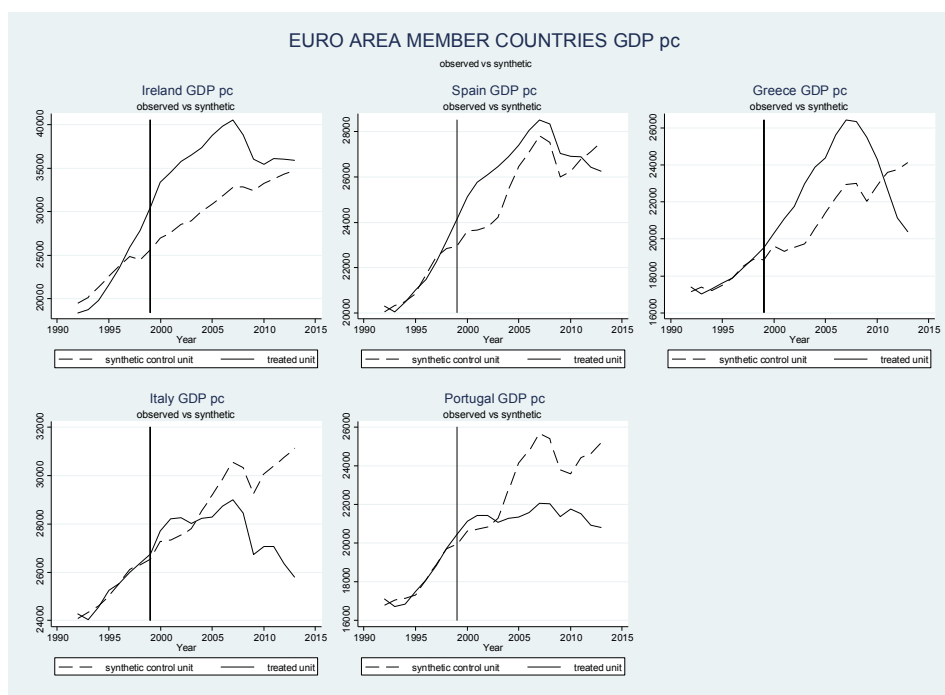
Turning now to the peripheral European countries, we can distinguish two subgroups. On one hand, three countries, Spain, Greece and Ireland<sup>12</sup> registered the expected jump to a durable higher growth path of GDP per capita. And this jump turned out to last throughout the expansion period, in contrast with the evidence we found for the euro area aggregate. In Figure A3 of the Appendix we also show that results remain when we consider a longer pre-intervention period. On the other, Italy and Portugal stand out as countries where the initial gains from the adoption of the euro in terms of GDP per capita disappeared very quickly but also turned into significant losses from the path of the counterfactual.

**Figure 9:** GDP per capita of euro area member countries . Observed vs. Synthetic estimation. Core countries



12. In the case of Ireland, we have not been able to obtain a good counterfactual, this is a vector of country weights that matches closely GDP per capita of Ireland for the pre-treatment period.

**Figure 10:** GDP per capita of euro area member countries. Observed vs. Synthetic estimation. Peripheral countries



### 3.5 Significance of the results

One important caveat of the synthetic control methodology is that it does not allow us to assess the significance of the results obtained. In Table 6 we report the average magnitude of the gains/losses from the adoption of the euro that we depicted in Figure 2 for the euro area and in Figures 9 and 10 for each of the member countries. We have divided the euro intervention period in three sub-periods, 1999-2003, 2004-2007 and 2008-2013, since the gap varies in sign across time. The reported gain or loss is calculated as the average difference in the per capita GDP between the observed and the counterfactual levels.

In order to assess the significance of these gaps we have followed the approach of Campos et al. (2014) by estimating a simple difference-in-difference model for the actual and the synthetic GDP per capita series of member countries as well as of the euro area aggregate. That is, for each country  $i$ , we test whether the following double difference is significant:

$$\left[ Y_i^{post-inter} - \sum_{j=2}^{J+1} w_j^* Y_j^{post-inter} \right] - \left[ Y_i^{pre-inter} - \sum_{j=2}^{J+1} w_j^* Y_j^{pre-inter} \right]$$

The significance is reported in Table 6 using the conventional asterisks.

As expected from scrutiny of Figure 9, we cannot conclude that the initial small positive gaps that we obtained for Austria, Germany and the Netherlands will ultimately turn out to be significant. The same is true for those gaps obtained for the euro area aggregate and for France. However, the positive gaps are significant in Spain, Greece and Ireland, and not only for the initial period, but also, in the case of the two latter countries, throughout the years of expansion. Until 2007 average GDP per capita for Spain, Greece and Ireland was

5.8%, 10.4% and 24.3% higher, respectively, than it could have been, if the euro had not been implemented. Finally, losses, in reference to the counterfactual, turn out to be significant during the boom years in Portugal and Belgium, averaging 11.2% and 6.31%, respectively.

**Table 6:** Growth dividends from euro area membership: average difference (%) in post-treatment GDP per capita between observed and counterfactual levels

	1999-2003		2004-2007		2008-2013	
SPAIN	7.91	**	3.85		0.43	
GREECE	8.74	***	15.12	***	1.00	
IRELAND	23.90	***	24.67	***	8.50	
ITALY	1.81		-3.26		-11.22	***
PORTUGAL	2.08		-11.21	***	-12.57	***
AUSTRIA	0.23		-2.54		-1.30	
GERMANY	0.94		-1.05		1.80	
NETHERLANDS	1.00		-3.72		-1.52	
FRANCE	3.32		-1.66		-1.36	
FINLAND	7.23		10.47	**	10.65	***
BELGIUM	-2.19		-6.31	**	-6.22	**
EURO AREA	2.66		-0.67		-2.78	

**Note:** Each figure represents the average difference in percentage points between the observed GDP per capita and the estimated counterfactual using the synthetic control methodology. Asterisks denote whether these estimated gaps are ultimately significant using a double-difference approach. \*\*\* significance at 1% level, \*\* significance at 5% level and \* significance at 10% level.

#### 4 Understanding the impact of the euro on GDP per capita

Since the end of World War II, Europe's history has been one of continuous steps towards achieving not only economic integration – the ECSC, the EEC and the Single Market – but also further political coordination. In this context, the launching of the euro was a bold move, not ever tried before by such a large set of nations, where the two motivations intertwined (Baldwin et al, 2008). In fact, member countries decided to join the euro even though they were well aware that the candidate countries did not constitute an optimal currency area. That is to say, despite fulfilling the nominal criteria set out in the Treaty of Maastricht, the area still lacked the desirable wage flexibility, labour mobility as well as the implementation of a common budgetary union<sup>13</sup>.

However, the countries decided to embark on such an ambitious project since they estimated that the greater economic integration expected from lower transaction costs would lead member countries endogenously to achieve convergence in real terms. Moreover, the increase in trade among member countries would also prompt the implementation of the pending structural reforms to gain further competitiveness (Artis and Zhang, 1995 and Frankel and Rose, 1998).

Regarding the first channel – trade integration – results derived from the adoption of the euro turned out not to be as fruitful as expected in the literature. Early studies predicted that the exchange rate stability and the single currency could trigger trade above 300% (Glick and Rose, 2002). This sizeable effect was later reduced by other researchers who found a significant positive effect of around a 5% increase<sup>14</sup> (Baldwin et al 2008). More recently, Glick and Rose (2015) revisited the literature on the effect of currency unions on trade and exports using a variety of empirical gravity models. Their results point out that EMU typically has a smaller trade effect than other currency unions but also that there is no consistent evidence that EMU stimulated trade<sup>15</sup>.

The adoption of the euro coincided with China's surge to prominence in world trade. The emergence of this new player completely changed the trade relations between all parties with an immediate consequence: all developed countries lost export share to China (Figure 11). Besides, production by firms was completely reorganised with the increasing presence of global value chains. Using the new information available from WIOD input-output tables<sup>16</sup>, Cuenca and Gordo (2015) document that, from 2000 onwards, euro area countries increased the proportion of intermediate inputs from eastern Europe and Asian emerging economies at the expense of those from other euro area countries. All in all, Figure 12 summarises the behaviour of trade flows within the euro area: the proportion of intra-euro area imports and exports remained fairly stable or even diminished in some countries. That is to say, partly because of the emergence of China as a major player in world trade and partly because of the increasing international fragmentation of production, the euro did not bring the expected boost to economic integration.

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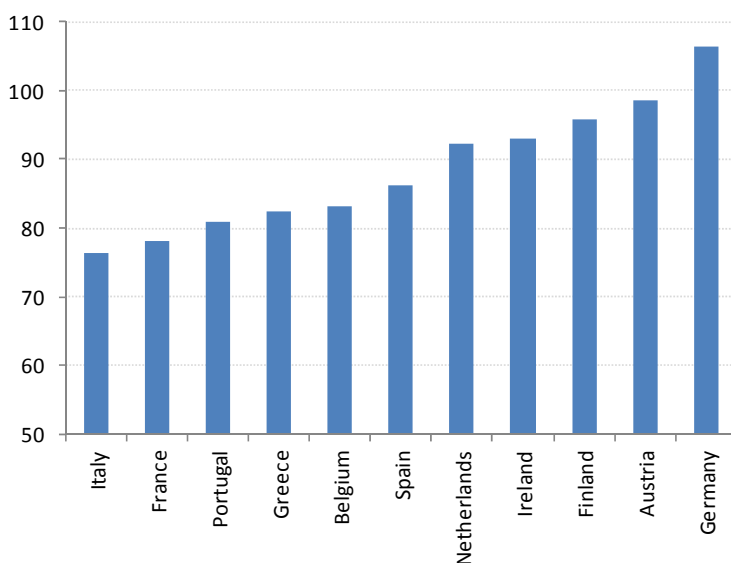
**13.** For an overview analysis of the expected economic benefits and cost of the common currency see Mongelli and Vega (2006).

**14.** Moreover, Baldwin et al (2008) qualified the origin of this increase. The channel was not one of lower Mundellian "transaction costs", but one of increasing competition derived from the extensive margin – newly-traded goods hypothesis.

**15.** They find that results are very sensitive to the exact econometric methodology.

**16.** WIOD dataset allows to disentangle foreign contribution to final production.

**Figure 11:** Change in real export share of global trade in goods and services in 2007 (1998=100)

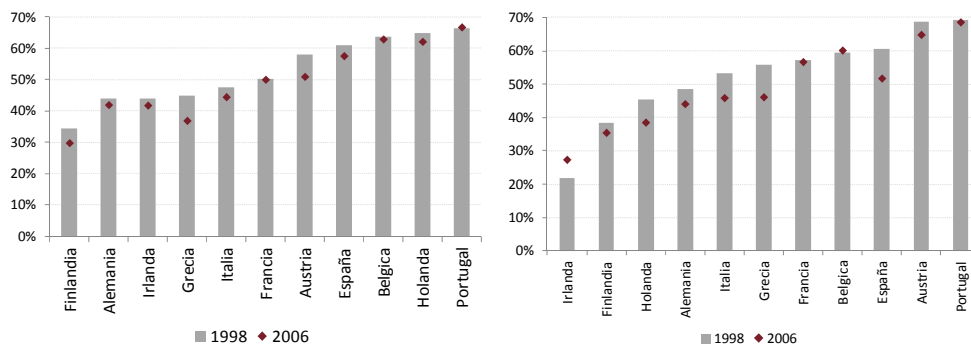


Source: Eurostat

As for the second channel, the designers of the euro were confident that market pressure would perform a key role in preventing imbalances given that sovereign interest rates would act as a red flag. However, international investors thought about the euro as a homogeneous union without taking into account the financial risks associated with the economic divergences (Malo de Molina, 2011). Therefore, government willingness to adopt the structural reforms needed quickly vanished (Alesina et al, 2010), especially in the peripheral countries, where the buoyant growth during the early 2000s led to a situation of “reform anaesthesia”, that is, a feeling that the reforms to facilitate an effective adjustment in the monetary union were no longer urgent (European Commission 2008). Duval and Elmeskov (2006) find that although, using a long perspective, euro area countries have undertaken more structural reforms than in other OECD countries, over the period 1999-2004 the intensity of reforms was lower than in the period 1994-1998 and this slowdown was not observed in non-euro area EU countries.

**Figure 12.a:** Share of intra-euro area exports

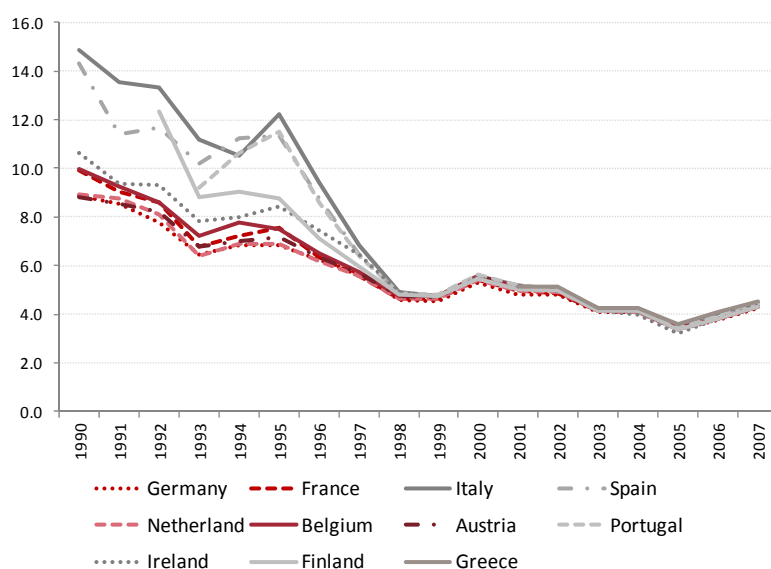
**Figure 12.b:** Share of intra-euro area imports



Source: Eurostat.

The fact that these two channels did not come into operation helps to explain why the adoption of the euro did not give the expected boost to GDP per capita during the years prior to the Great Recession. The euro area registered only a small and temporary increase of GDP per capita, with respect to its counterfactual, which did not turn out to be significant. However, as we documented in the previous section, benefits were very heterogeneous with the peripheral countries registering the highest gains. Where did these gains come from?

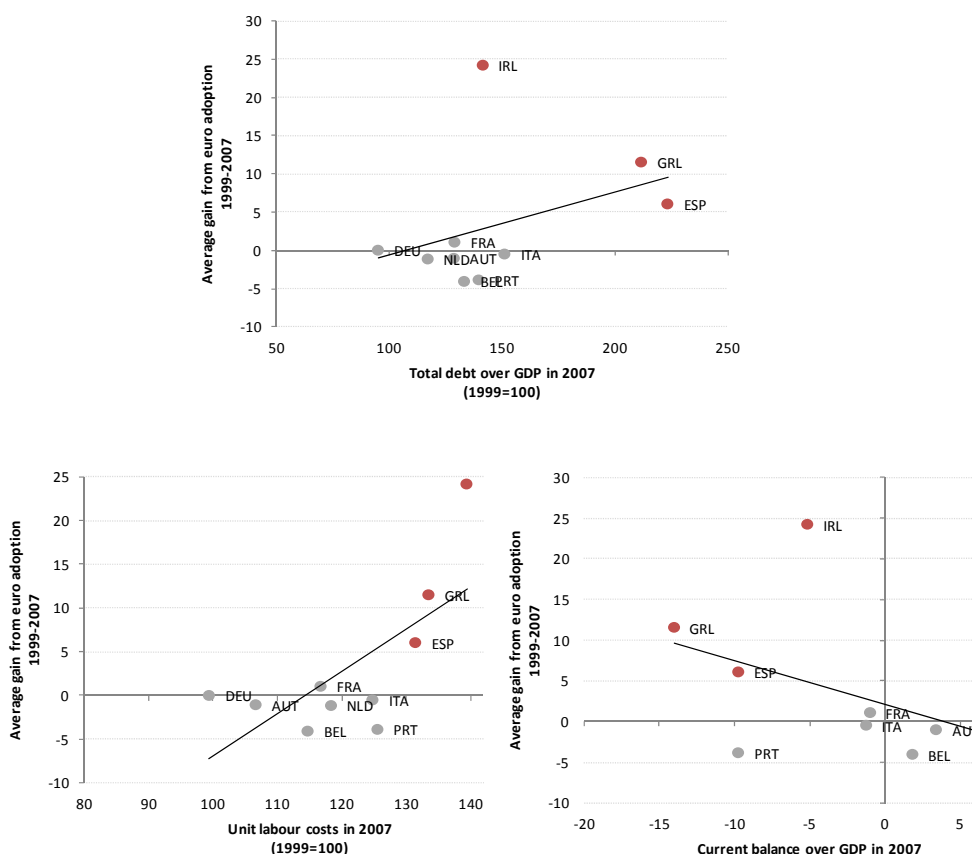
**Figure 13:** 10-year government bond rates



**Source:** European Central Bank.

The euro area did bring closer financial integration. Figure 13 shows how 10-year government bond rates quickly converged towards very low levels not previously registered, especially in peripheral countries. It is in fact in part of these countries, Spain, Greece and Ireland, where the adoption of the euro brought the highest significant benefits in terms of GDP per capita. The sharp decrease in real interest rates eased their access to the credit markets, stimulating domestic demand and alleviating the lack of productivity-enhancing reforms. Therefore, the capital inflows into these countries failed to generate a lasting increase in productive capital. Figure 14 shows how gains from joining the euro area during the boom years turn out to be positively correlated with credit expansion, but at the same time, they also turn out to be positively correlated with growing imbalances, such as, rising unit labour costs or wider negative trade imbalances (Lane, 2006).

**Figure 14:** Gains from the adoption of the euro vis-à-vis debt, unit labour costs and trade balance



**Source:** Eurostat.

In the case of Italy and Portugal, the other two peripheral countries, the gains from joining the euro were however small, non-significant and vanished very quickly. From 2004 onwards the euro brought them losses that turned out to be significant. Part of these disappointing developments stem from the fact that their higher debt levels before the euro was adopted limited their chances of accessing further credit and their domestic demand being based on GDP growth. But also, Italy and Portugal are countries that during the 2000s experienced a severe drop in their export shares without adopting reforms that would have bolstered foreign demand (Blanchard, 2007).

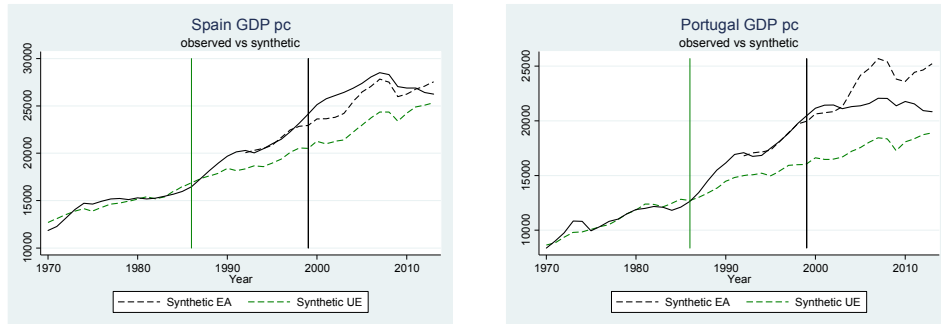
Finally countries from the central euro area - Germany, Austria and the Netherlands-, as we depicted in Figure 8, do not seem to obtain gains or losses from the adoption of the euro: observed GDP per capita follows the same path as that predicted by the counterfactual. In this case, even though they faced higher real interest rates and despite the competitive pressure from China, they managed to reduce unit labour costs and increase their external competitiveness through structural reforms that mainly gave more flexibility to their labour market (Scharpf, 2011 and Veld et al, 2015). These counteracting forces balanced evenly the final outcome from the adoption of the euro.

The launching of the monetary union was an additional step, although probably the most ambitious one, in the process of European integration that started just after World War II. It is not the last stepping stone, but an additional one. In order to contextualize the benefits



of the adoption of the euro within the European integration process, we have compared, for two countries – Spain and Portugal –, the benefits of joining the European Union with the benefits of joining the euro area. Results, displayed in Figure 15, show that although the euro did not bring the expected lasting gains, the GDP per capita of both countries is currently higher than it would have been, had they not participated in the European integration process (Campos et al, 2015). These results highlight the welfare improving effects of the integration process, but they also stress the need for further steps to “implement a consistent strategy around the virtuous triangle of growth-enhancing structural reforms, investment and fiscal responsibility” (Junker et al, 2015).

**Figure 15:** GDP per capita. Observed vs. synthetic estimation



**Note:** The solid black line is the observed euro area GDP per capita, the dashed black line is the euro area synthetic estimation and the dashed green line is the EU synthetic estimation.

## 5 Concluding remarks

The process of the adoption of the monetary union was preceded by a very intense debate on the gains and costs of launching a common currency. However, scepticism was finally set apart and the idea that the monetary union would imply a jump to a lasting growth path prevailed. In this paper we attempt to answer the question of what euro area GDP per capita would have been, had the monetary union not taken place. With this objective, we use the synthetic control methodology to build a counterfactual of the GDP per capita of the euro area and its initial member countries.

Although we have assessed the robustness of the exercise, empirical applications like the one presented here have to be interpreted with caution since defining a counterfactual is always subject to a variety of potential biases. Also, the longer the prediction horizon considered, the less reliable the counterfactual becomes, since non-controlled shocks in the pool of country donors or even in the treated country might take place. In fact, the 2010 debt crisis might be considered as an additional shock to the euro area countries. That's why although all our figures throughout the paper show the GDP per capita developments up to 2013, we do not draw any conclusion from the Great Recession period. That would require further research. Our analysis has only referred to the pre-crisis period.

Results show that the adoption of the monetary union in the euro area did not produce the expected lasting increase in GDP per capita. During the early 2000s adoption of the euro had a slightly positive effect on euro area GDP per capita but the effect turned negative afterwards. In the medium term, since the mid-2000s, the synthetic euro area predicts that GDP per capita should have climbed above the levels registered, erasing the initial gains obtained from the adoption of the euro.

Behind this aggregate result, we identify three different patterns across countries. First, for the group of countries comprising Germany, Austria and the Netherlands, joining the euro did not bring any significant gain or loss relative to their counterfactual. Second, the group of countries including Spain, Ireland and Greece greatly benefit from joining the euro during the years of expansion. And finally, in the third group – Italy, Portugal and Belgium - the relative gains from adopting the common currency were very temporary and quickly translated into losses relative to the counterfactual.

The success of the euro relied on endogenously achieving real convergence, which would act as an external constraint pushing countries to pursue structural reforms and thereby increasing potential output. The anticipated further trade integration was expected to also spur market demands for implementing the pending structural reforms. However, the emergence of China as a major player in world trade severely affected the second ingredient from coming into operation and prompted reforms in the central European countries which faced heightened external competitiveness, but not in the peripheral countries as was initially expected and desired. Also, the favourable financing conditions brought by the euro to previously inflationary member countries induced governments to delay the needed structural reforms. Therefore, the lack of a significant positive difference between the observed path of the euro area GDP per capita and its counterfactual might not be attributed to the common currency per se but to a combination of different factors, included the perversion of the incentives to implement the much needed structural reforms.

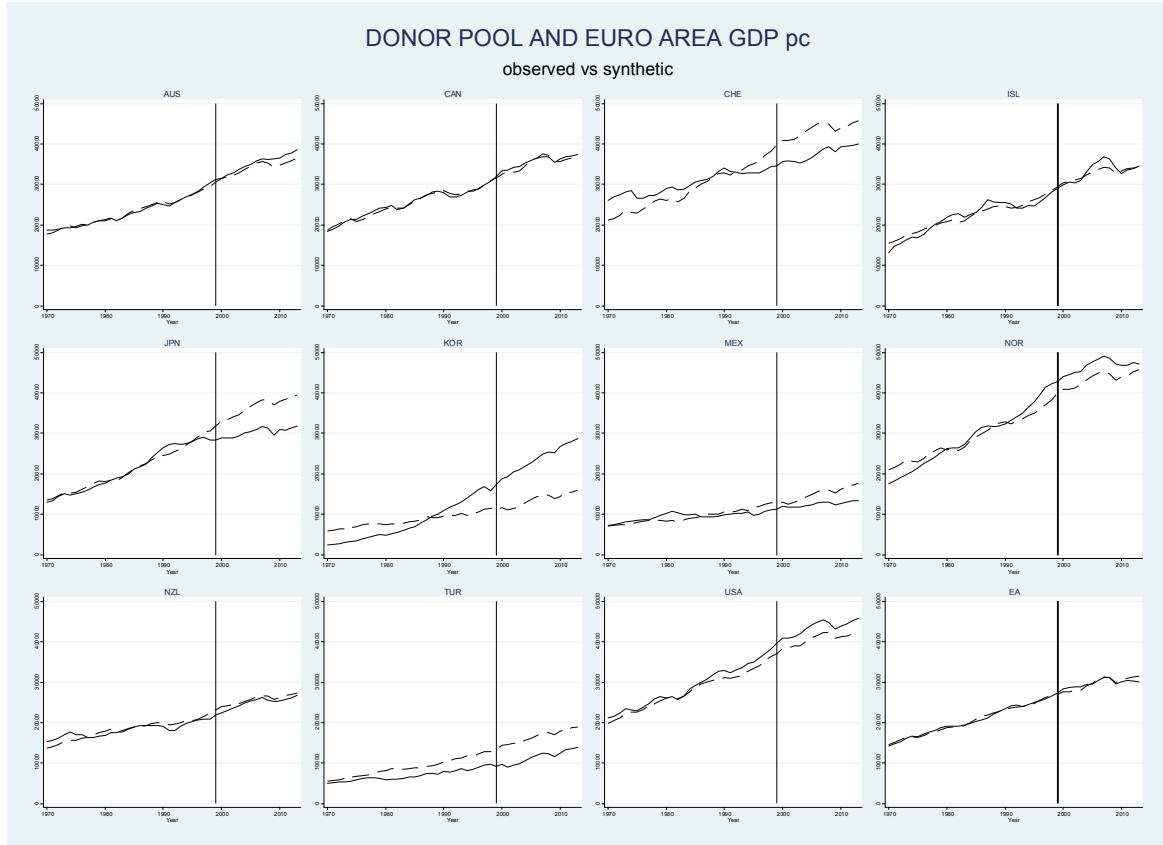
This evaluation of the euro project in terms of per capita GDP has to be understood, however, in the broader context of European integration where continuous and decisive steps forward have to be taken. The recent Five Presidents' Report highlights that in order for all members to gain from the euro, they will need to evolve from the current system of rules and guidelines involved in national economic policy-making towards a system of further sovereignty-sharing within common institutions. This will require Member States increasingly to accept joint decision-making on aspects of their respective national budgets and economic policies.

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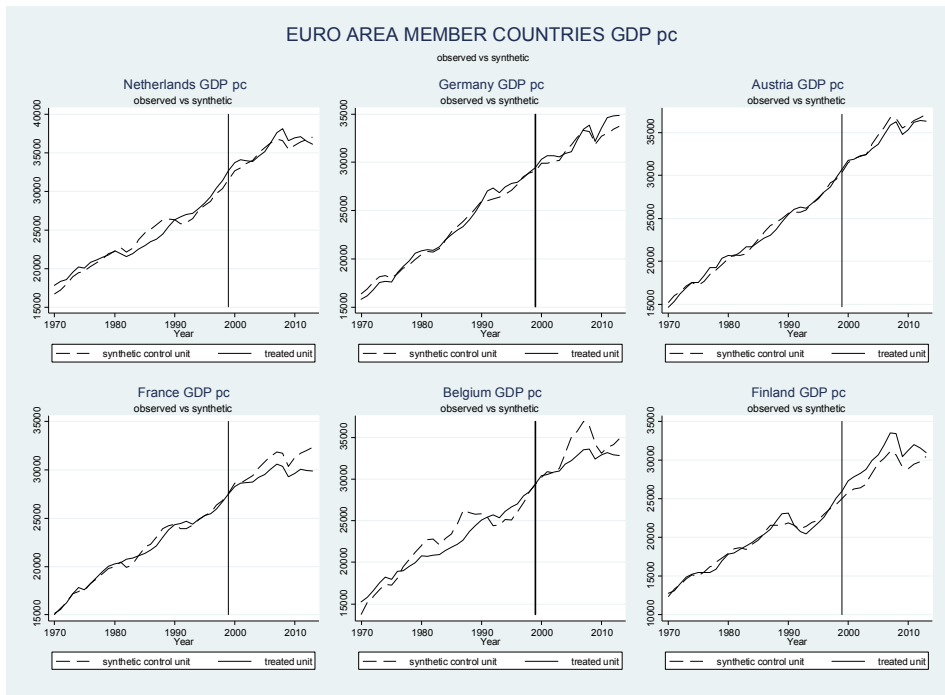
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## APPENDIX

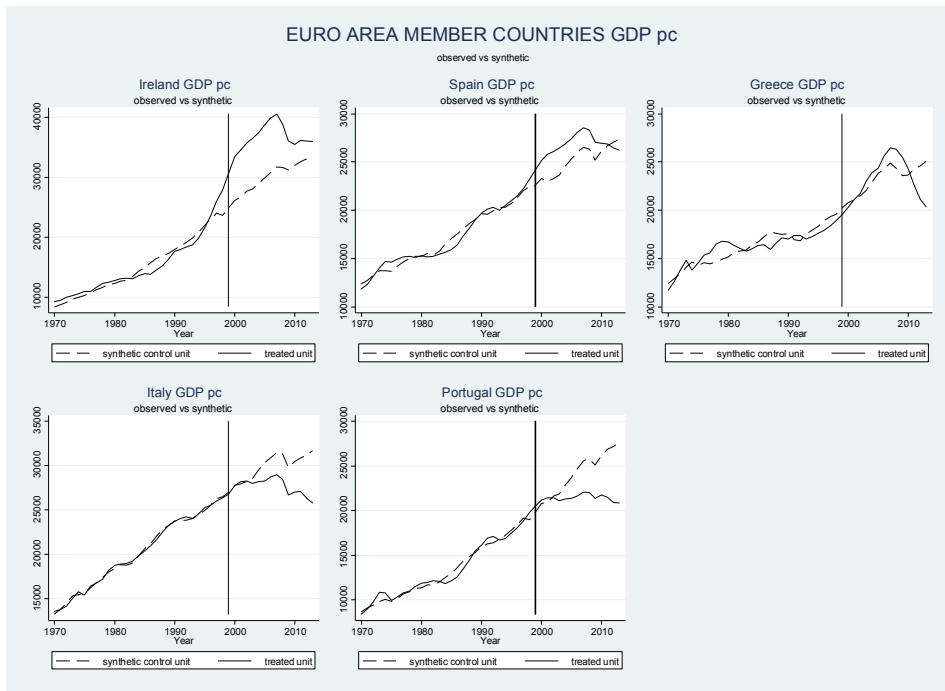
**Figure A1:** GDP per capita of the euro area and countries from the donor pool. Observed vs. synthetic estimation (pre-treatment period 1970-1998).



**Figure A2:** Euro area member countries' GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1970-1998). Core countries.



**Figure A3:** Euro Area member countries' GDP per capita. Observed vs. synthetic estimation (pre-treatment period 1970-1998). Peripheral countries.



**Table A1:** Synthetic weights of countries in the donor pool

	NETHERLANDS	GERMANY	AUSTRIA	ITALY	PORTUGAL	BELGIUM	FRANCE	FINLAND	IRELAND	SPAIN	GREECE
AUS	0	0	0	0	0	0	0	0	0	0	0
CAN	0	0	0	0	0	0.28	0	0	0	0	0
CHE	0.19	0.51	0.35	0.25	0.01	0.18	0	0	0	0	0.31
ISL	0.46	0.07	0.28	0.00	0.52	0.46	0.34	0.14	0	0.30	0.07
JAP	0	0.18	0	0.25	0	0	0.57	0	0	0.24	0
KOR	0.11	0	0.22	0	0.02	0.09	0	0.03	0.67	0	0.05
MEX	0	0	0	0	0	0	0	0.31	0	0	0
NOR	0.23	0	0.15	0.08	0	0	0	0.36	0.33	0.09	0
NZL	0.00	0.18	0	0.19	0	0	0	0	0	0	0
TUR	0	0.07	0	0.20	0.45	0	0.10	0.17	0	0.36	0.57
USA	0	0	0	0.04	0	0	0	0	0	0	0

**Table A2:** Mean of GDP per capita and its determinants before the adoption of the euro (1992-1998).

	NETHERLANDS		GERMANY		AUSTRIA	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP PER CAPITA	28768.89	28756.02	27813.58	27841.87	27598.58	27730.87
PRIVATE CONSUMPTION (SHARE OF GDP)	0.49	0.51	0.59	0.58	0.57	0.54
PUBLIC CONSUMPTION (SHARE OF GDP)	0.25	0.21	0.19	0.15	0.20	0.18
INVESTMENT (SHARE OF GDP)	0.19	0.20	0.19	0.21	0.24	0.23
EXPORTS (SHARE OF GDP)	0.49	0.33	0.23	0.27	0.35	0.31
IMPORTS (SHARE OF GDP)	0.43	0.28	0.23	0.24	0.36	0.28
AVERAGE YEARS OF EDUCATION	10.51	9.68	9.41	9.87	8.64	9.77
DEPENDENCY RATIO	21.25	21.24	25.46	21.96	24.69	20.11

	ITALY		PORTUGAL		BELGIUM		FRANCE	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP PER CAPITA	25149.12	25144.97	17847.58	17867.03	26778.90	26823.93	25357.31	25356.46
PRIVATE CONSUMPTION (SHARE OF GDP)	0.59	0.58	0.62	0.60	0.54	0.54	0.55	0.57
PUBLIC CONSUMPTION (SHARE OF GDP)	0.20	0.15	0.20	0.20	0.24	0.22	0.26	0.19
INVESTMENT (SHARE OF GDP)	0.19	0.21	0.23	0.18	0.20	0.20	0.17	0.23
EXPORTS (SHARE OF GDP)	0.22	0.23	0.22	0.23	0.62	0.30	0.20	0.17
IMPORTS (SHARE OF GDP)	0.19	0.19	0.28	0.23	0.60	0.28	0.19	0.17
AVERAGE YEARS OF EDUCATION	7.75	9.54	6.45	7.04	9.72	9.62	8.30	9.27
DEPENDENCY RATIO	26.81	20.69	25.10	15.85	26.52	19.62	25.83	21.01

	FINLAND		IRELAND		SPAIN		GREECE	
	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic	Treated	Synthetic
GDP PER CAPITA	22280.90	22286.08	22276.90	22380.67	21247.63	21244.90	17798.26	17790.56
PRIVATE CONSUMPTION (SHARE OF GDP)	0.51	0.53	0.50	0.51	0.57	0.58	0.70	0.64
PUBLIC CONSUMPTION (SHARE OF GDP)	0.27	0.17	0.20	0.17	0.17	0.18	0.18	0.13
INVESTMENT (SHARE OF GDP)	0.18	0.18	0.22	0.30	0.23	0.20	0.17	0.21
EXPORTS (SHARE OF GDP)	0.29	0.28	0.57	0.28	0.19	0.21	0.17	0.22
IMPORTS (SHARE OF GDP)	0.26	0.21	0.49	0.25	0.19	0.19	0.26	0.21
AVERAGE YEARS OF EDUCATION	9.16	9.16	10.88	10.39	7.73	7.93	8.18	6.89
DEPENDENCY RATIO	23.47	17.37	20.66	15.37	25.48	18.30	25.08	15.67

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