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Did the Euro Really Increase Corruption in the Eurozone? A Counterfactual Analysis

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Abstract

In this paper we apply the Synthetic Control Method developed by Abadie, Diamond and Hainmüeller (2010) to assess the extent to which the adoption of the euro has affected corruption in three groups of Eurozone countries: the core, southern and eastern countries. To do so, we construct counterfactuals for each group and for individual countries and compare them with the actual evolution of the corruption-control indicator. Except in the case of the Netherlands, where significant negative effects are detected, we find evidence that the adoption of the euro has either contributed to reducing corruption or has not affected it significantly.

Keywords: Corruption, Counterfactual analysis, Eurozone, Synthetic Control Method.

JEL Classification: F00, F50, P48.

1. Introduction

Corruption control generally worsened during the euro period in the euro area. This fueled the belief that the adoption of the single European currency created the breeding ground for increased corrupt practices in euro area (EA) members. However, to our knowledge, no work has empirically investigated to what extent there is a causal relationship between the two phenomena.

To fill this gap, in this paper we analyze the possible causal effects of the euro on the level of corruption in EA countries (considered individually and by subgroups), estimating the trajectory of corruption control since 1999 in the EA if EMU had not been implemented and

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comparing it with the actual evolution of this indicator. To do so, we perform a counterfactual analysis applying the Synthetic Control Method (SCM). We extend the methodology initially conceived by Abadie and Gardeazábal (2003) and Abadie *et al.* (2010) with the innovation of Cavallo *et al*. (2013) referred to the inference procedure. In the initial method the inference of the significance of the difference between the counterfactual and reality is left to the discretion of the researchers. Cavallo *et al*. (2013) resolve this weakness by offering a method of calculating statistical p-values for this difference. In what follows we will refer to the SCM completed with the innovation of Cavallo *et al*. (2013) as the "extended SCM method".

The method we apply here provides an appropriate way to select the comparison units to construct the counterfactual. The extended SCM selects the control units following a data-driven strategy to obtain the optimal results. Once this synthetic control is constructed, the counterfactual can be inferred and compared with the actual experience of the euro country (or group of countries) under analysis after the introduction of the euro. From this comparison, we can statistically infer whether the introduction of the euro has contributed to a change in the evolution of the corruption indicator in the country (or group of countries) analyzed.

Our empirical analysis is grouped around three sets of countries: the periphery, the former communist bloc and the core of the Eurozone. The main results can be summarized as follows: as far as the peripheral group is concerned, the adoption of the euro has not affected corruption in the group as a whole, but has had positive effects on corruption control in Portugal. No significant impact is found for Italy, Spain and Greece. However, our complementary analysis, based on kernel estimates of the conditional distribution, reveals that FDI inflows, and in particular fiscal decentralization, are potential drivers of the deterioration of corruption control in Italy, Spain and Greece. As for the group of eastern countries, we observe a positive impact of the euro on corruption control in the group mean indicator and in the case of Slovakia. As for the group of core countries, our analysis reveals that euro accession had a positive impact on corruption control in Germany and a negative and significant effect in the Netherlands. At this point, it is worth stressing that a "*positive* result of the euro on corruption in a given country", such as Portugal or Germany, obtained with our approach, should be considered as evidence that the euro has *contributed to improving* corruption control *compared to what would have happened if the country had not adopted the euro*.

The rest of the paper is structured as follows: Section 2 reviews the main literature on the topic; Section 3 explains the specific features of the extended Synthetic Control Method applied in this study. Section 4 presents the data and discusses the empirical results, including graphs attesting the quality of the estimated relationships and placebo tests, and kernel estimates of the distribution of corruption conditional on FDI flows and fiscal decentralization in Italy and Spain. Finally, Section 5 summarizes our findings and derives policy prescriptions.

2. Literature review

Fernández-Villaverde *et al*. (2013) show that the introduction of the euro slowed down economic and institutional reforms and deteriorated corruption control, especially in coun-

tries on the periphery of the EA. Their (untested) theoretical explanation is that the introduction of the euro caused risk premia to fall and led to large capital inflows into peripheral countries, which relaxed budget constraints on both governments and private agents. Transparency and accountability of politicians deteriorated as a result, reducing pressure for reforms. Schönfelder and Wagner (2016) apply a dynamic panel data model to show that once countries become EU member states or even introduce the euro, their institutional development loses momentum and corrupt activities become more frequent or less controlled.

In a related area of analysis, Gokcekus and Suzuki (2011) investigate the extent to which corruption is affected by the different phases of the business cycle. With the help of panel models, these authors show that corrupt practices expand in good times and shrink in bad times, confirming a relationship that Galbraith (1997) had found years earlier (Galbraith's proposition).

In an interesting analysis of the connection between the quality of governments and important economic, political and social outcomes, Rothstein (2011) comments on the difficulties of economic growth when there is government corruption.

Based on an interesting descriptive analysis, Papaioannou (2016) points out that the introduction of the euro did not prevent the gap between the institutional quality of two groups of eurozone countries, the periphery on the one hand and the core on the other, from widening in recent decades. This author stresses that the divergent trends on institutional quality in that area were particularly noticeable in the control of corruption.

Beyaert *et al*. (2019) focus on institutional convergence within the EA. Applying third-generation panel unit root tests and distribution dynamics analysis, these authors establish that, after the creation of the euro, the periphery and Eastern member countries have not followed a process of convergence towards the institution quality - including in this the control of corruption - of the better positioned euro area countries.

Applying an econometric test that allows discerning between various types of institutional convergence within the EA, Glawe and Wagner (2021) and García Solanes *et al*. (2021) find a lack of convergence in corruption control in the EU as a whole and in the EA as a whole, respectively, since the implementation of the euro. However, both contributions detect several convergence clubs for corruption control and other institutional indicators within the areas analyzed. Going deeper in this line, García Solanes *et al*. (2023) find additional evidence on the lack of institutional convergence –both in formal and informal institutions– in the EA after the introduction of the single currency. These authors draw important implications for long-term economic performance, since, according to their results, institutional development is closely related to the potential GDP per capita of euro area countries.

As far as econometric methodology is concerned, to the best of our knowledge our work is the first to apply the Synthetic Control Method (SCM), and a fortiori the extended SCM, to disentangle the effects of euro adoption on corruption. This methodology has been successfully applied in other areas. Authors have investigated the economic impact of the terrorist

conflict in the Basque Country (Abadie and Gardeazábal, 2003), the effects of Proposition 99 (a large-scale tobacco control program implemented in California in 1988) on tobacco consumption (Abadie *et al*., 2010), the economic impact of the 1990 German reunification in West Germany (Abadie *et al*., 2015), how the Stability and Growth Pact has influenced the evolution of public debt in the euro area after the introduction of the common currency (Koehler and Köenig, 2015), the impact of EMU on GDP per capita in several euro area groups (Fernández and García Perea, 2015), and the long-run effect of fiscal consolidation on economic growth in six OECD country case studies (Kleis and Moessinger, 2016).

3. Methodology: The Synthetic Control Method (SCM) approach

The objective of the Synthetic Control Method (SCM) is to construct a valid counterfactual with which to compare the actual evolution of the outcome of interest; in our case, this outcome is the corruption indicator of a specific euro country or group of countries. To this end, it uses a data-driven procedure to identify a valid comparison group and construct a reliable counterfactual: starting from a panel of non-euro area countries, the procedure identifies the group of countries that can best mimic –through a convex combination of the characteristics of all of them– the evolution of the corruption indicator of the euro country of interest prior to the introduction of the euro. From this optimal combination, the counterfactual is extracted: it reflects what would have been the evolution of the corruption indicator in the euro country (or group of countries) in the absence of the introduction of the euro. The comparison between the counterfactual and the actual evolution of the corruption indicator of the euro country provides the estimated effect of the introduction of the euro on corruption in this euro country. Once the effect is obtained, a sensitivity analysis is performed to reinforce the validity and robustness of the results obtained (This analysis can be found in Appendix A.2).

A brief technical summary of the SCM procedure is presented below. It is largely inspired by the pioneering work of Abadie and Gardeazábal (2003), as well as Abadie *et al.* (2010, 2015) and is completed by the results of Cavallo *et al*. (2013).

Assume we have data on $(J+1)$ units at time t, for $t = 1, ..., T_0, T_{0+1}, ..., T$, where $T_0 + 1$ is the date of the event whose effects are to be studied. In our case the units are countries and $T_0 + 1$ is the year of the introduction of the euro (or the date of entry of the country under study into the euro zone if it is after the introduction). Without loss of generality, country 1 is the affected unit (a specific euro country), while the remaining J countries do not belong to the euro area and constitute the possible control units; these J countries are often referred to as the "donor group". Let Y_{jt} be the outcome variable of interest (the corruption indicator) for $j = , 2, ..., J+1$ and $t = 1, ..., T$. Let X_1 be a $(K \times 1)$ vector of pre-euro values of K predictors for the corruption indicator of country 1. And let X_0 be the $(K \times J)$ matrix of the pre-euro values of the same characteristics or predictors for the J countries of the donor group. Let $W = (w_2, ..., w_{j+1})'$ be a $(J \times 1)$ vector of non-negative weights such that $\sum_{j=2}^{J+1} w_j = 1$. These weights will define the combination of control units (from non-euro countries) that will be

used to construct the synthetic control in the pre-event period from which the counterfactual corruption indicator for country 1 will be drawn for the post-event period. Each value of W defines a different weighted average of the control countries and thus a different synthetic control. Given the restrictions imposed on these weights, the resulting combination is convex. Finally, let V be a $(K \times K)$ diagonal matrix with non-negative components that will reflect the relative importance of the different predictors in the construction of the synthetic control.

The vector of optimal weights W^* will be selected to minimize the discrepancy between X_1 and $X_0 W$:

$$W^* = \arg\min_W (X_1 - X_0 W) V (X_1 - X_0 W)' \tag{1}$$

subject to $w_j \geq 0 \; \forall j = 2, ..., J+1$ and $\sum_{j=2}^{J+1} w_j = 1$.

Thus, W^* defines the convex combination of non-euro countries that best mimics the euro country in predictors of corruption prior to euro area membership.

However, W^* depends on V, the diagonal matrix of relative importance of the different predictors. The value of V will also be assessed by a data-driven procedure: it will be determined to minimize the distance between the pre-euro actual path of the euro country corruption indicator and its synthetic control estimator. Let Y_1 be the $(T_0 \times 1)$ vector containing the data on corruption of the euro country before joining the euro area. Similarly, let Y_0 be the matrix $(T_0 \times J)$ containing the data on corruption of the non-euro-zone countries before $T_0 + 1$. Then

$$V^* = \arg\min_V (Y_1 - Y_0 W^*(V))(Y_1 - Y_0 W^*(V))' \tag{2}$$

Thus, in the end, we obtain an optimal pair of W and V that provides the synthetic control estimator over the pre-euro period, $Y_0 W^*(V)$, which mimics as well as possible Y_1 in the sense of minimizing the root mean squared prediction error (RMSPE) of Y_1. The better the fit (the smaller the RMSPE), the more reliable the counterfactual for the post-euro period.

This counterfactual will be calculated using the data of the control countries –optimally selected and weighted by W^*– for the period after the euro (i. e. from $T_0 + 1$ onwards). Be it Y_1^N be this counterfactual. It is a $(T - T_0 \times 1)$ vector calculated as $Y_1^N = Y_0^N W^*(V^*)$ where Y_0^N is the $(T - T_0 \times J)$ data matrix of donor group outcome data for the post-intervention period. Similarly, let Y_1^I be the observed outcome variable for country 1 for the same period with the same dimension as Y_1^N. Then, the effect for country 1 of euro-zone membership, for every t from the date of entry into the euro area, will be estimated by the difference between these two vectors:

$$\alpha_1 = Y_1^I - Y_1^N \tag{3}$$

Alternatively:

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N \tag{4}$$

for $t = T_0 + 1, ..., T$.

To assess the significance of this difference, a "placebo test" is applied, following Abadie *et al*. (2010, section 3.4) and Cavallo *et al*. (2013). It consists of repeating the entire process for each of the J countries to obtain the placebo trajectories $\alpha_{jt} = Y^I_{j,t} - Y^N_{j,t}$, $t = T_0 + 1, ..., T$; $j = 2, ..., J + 1$. This generates a distribution of trajectories that is used to compare the trajectories of α_{1t} from $T_0 + 1$ onwards. According to the approach of Abadie *et al*. (2010), the latter must differ sufficiently from the others (it must lie sufficiently "outside" the distribution of trajectories obtained for the other countries) to be able to conclude that the event actually affected the outcome variable of country 1. However, in this paper, this placebo test is conducted using an extension of this approach, developed by Cavallo *et al*. (2013). They first obtain the trajectories α_{jt} and then develop a procedure to calculate a p-value for a one-sided non-zero effect test for each t-period after the adoption of the euro ($t = T_0 + 1, ..., T$). Following the notation of Cavallo *et al*. (2013), these p-values are calculated as follows:

For positive effects ($\alpha_{1t} > 0$):

$$p - value_t = \frac{\sum_{j \neq 1} I(\alpha_{jt} > \alpha_{1t})}{J} \tag{5}$$

for $t = T_0 + 1, ... T$ where $I(x) = 1$ if x is true and 0 otherwise.

For negative effects ($\alpha_{1t} < 0$):

$$p - value_t = \frac{\sum_{j \neq 1} I(\alpha_{jt} < \alpha_{1t})}{J} \tag{6}$$

for $t = T_0 + 1, ..., T$.

In addition, we use the methodology developed by Cavallo *et al*. (2013) to construct a counterfactual for the average level of corruption of specific subgroups of countries. These countries have implemented the common currency at different times, which means that $T_0 + 1$ may be different for each country. Let E be the number of events in the group, i. e. the number of euro inceptions in each group. In our case, each country in the group implements the euro only once. Therefore, E coincides with the number of countries in the group. Let us now assume that we can calculate the $T - T_0$ impacts of the E events. The estimated average effect for the introduction of the euro in each group is:

$$\bar{\alpha} = \frac{1}{E} \sum_{e=1}^{E} (\alpha_{e,T_0+1}, ..., \alpha_{e,T}) \tag{7}$$

with

$$\bar{\alpha}_t = \frac{1}{E} \sum_{e=1}^{E} \alpha_{e,t} \tag{8}$$

for $t = T_0 + 1, ..., T$, where $\alpha_{e,t}$ is the estimated effect after the event for country e and for period t. ($T_0 + 1$ is now the date of the last entry into the euro area within the group).

We then calculate an average placebo effect of the E countries composed of one placebo effect from each donor country. And all possible combinations of averages are performed, calculating $N = JE$ placebo averages. All these placebo averages are indexed with $np = 1, ..., N$. Next, we rank the $\bar{\alpha}_t$ into the distribution of N average placebo effects, which implies N comparisons. Finally, we calculate p-values as follows:

If $\bar{\alpha}_t > 0$

$$p - value_t = \frac{\sum_{np=1}^{N} I(\bar{\alpha}_t^{(np)} > \bar{\alpha}_t)}{N} \tag{9}$$

and if $\bar{\alpha}_t < 0$

$$p - value_t = \frac{\sum_{np=1}^{N} I(\bar{\alpha}_t^{(np)} < \bar{\alpha}_t)}{N} \tag{10}$$

The use of synthetic control is especially designed to determine the impact that certain policy interventions have had on different variables. The SCM has some advantages over other methods that use linear regressions. As Abadie (2021) explains, the synthetic control method is a transparent method to obtain a counterfactual that lends itself to simplicity and clarity and avoids extrapolations. In addition, it is easily interpretable and can be evaluated in several ways. Despite these benefits, the successful application of this methodology requires some conditions. The first is that the outcome variable must not be excessively volatile if we want to detect the effects on it. Institutional variables fit perfectly with this requirement since they change very slowly over time. Another important challenge of the synthetic control method is to find a suitable donor group and sufficient data before and after the intervention. This may limit the number of studies using this technique and make its use more difficult. However, when these challenges are overcome, the results obtained are clear and reliable. Given that our data meet these requirements, the SCM is well suited to analyze the impact of euro implementation on corruption in the euro area.

4. Data and results

Before showing the results, some considerations must be made about the data. The outcome variable in our analysis is the Corruption indicator, and the data comes from the International Country Risk Guide (ICRG)[1]. The indicator assesses corruption within the political system (bribery, reservation of jobs, party of secret funds, etc.). The scores provided by the ICRG database vary between 0 and 6, with an increase (decrease) in the score indicating an improvement (deterioration) in control of corruption.

The period examined is 1984-2017, and the event is the introduction of the euro, which takes place in 1999, except for Greece, Estonia, Slovakia and Slovenia, where the event occurred in 2001, 2011, 2009 and 2007, respectively. We use annual country-level data for the main euro area countries, leaving out Latvia and Lithuania because their recent accession does not allow us to obtain sufficient data for a reliable empirical analysis.

To evaluate the effect of the common currency on this variable we need a counterfactual that reflects how corruption would have evolved in the absence of the introduction of the euro. As explained above, the SCM uses a convex combination of the countries in the donor pool that most resemble the country under analysis in the years before the euro (see Section 2). Our donor group consists of all countries belonging to the European Union but outside the euro area: Bulgaria, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden and the United Kingdom.[2]

For these eight donor pool countries and the euro country under study, eleven predictors are used. We selected them taking as a guide the variables that are generally accepted in the literature as the most related to corruption. Following Seldadyo and De Haan (2006), we include variables covering institutional factors as well as economic, demographic and gender equality aspects.

The variables related to our institutional predictors come from the International Country Risk Guide (IGRG) and are defined as follows:

— *Government stability*: measures the government's ability to accomplish its program and its capacity to stay in office. This variable ranges from 0 to 12.

— *Investment profile*: evaluates three important factors related to public administration, namely expropriation, repatriation of profits and delays in payments. The variable ranges from 0 to 12.

— *Democratic accountability*: evaluates the quality of democracy, transparency and accountability in the country. The variable varies between 0 and 6.

— *Quality of bureaucracy*: evaluates whether the bureaucracy of each country is free of political pressures. The variable varies between 0 and 6.

— *Public order*: evaluates the legal and judicial framework and crime rates of each country. This variable ranges from 0 to 6.

The scores of the institutional variables from the IGRG vary between 0 and 6 or between 0 and 12, with 0 if the country does very poorly in that institutional aspect and 12 or 6 if its performance is the best possible. These scores are given by international experts on issues related to institutional quality and economic development.

For variables of an economic nature, we include the sum of exports and imports as a proportion of GDP (trade) to capture the association between foreign trade and corruption, and GDP per capita in constant 2010 US dollars as a proxy for the country's level of wealth. We use the country's total population to account for the relationship between demographics and corruption. Finally, we include the female labor force as a percentage of the total labor force as a proxy for gender equality. All these variables are from the World Bank.

It is important to note that the Synthetic Control Method is a data-driven methodology, which means that we offer as predictors a set of variables that are related to the level of cor-

ruption control, and let the methodology select the importance given to each predictor with the help of the optimal weights (W^*) obtained in the construction of the counterfactual. Note that some of these weights could be zero, in which the corresponding predictors would not enter into the construction of the synthetic variable.

Since our institutional variables are final evaluations based on expert opinions, the resulting scores are a discrete reflection of an underlying unobserved continuous process. To perform an analysis in the most appropriate way possible, it was desirable to transform the institutional variables from discrete to continuous using estimated trends[3]. We therefore chose to fit polynomial trends (of degree up to 4) to extract this underlying[4] continuous phenomenon. Table 1 presents a brief summary of what has been described so far.

Table 1
SUMMARY DATA

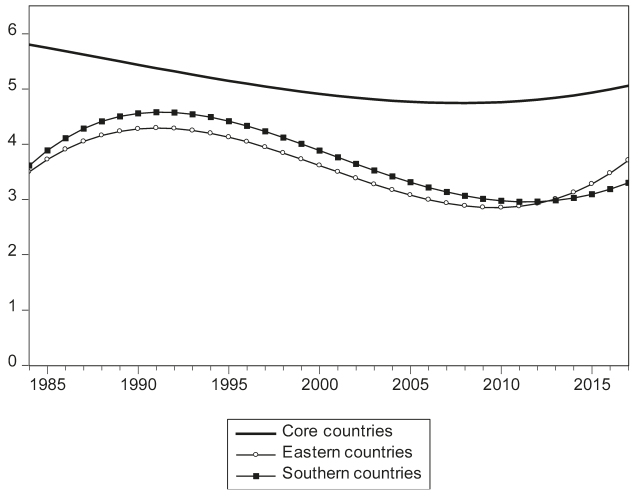
Treated countries	Outcome variables	Predictors	Event years	Donor pool
Austria	Corruption	Government Stability	The implementation of the euro	Bulgaria
Belgium		Investment Profile	1999 for Spain, Portugal, Austria, Belgium, France, Finland, Germany, Luxembourg and the Netherlands	Czech Republic
Estonia		Democratic Accountability		Denmark
Finland		Law and Order		Hungary
France		Bureaucracy Quality		Poland
Germany		Female Labour Force	2001 for Greece	Romania
Greece		Population	2007 for Slovenia	Sweden
Luxembourg		Trade	2009 for Slovakia	United Kingdom
The Netherlands		GDPpc	2011 for Estonia	
Portugal				
Slovakia				
Slovenia				
Spain				

4.1. Group analysis

In the following, we present our results grouped into three sets of economies: a) the southern periphery of the euro area, consisting of Italy, Spain, Greece and Portugal; b) the eastern ex-communist bloc, consisting of Estonia, Slovakia and Slovenia; and c) the core of the euro area, consisting of Austria, Belgium, France, Finland, Germany, Luxembourg and the Netherlands. This division is well established in the literature and is based on general economic and institutional aspects. Moreover, these three groups have different levels of corruption control over the period studied, as can be seen in Figure 1, where the trend-adjusted average level of corruption control is presented and can be compared[5]. It is worth recalling

that an increase (decrease) in the indicator means an improvement (deterioration) in control of corruption. It is obvious that the central countries performed much better than the other two groups; the eastern bloc is in the worst position throughout most of the period, and the southern countries are in an intermediate position.

Figure 1
MEAN OF TREND-FITTED CORRUPTION-CONTROL INDICATOR BY GROUPS



For all countries and groups, the results of our estimates are presented in two figures. The first figure shows the actual level of corruption control and the corresponding counterfactual obtained. In this first figure, the vertical line in the center of the graph locates the starting date of the Euro, the date $T_0 + 1$ in the methodology identified as moment "0" in the graphs (see, for example, Figure 2). The second figure represents the estimated effect of the euro on corruption control (continuous curve on the right scale, with the continuous horizontal line at zero as reference), together with the one-sided p-values (left scale, dots, with the dashed horizontal line at 10% as reference) that allow us to confirm or not the statistical significance of this estimated effect (see, for example, Figure 3 below).

Figures 2 and 3 present the results for the average of the southern countries, Italy, Spain, Greece and Portugal. They give us a first information on the impact of the common currency on corruption in these countries. For the construction of the synthetic control in the case of the southern countries, the donor pool countries selected are the Czech Republic, Romania or Hungary, while richer countries, such as the United Kingdom, are only selected for Italy and Spain. Moreover, the main predictors used in the construction of this averaged counterfactual are those related to institutional quality, except in the case of Greece, where variables related to education and gender equality also have an important weight.

In Figure 2, the vertical line indicates the date of the last introduction of the euro in the countries of the South, and the solid curve corresponds to the trend-adjusted real average

level of corruption control in this group of countries. The dotted curve is its counterfactual. As illustrated in this figure, the counterfactual (the dashed line) follows almost perfectly the evolution of actual corruption control (continuous curve) before the adoption of the euro: the dashed curve is very close to the solid one in the years before the event, to the left of the red vertical line. At the same time, the actual variable shows a large decline around and after the implementation of the euro, corresponding to the deterioration of corruption control in southern countries extending until 2012. However, this does not mean that the euro is the cause of this worsening.

Figure 2
SOUTHERN COUNTRIES: ACTUAL VERSUS SYNTHETIC CORRUPTION CONTROL

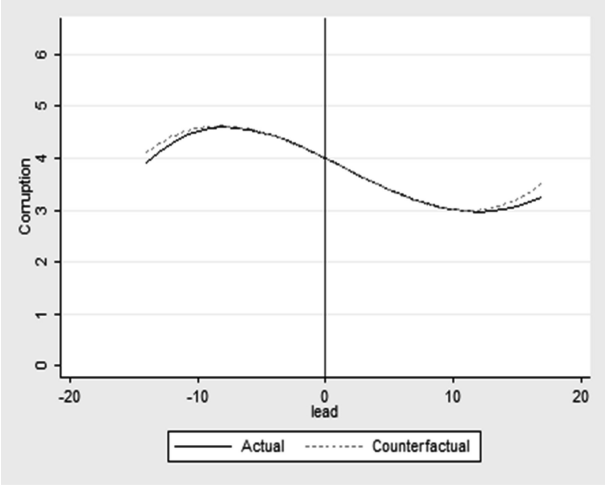
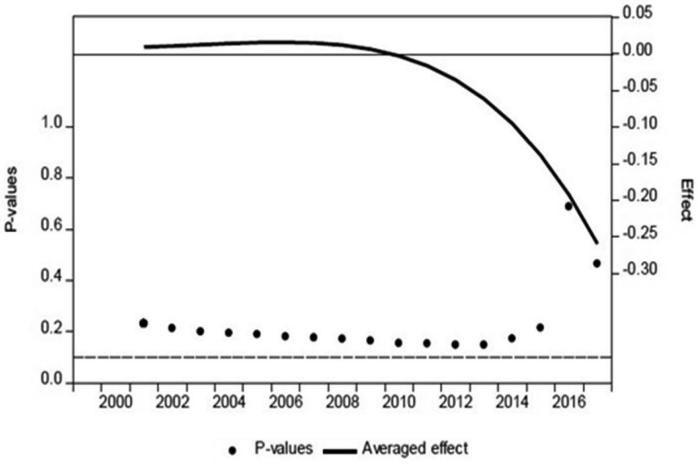


Figure 3
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR AVERAGED SOUTHERN COUNTRIES



To assess whether the euro is the cause of worsening corruption control, the actual variable must be compared with its counterfactual. In fact, the difference between the two is small, which means that this average indicator does not differ much from its evolution in the absence of the euro. Figure 3 provides the results that complete the analysis. In this figure, the estimated effect of the euro (which is the difference between the solid and dotted curves in Figure 2) on corruption control in the southern countries as a whole evolves from practically zero effects to increasingly negative effects at the end of the period (solid curve, with values on the right-hand scale). The statistical information on the significance of these estimated effects in the lower part of the figure (with p-values on the left scale) indicates that this worsening is not significant, as all p-values are above the 10% threshold. This means the observed setback is not due to the entry into force of the euro, at least in the southern group considered as a whole.

The evolution of corruption control and its link to the euro in eastern European countries is also interesting. These countries belonged to the Soviet bloc and, since the dissolution of the Soviet Union in the 1990s, have undergone a profound economic and institutional transformation. The introduction of the euro in the eastern EU countries took place between 2007 and 2011. Estonia adopted the euro in 2011, Slovakia in 2009 and Slovenia in 2007.

Figures 4 and 5 present the evolution of the averaged corruption control of Estonia, Slovenia and Slovakia and their counterfactual, i.e., the evolution if they had not implemented the euro. Tables A6 and A7 (see Appendix) show that the countries in the donor pool used to construct the counterfactual of the averaged eastern countries are mainly Romania and Hungary. As for the predictors, we find some differences with what happens in the southern countries. In the case of the eastern countries, the most used predictor variables are economic and educational for Estonia and Slovenia, and only in the case of Slovakia the institutional variables, especially bureaucratic quality, are the most relevant.

Figure 4
EASTERN COUNTRIES: ACTUAL VERSUS SYNTHETIC CORRUPTION CONTROL

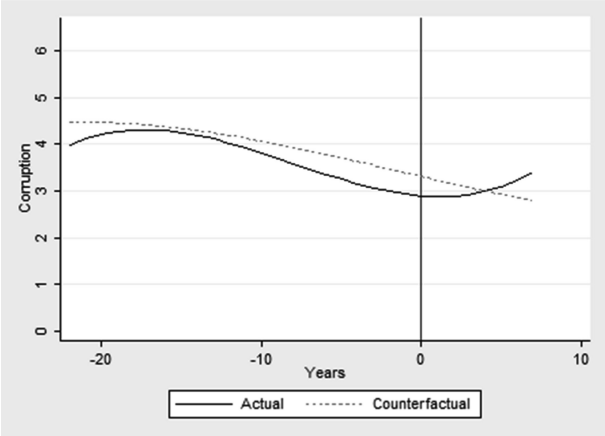
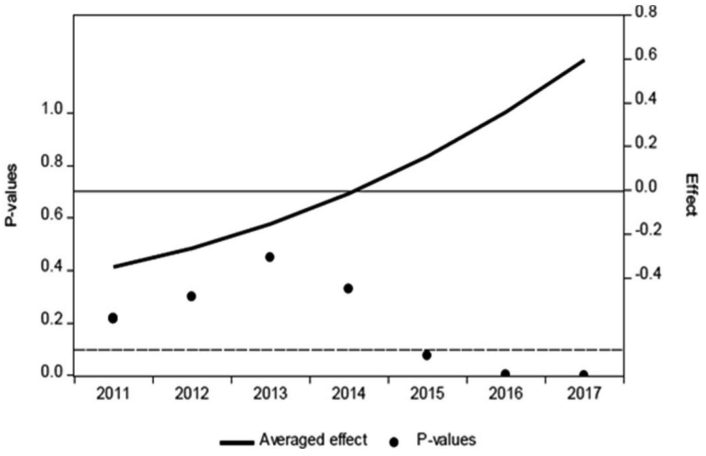


Figure 5
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR AVERAGED EASTERN COUNTRIES



The counterfactual presented in Figure 4 reveals that without the euro, the average evolution of control of corruption in these three eastern countries would have tended to be worse and, on the contrary, the actual variable shows an improvement after the entry into force of the euro. The estimated effect of the euro is presented in Figure 5. The results of this figure indicate that the average effect of the euro on corruption control in the eastern countries is positive and significant as of 2015. Levitz and Pop-Eleches (2010), show that in European eastern countries there was no backsliding but only a slowdown in institutional reforms, probably because the persistence of institutions is particularly strong in these countries. Our study enriches this conclusion and allows us to state that, on average, there was no backsliding in corruption control due to the euro, but a positive impact on their corrupt behaviors, at least in recent years.

The last set of euro countries grouped together are the core countries, which, as noted above, consist of Austria, Belgium, Germany, Finland, France, Luxembourg and the Netherlands. As expected, the average synthetic control for the core countries is constructed mainly with data from the United Kingdom. This country is the most similar both economically and institutionally to the core countries of the Eurozone. In second and third position are Denmark and Sweden, respectively. These three countries are the richest of the donor set and it is reasonable that they are the most used to construct the core counterfactual. Moreover, in this case, we can detect a pattern related to geographical proximity. Some countries such as Belgium, France or Finland use as donor countries those with which they share a border or are very close geographically. As for the predictor variables, the most important are law and order, investment profile and secondary school enrollment. This indicates that, for these euro members with the lowest levels of corruption, formal institutional quality and educational attainment are highly correlated with their control of corruption levels. Figure 6 shows the actual average corruption-control level of the group and its synthetic control version.

Figure 6
CORE COUNTRIES: ACTUAL VERSUS SYNTHETIC CORRUPTION CONTROL

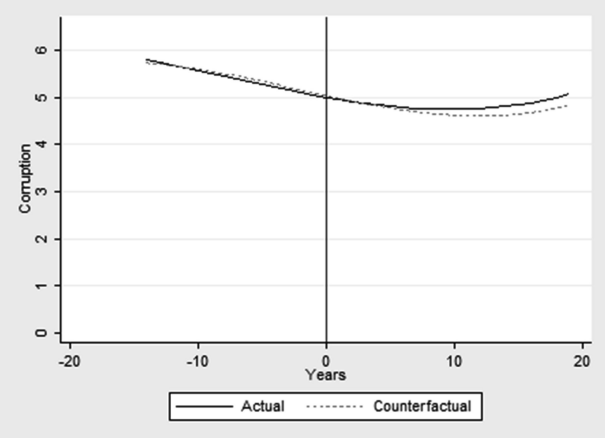


Figure 7
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR AVERAGED CORE COUNTRIES

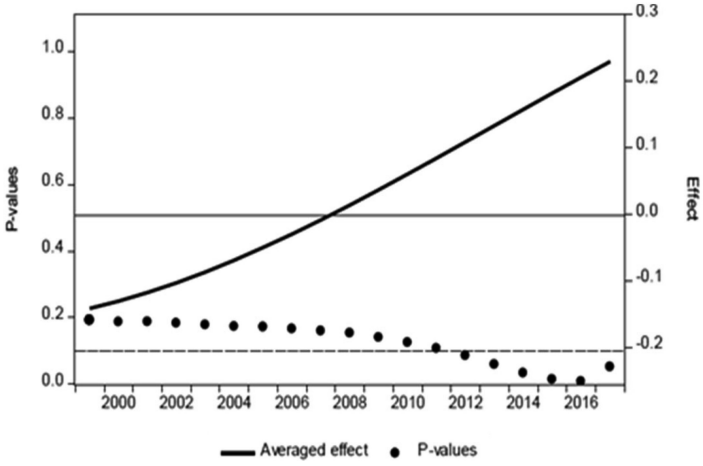


Figure 6 shows that, although the average level of corruption control has worsened, the core countries have benefited from a positive impact of the euro on corruption control, as the counterfactual is below the actual level of corruption control after the introduction of the euro. Figure 7 shows that this improvement, which occurred with a lag of four years, is at least partially attributable to the euro, since the estimated effect of the euro becomes significant at the end of the analyzed period.

In summary, there is no effect of the euro on average corruption control in southern countries, but the common currency has had a positive impact on corruption control in eastern and

core countries, where, after some years, the changes introduced by the euro have implied a significant relative improvement in their average level of corruption control.

Since these results are averaged, the impact of the euro could differ from country to country. Below we analyze each country individually within these three different subgroups.

4.2. Analysis of each country

Since the counterfactual variable must fit the real variable well in the period prior to the introduction of the euro in order to obtain reliable counterfactual results, we only present here the results for the individual countries for which we obtain a good counterfactual, i. e., a good fit prior to the event.

4.2.1. *Southern countries*

In the group formed by Italy, Greece, Spain and Portugal, we only found a reliable individual counterfactual for Portugal. Figures 8 and 9 present the results for this country.

From the comparison of the actual corruption indicator with its counterfactual in Figure 8 we derive a positive effect of the euro on the level of corruption control (the counterfactual is below the actual indicator). As a southern European country, it is often suspected that corrupt behaviors increased with the adoption of the euro. But our results show that in this country the opposite occurred; although control of corruption worsened, it would have degraded more in the absence of the euro, and this positive effect of the common currency is highly significant throughout the entire post-event period, as can be seen in Figure 9.

Figure 8
CORRUPTION CONTROL IN PORTUGAL: ACTUAL VERSUS SYNTHETIC

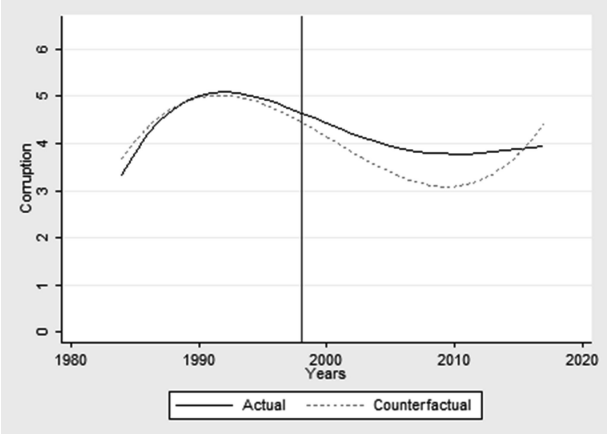
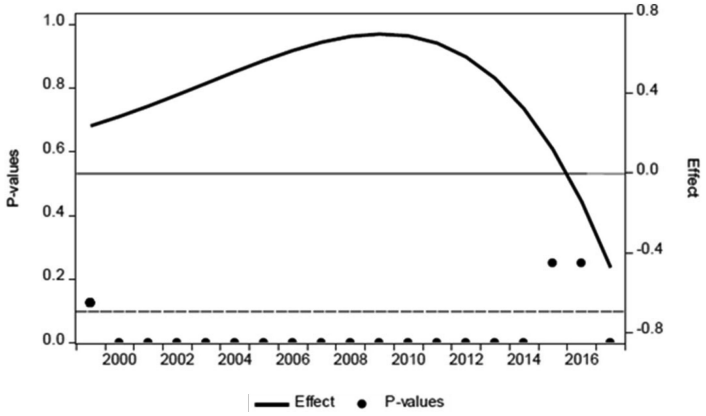


Figure 9
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR PORTUGAL



We did not achieve a good fit of the synthetic indicators for Italy, Spain and Greece probably due to the special characteristics of corruption in these countries. As a complementary analysis, we consider it appropriate to analyze the relationship between corruption control and other variables that in the literature are usually considered sources of corrupt activities. We focus on two factors that, especially for these countries, could be related to corruption.

The first factor is the inflow of foreign capital into these countries, triggered by the adoption of the euro, which, as emphasized by Fernández-Villaverde *et al*. (2013), fueled corrupt behavior in both the public and private spheres. We analyze the relationship between this factor and corruption control by estimating the conditional density function developed by Hyndman *et al*. (1996), conditioning corruption-control levels on net foreign direct investment (FDI) inflows over GDP for both countries. The results are presented in Figures 10, 11 and 12.

Figure 10
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON THE FDI (NET INFLOW/GDP) IN ITALY. PERIOD: 1984-2017

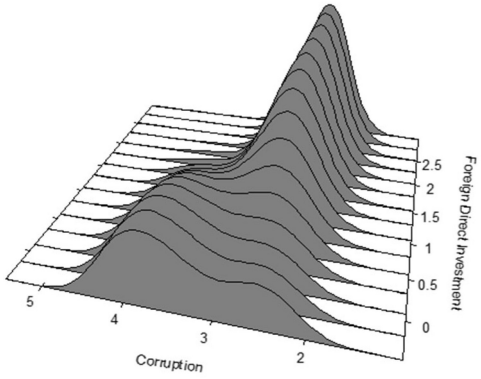


Figure 11
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON THE FDI (NET INFLOW/GDP) IN SPAIN. PERIOD: 1984-2017

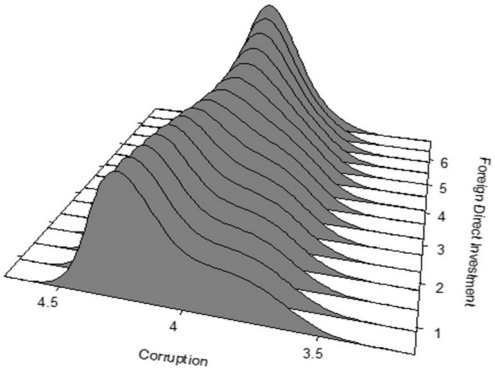
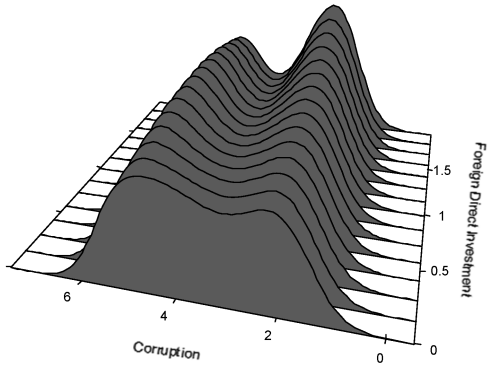


Figure 12
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON THE FDI (NET INFLOW/GDP) IN GREECE. PERIOD: 1984-2017



The relative positions of the distributions of the corruption-control indicator conditional on FDI in Italy, Spain and Greece show that the increase in net FDI inflows as a percentage of GDP is accompanied by a deterioration of the corruption indicator: the higher the percentage of FDI, the more the distribution of corruption control is concentrated around a lower (worse) level. This is particularly clear in the case of Italy and Greece, but we can also appreciate it for the case of Spain when FDI is above 4%. Figures 10 to 12 seem, therefore, to give some additional descriptive support to the theoretical hypothesis of Fernández-Villaverde *et al*. (2013).

The second factor that we want to highlight as a possible cause of corrupt behavior is fiscal decentralization, based on the arguments of Rodríguez-Pose and Gill (2003, 2005), Treisman (2000), Prud'homme (1995) or Tanzi (1995). The rationale for this is twofold: on the one hand, local governments are less controlled than the national government and, on the other hand, local politicians have more personal relationships with local actors. This proximity could be an important reason why decentralization negatively affects institutional quality.

Figures 13, 14 and 15 show the kernel distribution of the corruption-control indicator conditional on tax revenue decentralization in Italy, Spain and Greece, measured as the percentage of subnational government tax revenues over general government taxes. These graphs support the arguments of Rodríguez-Pose and Gill (2003, 2005) in each of the three countries. They clearly show that control of corruption worsens as fiscal decentralization increases. Since the three countries, and particularly Spain, are among the most decentralized countries in the EU, it is not surprising that control of corruption has worsened so much in these countries during their euro era. It is noteworthy that fiscal decentralization appears to be more highly correlated with corruption than FDI. To the extent that FDI inflows in the southern countries of the eurozone is more closely linked to the creation of the euro than to fiscal decentralization –which is a reflection of national policy preferences–, we can argue that in these countries corruption has more to do with internal factors than with the introduction of the euro.

Figure 13
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON TAX REVENUE DECENTRALIZATION[6] (SUBNATIONAL/GENERAL GOVERNMENT TAXES) IN ITALY. PERIOD: 1995-2016

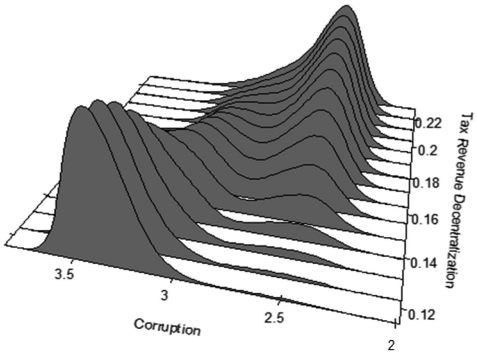


Figure 14
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON TAX REVENUE DECENTRALIZATION (SUBNATIONAL/GENERAL GOVERNMENT TAXES) IN SPAIN. PERIOD: 1990-2016

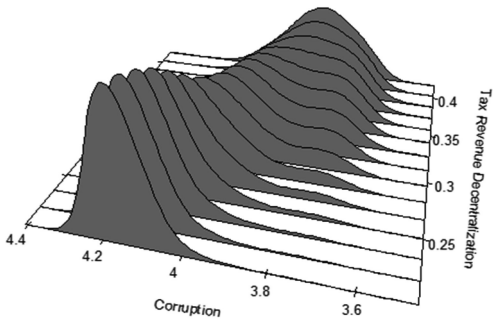
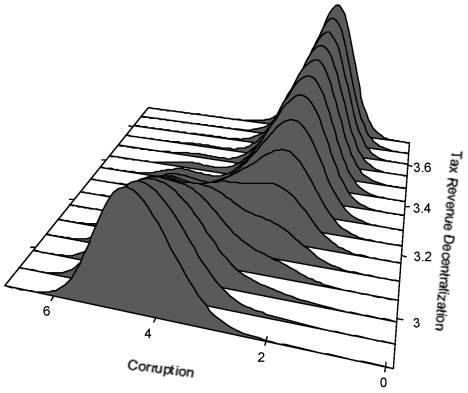


Figure 15
KERNEL ESTIMATES OF THE DISTRIBUTION OF CORRUPTION CONTROL CONDITIONAL ON TAX REVENUE DECENTRALIZATION (SUBNATIONAL/GENERAL GOVERNMENT TAXES) IN GREECE. PERIOD: 1995-2016



In summary, contrary to the general view, our results show that the Euro has had no direct negative effects on corruption control in the countries of the South as a whole, and a positive impact in Portugal.

4.2.2. *Eastern Countries*

The country-by-country analysis of this group only provides a reliable counterfactual for the case of Slovakia. Figures 16 and 17 show what happens with corruption in this euro member. According to Figure 16, Slovakia seems to benefit from the euro, and this effect, although small, is very significant according to the results presented in Figure 17. Therefore, in this country we do not find any evidence of a backward effect due to the common currency. On the contrary, we detect that the euro has prevented corruption from increasing.

Figure 16
CORRUPTION CONTROL IN SLOVAKIA: ACTUAL VS SYNTHETIC

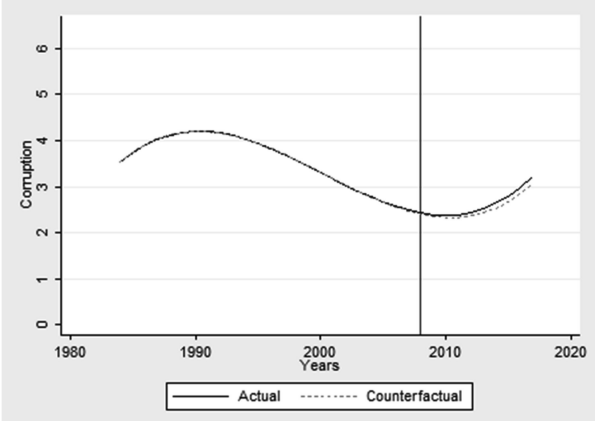
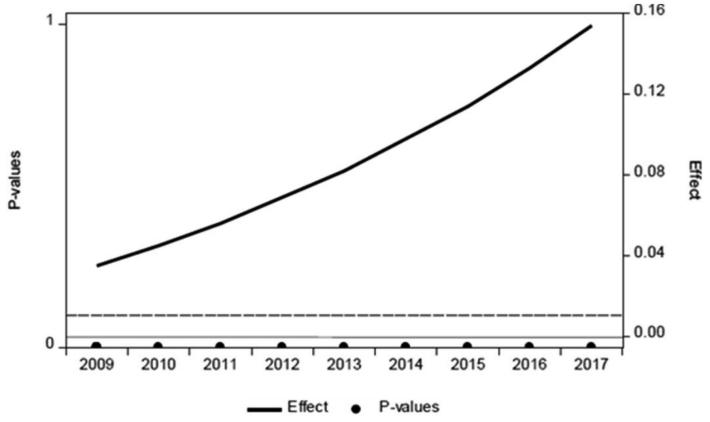


Figure 17
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR SLOVAKIA



Thus, the whole set of results we have obtained for the eastern countries of the EA are in line with the findings obtained by Levitz and Pop-Eleches (2010) and Beyaert *et al.* (2019): neither the accession to the European Union nor the adoption of the euro have led to an institutional setback in the eastern Euro countries, at least as far as control of corruption is concerned.

4.2.3. *Central countries*

The core countries are the best performers in terms of corruption control in the entire euro area. It is often thought that they have not changed their institutions and therefore no event has been able to change their corruption trajectory. However, our country-by-country analysis reveals some interesting characteristics that complement those of the core group as a whole, for which we detect a positive impact of the euro (see section 3.1).

Figure 18
CORRUPTION CONTROL IN GERMANY: ACTUAL VS SYNTHETIC

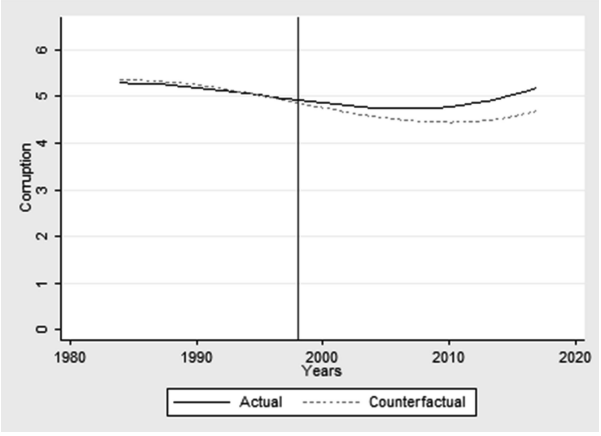
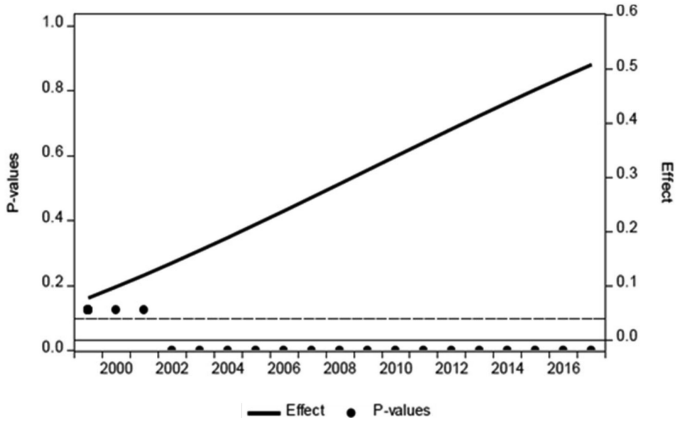
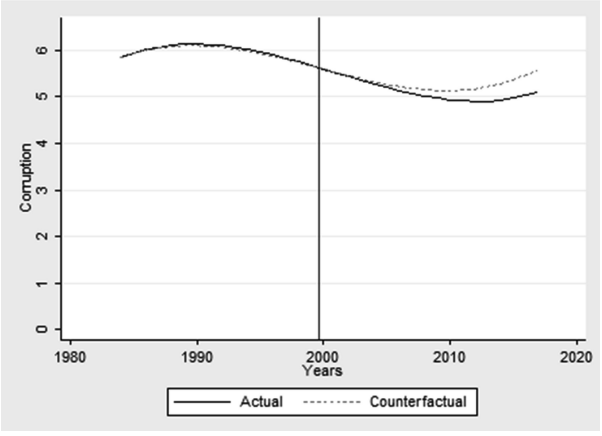


Figure 19
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR GERMANY



As for Germany, Figure 18 illustrates a degradation in corruption control until around 2008, probably due to German reunification. However, according to the trajectories in Figure 18, the euro has impacted positively on corruption control of this country, and this effect is highly significant almost immediately after the implementation of the single currency.

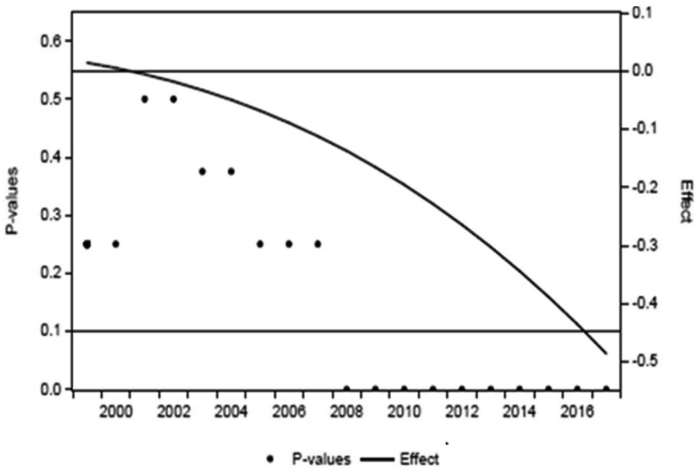
Figure 20
CORRUPTION CONTROL IN THE NETHERLANDS: ACTUAL VS SYNTHETIC



In the case of the Netherlands, corruption control shows a large worsening after the euro, and it appears that the introduction of the single currency has amplified this decline (Figure 20). The p-values plotted in Figure 21 indicate that the effect is not significant until 2008, after which it becomes highly significant. This establishes a causal effect from the adoption of the euro to the worsening of corruption control in this country. This negative impact could be explained by the "level effect" for institutional development, according to which countries with high institutional quality, such as the Netherlands, find it more difficult to improve

their institutions than countries with a lower institutional level. In fact, at the time of euro adoption, the Netherlands was the best country in the EA in controlling corruption and, even after the significant decline between 1990 and 2012, the recorded level of this indicator in the Netherlands was similar to that of Germany.

Figure 21
EFFECT AND ADJUSTED ONE-SIDED P-VALUES FOR THE NETHERLANDS



Thus, in the core euro countries, the analysis by country shows different impacts of the euro. While in Germany the euro has helped reduce corruption, in the Netherlands the common currency has increased corrupt activities

5. Concluding remarks

There is a widespread conviction that the adoption of the euro has aggravated corruption in the eurozone, especially in the peripheral economies. However, to our knowledge, no study has been conducted so far to econometrically demonstrate this alleged causal effect in the EA. In this paper we have investigated the extent to which the adoption of the euro has affected the level of corruption in three groups of eurozone countries, and in their individual components, by comparing the actual trajectory of the corruption-control indicator with that which would have occurred in the absence of the euro. Our counterfactual analysis has been carried out by applying the Synthetic Control Method (SCM).

Regarding the core, our results indicate that, on average, the euro has had a positive impact on corruption control. In the country-by-country analysis we find that the common currency significantly and negatively affected corruption control in the Netherlands, and that it has had a positive effect on the corruption-control indicator in Germany. The analysis conducted on the group as a whole reveals a significant and positive overall effect (although it

occurs several years after the implementation of the common currency, probably due to the persistence of institutions).

As for the peripheral countries, we do not detect any significant impact of the euro, either positive or negative, on corruption in the countries of the South as a whole. However, we find a significantly positive effect in Portugal. These results show that the generalized idea of more widespread and intense corrupt behavior in southern countries as a consequence of the introduction of the euro does not correspond to the facts. We also point to the amount of capital inflows and especially fiscal decentralization as possible alternative explanations for the increase in corruption in Italy, Spain and Greece, although a more in-depth empirical analysis of this possible causality is left for further research.

Finally, as far as the eastern euro area countries are concerned, we detect an overall positive effect of the euro on corruption control in this group, with a special mention for Slovakia, for which we show that the adoption of the euro has significantly reduced the level of corruption compared to the case in which the country had not adopted the euro. These results indicate that the introduction of the common currency has not led to a decline in corruption control in the ex-communist euro area countries.

Some policy prescriptions can be derived from these results. Since the governments of the EMU periphery cannot blame the euro for the spike in corruption observed in their countries in recent decades, they have no excuse for vigorously fighting the deterioration of this institutional variable with domestic measures. According to our findings, there are causes of corruption other than the introduction of the euro that should be urgently addressed in EU countries for the welfare of the population.

Appendix

A.1. Donor pool weights and predictor matrices

Table A1
ACTUAL VS SYNTHETIC CORRUPTION CONTROL. AVERAGED CORE COUNTRIES

	Corruption control	Synthetic Corruption control
Lag 5	5.301	5.450
Lag 4	5.211	5.361
Lag 3	5.188	5.236
Lag 2	5.099	5.200
Lag 1	5.073	5.132
Lead 0	5.000	5.102
Lead 1	4.971	5.054
Lead 2	4.911	5.000
Lead 3	4.874	4.966
Lead 4	4.811	4.890
Lead 5	4.801	4.805

Table A2
ACTUAL VS SYNTHETIC CORRUPTION CONTROL. AVERAGED SOUTHERN COUNTRIES

	Corruption control	Synthetic Corruption control
Lag 5	4.495	4.514
Lag 4	4.345	4.410
Lag 3	4.287	4.365
Lag 2	4.153	4.263
Lag 1	4.109	4.189
Lead 0	4.000	4.101
Lead 1	3.812	3.879
Lead 2	3.681	3.820
Lead 3	3.593	3.671
Lead 4	3.522	3.611
Lead 5	3.400	3.587

TableA3
ACTUAL VS SYNTHETIC CORRUPTION CONTROL. AVERAGED EASTERN COUNTRIES

	Corruption control	Synthetic Corruption control
Lag 5	3.251	3.423
Lag 4	3.153	3.335
Lag 3	3.065	3.251
Lag 2	2.991	3.171
Lag 1	2.934	3.097
Lead 0	2.896	3.031
Lead 1	2.879	2.972
Lead 2	2.887	2.924
Lead 3	2.922	2.885
Lead 4	2.988	2.859
Lead 5	3.086	2.845

Table A4
WEIGHTS OF THE DIFFERENT CONTROL UNITS (DONOR POOL) FOR SOUTHERN COUNTRIES

	Greece	Italy	Portugal	Spain
Bulgaria	0.000	0.000	0.000	0.000
Czech Republic	0.540	0.765	0.000	0.000
Denmark	0.031	0.000	0.000	0.000
Hungary	0.003	0.000	0.959	0.000
Poland	0.000	0.029	0.000	0.000
Romania	0.426	0.000	0.000	0.126
Sweden	0.000	0.000	0.000	0.000
United Kingdom	0.000	0.206	0.041	0.874

Table A5
PREDICTORS WEIGHTS FOR SOUTHERN COUNTRIES

	Greece	Italy	Portugal	Spain
Government Stability	0.0313	0.0716	0.0180	0.0055
Investment Profile	0.1666	0.2074	0.2715	0.3192
Democratic Accountability	0.0158	0.0015	0.0082	0.0351
Law and Order	0.1922	0.0208	0.5513	0.4960
Bureaucracy Quality	0.000	0.6132	0.0000	0.0000
Population	0.0901	0.0108	0.0545	0.0648
Female Labor Force	0.1078	0.0678	0.0035	0.0110
Secondary School	0.3403	0.0000	0.0633	0.0392
Trade	0.0076	0.0025	0.0030	0.0077
GDPpc	0.0479	0.0041	0.0264	0.0214

Table A6
WEIGHTS OF THE DIFFERENT CONTROL UNITS (DONOR POOL) FOR EASTERN COUNTRIES

	Slovakia	Slovenia	Estonia
Bulgaria	0.019	0.000	0.000
Czech Republic	0.000	0.000	0.000
Denmark	0.000	0.000	0.000
Hungary	0.791	0.746	0.780
Poland	0.000	0.000	0.000
Romania	0.190	0.000	0.000
Sweden	0.000	0.034	0.220
United Kingdom	0.000	0.219	0.000

Table A7
PREDICTORS WEIGHTS FOR EASTERN COUNTRIES

	Slovakia	Slovenia	Estonia
Government Stability	0.1712	0.0908	0.1093
Investment Profile	0.1693	0.1693	0.0896
Democratic Accountability	0.1228	0.0348	0.0533
Law and Order	0.06246	0.0000	0.0257
Bureaucracy Quality	0.2185	0.0855	0.0000
Population	0.1410	0.0677	0.0296
Female Labor Force	0.0098	0.0086	0.0377
Secondary School	0.0000	0.4046	0.3136
Trade	0.08303	0.0377	0.1013
GDPpc	0.02205	0.1009	0.2396

Table A8
WEIGHTS OF THE DIFFERENT CONTROL-CONTROL UNITS (DONOR POOL) FOR CORE COUNTRIES

	Austria	Belgium	Germany	Finland	France	Netherlands	Luxembourg
Bulgaria	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Czech Republic	0.044	0.000	0.000	0.000	0.000	0.000	0.000
Denmark	0.381	0.999	0.455	0.366	0.145	1.000	0.000
Hungary	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Poland	0.000	0.000	0.000	0.000	0.056	0.000	0.000
Romania	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sweden	0.298	0.000	0.000	0.616	0.000	0.000	0.000
United Kingdom	0.278	0.000	0.545	0.018	0.798	0.000	1.000

Table A9
PREDICTORS WEIGHTS FOR CORE COUNTRIES

	Austria	Belgium	Germany	Finland	France	Netherlands	Luxembourg
Government Stability	0.0165	0.0158	0.0439	0.0204	0.0163	0.0059	0.2335
Investment Profile	0.1883	0.1911	0.0792	0.2710	0.2540	0.1431	0.0381
Democratic Accountability	0.0294	0.0172	0.0093	0.0570	0.0035	0.0308	0.0161
Law and Order	0.4459	0.0000	0.3032	0.3986	0.5298	0.0000	0.0000
Bureaucracy Quality	0.0000	0.4896	0.0000	0.000	0.000	0.3038	0.2089
Population	0.0443	0.0044	0.0390	0.0499	0.0743	0.0043	0.0001
Female Labor Force	0.0085	0.0034	0.0229	0.0069	0.0032	0.0023	0.1208
Secondary School	0.1581	0.1728	0.3219	0.1459	0.0657	0.3624	0.1562
Trade	0.0178	0.0554	0.0329	0.0122	0.0069	0.0585	0.1009
GDPpc	0.0911	0.0501	0.1476	0.0377	0.0459	0.0887	0.1252

A.2. Sensitivity analysis

To perform a sensitivity analysis, we have recalculated the synthetic controls for the groups and countries using one or two less predictors. In the case of the average of the southern, eastern and central countries, we have eliminated two variables, one institutional (Law and Order) and one economic (GDPpc).

In the case of the one-to-one countries, we have dropped the predictor that had the highest weight in the original counterfactual construction. In the case of Portugal, it is the Law and Order variable, and in the case of Slovakia, the dropped variable is secondary school enrollment, as in the case of Germany. Finally, for the Netherlands analysis, the education variable was also left out of the counterfactual analysis.

The results are shown in Figures A1 to A7. As can be seen, the synthetic control fit worsens, as expected. However, the results obtained after the introduction of the euro do not contradict those obtained previously.

Figure A1
SENSITIVITY ANALYSIS.
SOUTHERN COUNTRIES: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING TWO LESS PREDICTORS

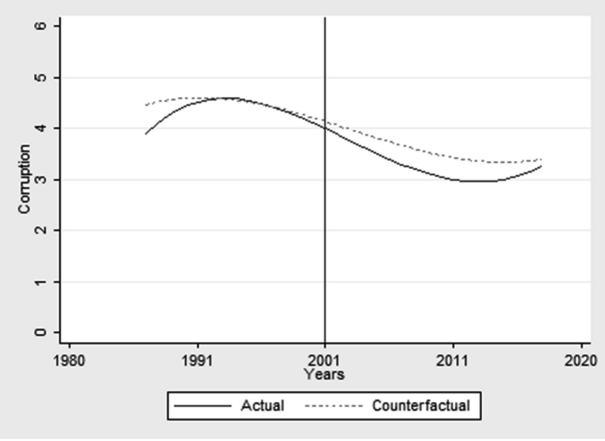


Figure A2
SENSITIVITY ANALYSIS.
EASTERN COUNTRIES: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING TWO LESS PREDICTORS

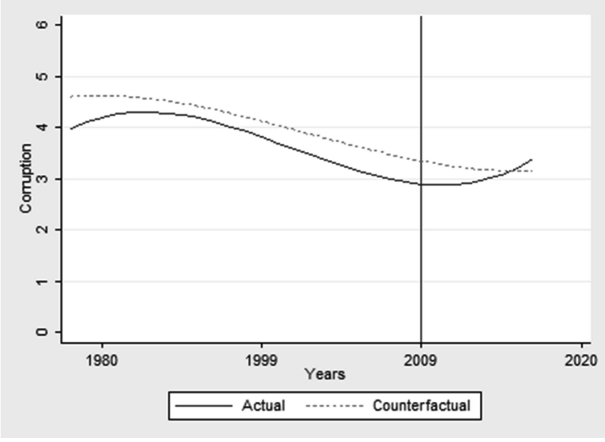


Figure A3
SENSITIVITY ANALYSIS.
CORE COUNTRIES: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING TWO LESS PREDICTORS

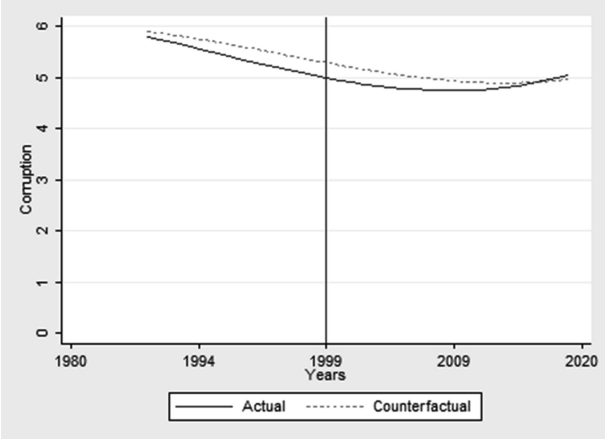


Figure A4
SENSITIVITY ANALYSIS.
PORTUGAL: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING ONE LESS PREDICTOR

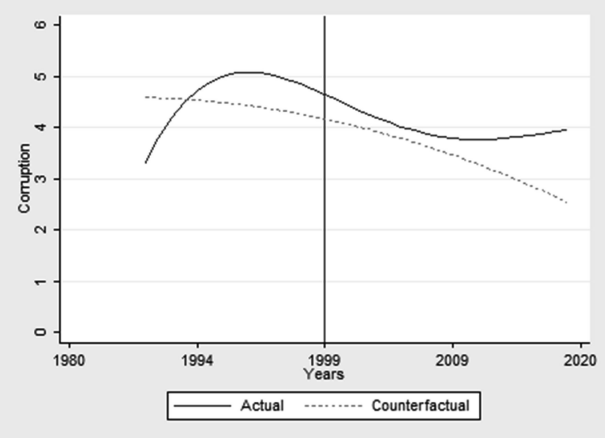


Figure A5
SENSITIVITY ANALYSIS.
SLOVAKIA: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING ONE LESS PREDICTOR

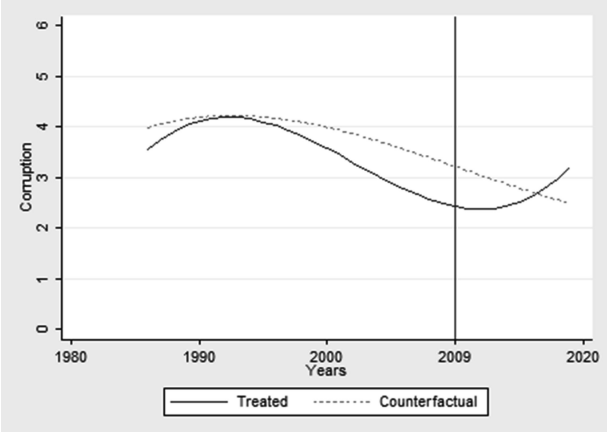


Figure A6
SENSITIVITY ANALYSIS.
GERMANY: ACTUAL CORRUPTION CONTROL VERSUS SYNTHETIC CORRUPTION CONTROL USING ONE LESS PREDICTOR

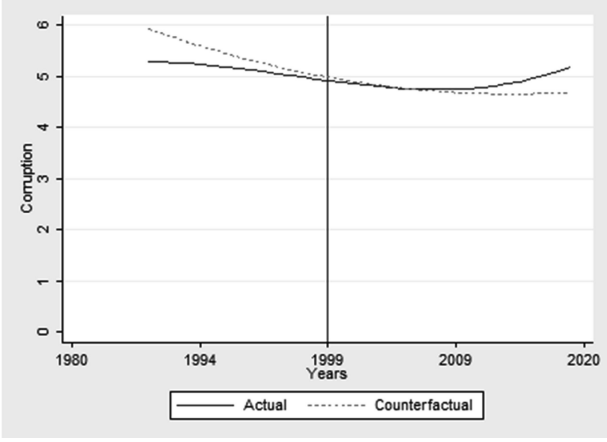
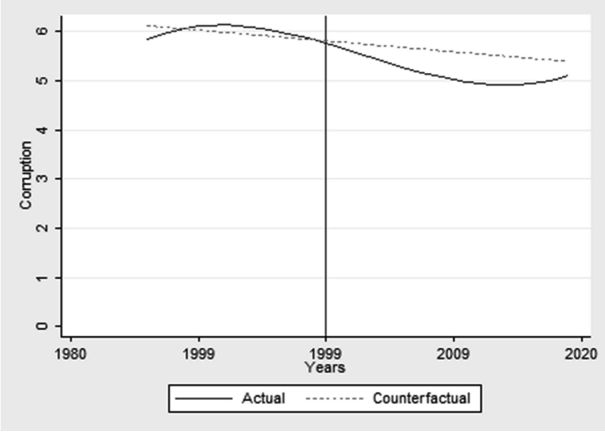


Figure A7
SENSITIVITY ANALYSIS.
THE NETHERLANDS: ACTUAL VERSUS SYNTHETIC CORRUPTION
CONTROL USING ONE LESS PREDICTOR



Notes

1. This database enjoys international prestige and is, according to Savoia and Sen (2015) the most widely used in the empirical literature, not only in economics, but also in other fields of knowledge. It is based on the rating of the world's leading experts and, in addition, it is the basis on which the Transparency International indicator is built. All this coupled with the methodology used, ensures that any effects detected are purely due to the implementation of the euro and, therefore, robust results.
2. We have also used the OECD countries as a donor group, but the results obtained do not improve on those obtained with the non-euro EU countries.
3. The institutional variables in our database follow a punctuated pattern that makes pre-event adjustment of the synthetic control difficult. The use of estimated trends allows us to avoid this problem without affecting the results, as these trends extract the underlying long-term evolution of our variables.
4. Data corresponding to these trends are available upon request.
5. Calculated as the average of the country's corruption trends adjusted for corruption indicator scores
6. Tax revenue decentralization index is derived from the IMF database.

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Resumen

En este trabajo aplicamos el Método de Control Sintético desarrollado por Abadie, Diamond y Hainmüeller (2010) para evaluar en qué medida la adopción del euro ha afectado a la corrupción en tres grupos de países de la eurozona: los del núcleo, los del sur y los del este. Para ello, construimos contrafactuales para cada grupo y para países individuales y los comparamos con la evolución real del indicador de control de la corrupción. Salvo en el caso de los Países Bajos, donde se detectan efectos negativos significativos, encontramos pruebas de que la adopción del euro ha contribuido a reducir la corrupción o no la ha afectado significativamente.

Palabras clave: corrupción, análisis contrafactual, Eurozona, Método de Control Sintético.

Clasificación JEL: F00, F50, P48.