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The Price of Euro: Evidence from Sovereign Debt Markets

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ABSTRACT

The objective of this paper is to figure out how the Economic and Monetary Union in Europe (EMU) has affected on its member's sovereign risk-premiums and long-term government bond yields. In order to estimate the effect, this paper utilizes synthetic control method. Contrary to the popular belief, this paper finds that the majority of member countries did not receive economic gains from EMU in sovereign debt markets. Synthetic counterfactual analysis finds strong evidence that Austria, Belgium, France, Germany and Netherlands have paid positive and substantial euro-premium in their 10-year government bonds since the adoption of single currency. After the latest financial crisis, government bond yields have been higher in all member countries compared to the situation that would have been without monetary unification. This paper concludes that from the sovereign borrowing viewpoint, it would be beneficial for a country to maintain its own currency and monetary policy.

JEL Classification: F34, E42, G15

Keywords: Synthetic Control Method, Monetary Union, Sovereign Risk, Government Bond Yield

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1. INTRODUCTION

After 15 years since its start, the costs and benefits of the Economic and Monetary Union in Europe (EMU) continue to be debated. There is a wide empirical literature that studies the effects of unification on international trade and capital market integration (see e.g. survey studies Baldwin 2006 and Lane 2006) and suggests that euro countries have gained in these fields. After the outbreak of Eurozone crises, the focus in political and academic debates has moved to the cons and costs from the monetary union. These potential costs arise from the fiscal free-riding problem that may courage politicians to increase debt to unsustainable levels, missing opportunity to guarantee government's solvency by printing money and restore the external competitiveness by devaluation.

This paper contributes to the existing literature from the sovereign debt market viewpoint. The aim is to offer empirical evidence of the EMU membership´s effect on the long-term government bond yields. Do euro sovereigns pay some premium for belonging to the monetary union? And how big is that premium? In order to estimate the effect, this paper utilizes an estimation approach that is recently implemented for comparative case studies, the synthetic control method, developed by Abadie and Gardeazabal (2003) and extended in Abadie, Diamond and Hainmueller (2010).

The main finding is that the majority of EMU countries have paid significant premiums since the adoption of single currency. After the latest financial crisis, government bond yields have been higher in all member countries compared to the situation that would have been without monetary unification.

Economist Intelligence Unit (2011) claim that if the euro area is treated as a single entity, its economic and fiscal position looks no worse and in some respects, rather better than that of the US or the UK. The budget deficit for the euro area as a whole is much lower and the euro area's government debt/GDP ratio of 86% in 2010 was about the same level as that of the United States. Numerous studies (see e.g. De Grauwe & Ji 2013) claim that during the current crisis many sovereign borrowers in Eurozone, especially the peripheral ones, have paid significant risk premiums that cannot be justified by fiscal or macroeconomic fundamentals.

This branch of literature suggests that these excess premiums arises from the investor sentiment, flight-to-safety (or liquidity) and speculations on the future of monetary union.

Traditionally, government bond yields are considered as risk-free rates in economies, which create direct relationships between sovereign risk, country risk, asset prices and investments. Borrowing costs are significant expenditure component in government´s budget. High yields weaken fiscal balance and might even increase default probability in a self-fulfilling manner. Taking into account these potential channels, it is clear that government bond yields have significant effect on the overall economy. Surprisingly, the existing studies tell us quite a little about the role of monetary union in sovereign debt pricing. This paper aims to fill this gap.

Under synthetic counterfactual approach, a weighted combination of potential control countries, the synthetic control, is constructed to approximate relevant characteristics of the country affected by the intervention. After the regime change (EMU membership) takes place in a specific country, the synthetic control method can be used to estimate the counterfactual situation of this country in the absence of the regime change by looking at the outcome trend of the synthetic control. The research question that this paper answers is: what would have been the 10-year government bond yield in Austria after 1999 if Austria had not become a member of the EMU in 1999? This paper answers similar questions for all countries that were the first adopters of euro in 1999.

Contrary to the popular belief, this paper claims that the majority of member countries did not receive economic gains from EMU in sovereign debt markets. Synthetic counterfactual analysis finds strong evidence that Austria, Belgium, France, Germany and Netherlands have paid positive and substantial euro-premium in their 10-year government bonds since the yearly 2000´s. In Italy and Spain, EMU membership lowered yields during the first decade. After the latest financial crisis, euro-premium turned positive for all member countries that were included to analysis.

The rest of the paper is organized as follows. Next section discusses the relationship between monetary unification and sovereign risk. Section 3 presents the synthetic control method. Section 4 estimates the effect of EMU on government bond yields and the last section concludes.

2. SOVEREIGN RISK AND THE EMU

There exists wide literature on sovereign yield spreads and country risk. This branch of literature suggests four major points for assessing the debt sustainability and sovereign risk of a country. In words of IMF (2002), these points are solvency, liquidity, sustainability and vulnerability. They can be defined in a following way:

Solvency; if the present value of current and future primary expenditure plus the stock of an initial debt is smaller or equal than the present value of current and future income. Liquidity; a country is illiquid if, regardless of whether it satisfies the solvency condition, its liquid assets and available financing are insufficient to meet or roll-over its maturing liabilities. Sustainability; a country debt is sustainable if it satisfies the solvency constraint without a major correction in the balance of income and expenditure given the costs of financing it faces in the market. Vulnerability; the risk that the solvency condition is violated and the country enters a crisis. In addition, investor faces exchange rate risk (foreign currency denominated debt), inflation risk (debt is in domestic currency) and liquidity (bid-ask-spread).

According to Lane (2006) the most immediate step toward financial unification was the swift integration of the euro-area bond market after the introduction of the single currency, yield differentials across member countries fell sharply and the volume of bond issues grew rapidly. Also the competition among financial intermediaries for underwriting and trading activities increased markedly, which led to a reduction in transactions costs, improved market access for higher-risk issuers and greater financial innovation.

[Figure 1]

The monetary union was thought to mean some kind of joint liability for the government debts. During the first decade of EMU, sovereign risk was equally priced for all member countries. Especially Southern-European countries gained from this development.

Maastricht Treaty was signed to prevent fiscal free riding problem and guarantee sustainable fiscal policy. Former high-inflation countries moved to new regime that highlighted price

stability. The common commitment for low inflation and sustainable debt levels among member countries prompted investors to demand lower risk premiums for euro-sovereigns.

Bernoth, Hagen and Schuknecht (2004) studied bond yield differentials among EU Eurobonds issued between 1991 and 2002 and concluded that interest differentials between bonds issued by EU countries and Germany or the USA contain risk premium which increase with the debt, deficit and debt-service ratio and depend positively on the issuer's relative bond market size. They also found that the liquidity risk premium is reduced with EMU membership, which points to an increase in financial market integration. Additionally, EMU members enjoyed a lower default risk premium than before, but this benefit declined with the size of public debt compared to Germany. Bernoth et al (2004) claim that this is consistent with the view that markets may anticipate fiscal support for EMU countries in financial distress.

In 2007 the financial crisis erupted and forced the western countries to save their domestic banking systems from collapse and to sustain their economies that experienced their sharpest postwar recession. As a result, government debt levels increase dramatically. In the aftermath of the financial crisis, government bond yields diverged in the Eurozone. It seemed that Germany gained from the safe-haven-status whereas substantial default-premium was born to other member countries. This development escalated to sovereign debt crisis and hit strongest to Portugal, Ireland, Greece and Spain.

According to De Grauwe and Ji (2013) after the latest financial crisis there was a significant break in the relationship between the spreads and the debt to GDP ratio in the Eurozone. Before the crisis the debt to GDP ratios have not affected the spreads and after 2008 this relationship became significant. This contrasts with the stand-alone countries where the financial crisis did not the relationship between spreads and debt to GDP ratios. De Grauwe and Ji (2013) claim that financial markets was not eager to impose more discipline on the stand-alone countries since the start of the financial crisis, while they became very eager to do so in the Eurozone.

De Grauwe (2011) develops a theory of the fragility of the Eurozone that aims to explain why the Eurozone countries are more prone to experience a sovereign debt crisis than countries

that are not part of a monetary union even when these countries experience a worse fiscal situation. According to the theory, the main reason is that members of monetary union issue debt in a currency over which they have no control. As a result the governments of these countries cannot guarantee that they have always cash to pay bondholders out at maturity. This is not the case in countries that issue debt in their own currency. These countries can guarantee to the bondholders that the cash will always be available. The reason is that if the government were to experience a shortage of liquidity it would call upon the central bank to provide the liquidity. And there is no limit to the capacity of a central bank to do so.

Monetary union might increase the default risk also from the viewpoint of long-term solvency and economic growth. If some EMU country loses its external competitiveness, the only way to restore it is the internal devaluation by lowering wages, which is slow and politically hard way. Stand-alone countries instead have ability to support exports by exchange rate devaluation. On the other hand, frequently devaluating countries with high inflation may receive reputational gains and stability from monetary union, if the new central bank is credibly committed to price stability and conservative monetary policy.

During the first decade of EMU, member countries received gains from unification on international trade and capital market integration (Baldwin 2006 and Lane 2006). Government bond yields converged, which is generally perceived to have reduced the borrowing costs of the euro sovereigns. In late 1990`s the level of average yield in 10-year government bonds converged between EMU and non-EMU OECD countries. After financial crisis, yields diverged and the average yield in Eurozone started to rise.

[Figure 2]

EMU was formed with heterogeneous group of countries from the viewpoint of economic and fiscal fundamentals. Also the sovereign yield spreads were substantial before the unification. From the adoption of the single currency to the Eurozone crisis, the sovereign risk was almost equally priced in these countries. Did all countries benefitted or was the effect different for different countries? An interesting and topical question is what the current situation would be in EMU countries if the monetary union was never established. Synthetic control method provides a way to create these counterfactual scenarios.

3. SYNTHETIC CONTROL METHOD

According to Abadie, Diamond, and Hainmueller (2012) (ADH henceforth), relative to small sample studies, the synthetic control method helps in the selection of comparison cases and opens the door to a method of quantitative inference. Relative to large sample regression-based studies, the synthetic control method avoids extrapolation biases and allows a more focused description and analysis of the similarities and differences between the case of interest and the comparison unit. This section shows how to construct synthetic control group. The presentation follows mainly the one in ADH.

Suppose that there is a sample of J + 1 units (countries) indexed by j, among whom unit j = 1 is the case of interest and units j = 2 to j = J + 1 are potential comparisons. Treated unit, j = 1, is the unit exposed to the event or intervention of interest (EMU membership), while units j = 2 to j = J + 1 constitute the donor pool (potential comparison units). Because comparison units are meant to approximate the counterfactual of the case of interest without the intervention, the donor pool should be restricted to units with outcomes that are thought to be driven by the same structural process as the unit representing the case of interest and that were not subject to structural shocks to the outcome variable during the sample period of the study.

Assume that sample is a balanced panel data set where all units are observed at the same time periods, t = 1,...,T. Assume also that the sample includes a positive number of pre-intervention periods, T_0, as well as a positive number of post-intervention periods, T_1, with $T = T_0 + T_1$. The goal of the study is to measure the effect of the event of interest on some post-intervention outcome. A synthetic control is defined as a weighted average of the units in the donor pool. That is, a synthetic control can be represented by a (J×1) vector of weights $W = (w_2, \dots, w_{J+1})'$, with $0 \leq w_j \leq 1$ for $j = 2,\dots,J$ and $w_2 + \cdots + w_{J+1} = 1$. These conditions guarantee the non-interpolation. Choosing a particular value for W is equivalent to choosing a synthetic control.

The value of W is selected so that the characteristics of the treated unit are best resembled by the characteristics of the synthetic control. X_1 is a (k × 1) vector containing the values of the pre-intervention characteristics of the treated unit that we aim to match as closely as possible

and X_0 is the k × J matrix collecting the values of the same variables for the units in the donor pool. The differences between the pre-intervention characteristics of the treated unit and a synthetic control is given by the vector $X_1 - X_0W$. Synthetic control, W*, is selected so that it minimizes the size of this difference. This can be done in the following manner. For *m=1,…,k,* X_{1m} is the value of the m-th variable for the treated unit and $X_{0m}$is a 1×J vector containing the values of the m-th variable for the units in the donor pool. W* is chosen as the value of W that minimizes:

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

where v_m is a weight that gives the relative importance that is assigned to the m-th variable when measuring the deviance between X_1 and X_0W. The usability of the method depends on that synthetic controls closely reproduce the values that variables with a large predictive power on the outcome of interest take for the unit affected by the intervention. Those variables should be assigned large weights.

The choice of v_m influences the mean square error of the estimator. An optimal choice of v_m assigns weights to linear combinations of the variables in X_{0m} and X_{1m} to minimize the mean square error of the synthetic control estimator. One possibility is to choose v_m such that the resulting synthetic control region approximates the trajectory of the outcome variable of the affected region in the pre-intervention periods. In Abadie and Gardeazabal (2003) V is chosen among positive definite and diagonal (k×k) matrices such that the mean squared prediction error of the outcome variable is minimized for the pre-intervention periods. Whereas Abadie, Diamond and Hainmuller (2010) suggest that alternatively, if the number of pre-intervention periods in the sample is large enough, it can be divided into an initial training period and a subsequent validation period. Given a V, W*(V) can be computed using data from the training period. Then, the matrix V can be chosen to minimize the mean squared prediction error produced by the weights W*(V) during the validation period.

Y_{jt} is the outcome of unit j at time t. In addition, Y_1 is a $(T_1 \times 1)$ vector collecting the post-intervention values of the outcome for the treated unit $(Y_1 = (Y_{1T_0+1}, \dots, Y_{1T})')$. Similarly, Y_0 is a $(T_1 \times J)$ matrix, where column j contains the post-intervention values of the outcome for unit j + 1. The synthetic control estimator of the treatment effect is given by the comparison

of post-intervention outcomes between the treated unit, which is exposed to the intervention, and the synthetic control, which is not exposed to the intervention, $Y_1 - Y_0 W^*$. That is, for a post-intervention period t (with $t \geq T_0$) the synthetic control estimator of the effect of the treatment is given by the comparison between the outcome for the treated unit and the outcome for the synthetic control at that period:

$$Y_{1t} - \sum_{j=2}^{J+1} W_j^* Y_{jt} \qquad (2)$$

The matching variables in X_1 and X_0 are meant to be predictors of post-intervention outcomes, which are themselves not affected by the intervention. Using a linear factor model, 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 controlling 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.

While panel models control only for confounding factors that are time invariant (fixed effect) or share a common trend (difference-in-differences), the synthetic control method allows the effect of unobservable confounding factors to vary with time. Although the synthetic control method can handle endogeneity due to time-varying omitted bias, it would still suffer from reverse causation. (Billmeier and Nannicini 2012)

The method requires two identification assumptions: the pre-treatment characteristic variables should not anticipate the intervention effects and the donor countries should not be affected by the intervention. If these assumptions fail, it is likely that the synthetic control method generates lower-bound or conservative estimate of the true effect of intervention.

ADH point out that the use of statistical inference in comparative case studies is difficult because of the small sample nature of the data, the absence of randomization, and because of the fact that probabilistic sampling is not employed to select sample units. These limitations complicate the application of traditional approaches to statistical inference. However, the synthetic control method enables to conduct falsification exercises, which are termed to placebo studies in the literature.

As in permutation tests, the synthetic control method can be applied to every potential control in the sample. This allows researcher to assess whether the effect estimated by the synthetic control for the region affected by the intervention is large relative to the effect estimated for a region chosen at random. This method is referred as unit-placebo. Another widely used falsification exercise is called in-time-placebo, where the synthetic control method is applied to dates when the intervention did not occur. This test is feasible if there are data for a sufficiently large number of time periods when no structural shocks to the outcome variable occurred.

Later on, it can be examined whether the estimated effect of the actual intervention is large relative to the distribution of the effects estimated for the countries not exposed to the intervention. This is informative inference if under the hypothesis of no intervention effect the estimated effect of the intervention is not expected to be abnormal relative to the distribution of the placebo effects.

4. ESTIMATING THE EFFECT OF EURO ON GOVERNMENT BOND YIELDS

4.1 Background

In 1988 Delors committee proposed three stages for the realization of EMU. The first stage began in July 1990 and called for the elimination of exchange controls and most restrictions on capital movement. It also promoted coordination of national economic policies and the intensification of central bank coordination among the member states. The Maastricht Treaty was signed in 1992 and the criteria for entry into last stage were set.

These convergence criteria concerned price and currency stability, budgetary discipline and interest rate convergence. More specifically the criteria were that, the average inflation rate should not exceed by more than 1.5% that of the three best-performing member states, the exchange rate should stay in normal fluctuation margins of the ERM for at least two years with no devaluations, the budget deficit should be less than 3% of GDP and a public debt ratio should not exceed 60% of GDP and the average nominal long-term interest rate should not exceed by more than 2% that of the three best performing member states.

During the second stage in 1994, the European Monetary Institute was established to monitor member states progress in convergence process and to prepare for the introduction of the European Central Bank (ECB) and the Euro. Member countries adopted the Stability and Growth Pact to further enforce the Maastricht Treaty`s budgetary rules. In 1995, Finland, Sweden and Austria joined to the European Union and signed the Maastricht Treaty. The UK and Denmark announced in 1992 and 1997, respectively, not to continue monetary unification.

In May 1998 the birth of euro and the member countries were officially announced. Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain constituted the monetary union and adopted single currency. Sweden and Greece did not meet the criteria at the time, but Greece joined the Eurozone later in 2001.

In 1999, third stage initiated the irrevocable fixing of exchange rates and the ECB took responsibility of conducting the monetary policy. Finally, the introduction of euro was completed in January 1 2002 with the cash changeover.

4.2 Data and Sample

I use annual country-level panel data for the period 1985-2011. The member countries of EMU were officially announced in 1998 and euro was adopted in 1999. In order to reduce the anticipation bias, 1998 is selected for the treatment period giving 13 years of pre-intervention data. Roughly decade-long post-treatment period seems like a reasonable limit on the span of plausible prediction of the effect. This period includes the main phases of the euro from the debt market viewpoint, the yield convergence and the burst of the Eurozone crisis.

The aim is to figure out how monetary unification has affected on the 10-year government bond yields in countries that were the first ones that adopted the single currency. These countries are Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. Luxembourg is dropped out from the analysis due to lack of data.

Recall that the synthetic EMU-countries are constructed as weighted average of potential control countries, with weights chosen so that resulting synthetic countries best reproduces

the values of a set of predictors of 10-year bond yield before 1998. Donor pool countries should be the ones that share the same relevant economic characteristics with EMU-countries and were not subject to structural shocks to the bond yield during the sample period. Donor pool is formed by 16 countries, namely Australia, Canada, Chile, Denmark, Japan, Mexico, New Zealand, Norway, Singapore, South-Africa, South-Korea, Sweden, Switzerland, Taiwan, UK and USA. These countries can be considered as industrialized and relatively developed.

The outcome variable of interest is the annual yield in 10-year government bond. Government bond with 10-year maturity is the most widely used benchmark and measure for the sovereign default risk in sovereign debt research literature. I include in X_1 and X_0 the values of predictors of government bond yield for EMU-countries and donor pool countries respectively. The predictor variables are budget deficit to gdp (gross domestic product), government gross debt to gdp, government receipts to gdp, government net interest payments to gdp, annual real gdp growth rate, annual inflation rate, liquidity and yield spread to libor. These predictors are widely used as explanatory variables for yields in market-discipline and sovereign yield spread studies (see e.g Alesina, De Broeck, Prati and Tabellini 1992, Laubach 2003, Bernoth et al 2004). Predictor variables are averaged over the 1985-1997. Dataset is collected from Reuters DataStream.

Due to lack of bid-ask spread data, liquidity is measured as the share of the issuers debt over the overall sovereign debt in EMU- and donor countries. This proxy is motivated by Gravelle (1999), who claims that the correlation between bid-ask spreads and the total supply of debt is significantly negative.

In order to test the robustness of the results, I do additional analysis where the outcome variable is the yield spread to USA in 10-year government bonds. This choice stems to the fact that American government bonds are traditionally considered as the safest assets in the world. Thus these bonds can be considered as a benchmark in sovereign risk pricing. In this analysis the annual change in exchange rate (domestic currency/USD) is added to the predictor list (and USA is dropped out from the donor pool).

Using the synthetic control method described in section 2, this paper constructs next the synthetic EMU-countries which mirror the values of the predictors of 10-year government

bond yields and yield spreads to USA in 10-year government bonds before the official announcement of the monetary union in 1998. Then the effect EMU on bond yields is estimated as the difference between actual countries and its synthetic controls in the years after the announcement. Last, a series of placebo and statistical tests confirm that the estimated effects for EMU countries are unusual large relative to the distribution of the estimates that are obtained when the same analysis is applied to the countries in donor pool.

4.3 Results

Figures 3 and 4 report the baseline results from the analysis based on the method and data described above. The series represented by the continuous line shows the actual yield (or yield spread to USA) of the country in question and a dashed line shows the estimated synthetic counterfactual. Table 1 reports the differences between the actual country and it's synthetic. Recall that the synthetic country represents the situation where the country in question did not become an EMU member in 1998. The difference between actual and synthetic represents the treatment effect of the monetary union.

Tables 4 and 5 report the predictor balance and unit (country) weights. Predictor balance presents the average pre-treatment predictor values for the synthetic and actual country. This illustrates the similarity of the actual and synthetic from the viewpoint economic and fiscal fundamentals. Big differences in predictor balance may tell about the uniqueness of the country (hardness mimic its characteristics with the combination of other countries) or the low predicative power of the predictor to the outcome variable. Unit weights present how the synthetic counterfactual is constructed, i.e. what are the weights of each donor country.

Figure 3 shows that the pre-treatment fit between synthetic and actual 10-year government bond yields is quite good for the majority of countries. In cases of Finland and Portugal, synthetic control mimics quite poorly the actual pre-treatment development. During the first two years after the official announcement of the single currency, actual yields are lower than the synthetic ones in all countries (except in France). After 2000, the difference between actual and synthetic yield is positive and increasing in Austria, Belgium, Germany and Netherlands. In France the difference is positive during the whole post-treatment period. In Southern-European countries, the difference is negative from 1998 to 2008 (Spain) and 2010 (Italy and Portugal), when it turns to be positive. There can be seen some anticipation in Italy

and Spain, where the actual yield lowered below the synthetic in 1996. In Ireland there is no significant difference before 2008 when the actual yield shoots up rapidly.

Table 1 presents the magnitudes of the differences. During the first years of EMU, the effects of monetary unification are heterogeneous. In 2001 differences between actual and synthetic 10-year government bond yields varies from 72 basis points (France) to -263 (Portugal). Ten years later, in 2011, the difference is positive for all countries and varies from 29 basis points (Finland) to 685 (Ireland). On average, Austria, Belgium, France, Germany, Ireland and Netherlands have paid 50 to 76 basis points premium for the EMU membership.

Figure 4 shows the results from the similar analysis where the outcome variable of interest the yield spread to USA in 10-year government bonds (difference between USA and EMU-country). As mentioned, in this analysis the annual change in exchange rate (domestic currency/USD) is added to the predictor list (and USA is dropped out from the donor pool). The results are quite similar and confirm the conclusions made above.

4.4 Inference

In order to evaluate the significance of the estimates, I study the possibility whether the obtained results could be driven entirely by chance. This exercise is based on placebo studies, (unit- and in-time-placebos) suggested by ADH. In addition, I do standard statistical tests (t-tests) to evaluate whether the mean differences between the actual and synthetic yields are equal in pre- and post-treatment periods.

The unit-placebo study is done by iteratively applying the synthetic control method to every country in donor pool (countries that did not join to EMU). In each iteration, the treatment is reassigned to one of the 16 control (donor) countries, shifting the EMU country in donor pool. The analysis is proceeded as if one of the countries in donor pool would have joined to EMU. This placebo study is done with every EMU country separately. If these placebo studies creates gaps of magnitude similar the ones estimated for EMU countries, then the interpretation is that this paper does not provide significant evidence of the effect EMU on government bond yields.

Table 3 shows the results of unit-placebo study for each EMU country. Countries are ranked by MSPE (mean squared prediction error) ratio that is the post-treatment MSPE divided by pre-treatment MSPE. This ratio illustrates how big the difference is between actual and synthetic after the treatment compared to difference before the treatment. For Austria, Belgium, France, Germany, Ireland and Netherlands the ratio is large compared to its placebo units. Note that in each placebo test Taiwan and Japan receives high MSPE ratios. This indicates that these countries might have been subject to some structural shocks that have affected on their bond yields during the sample period of the study (for example East-Asian financial crisis in late 90´s, Japanese banking crisis in 1999).

Table 6 reports the results from t-test that tests the equality of means of MSPE ratios between EMU- and non-EMU countries (placebo units). The hypothesis of equality of means is rejected at 1% level. Table 7 reports the results of non-parametric version from the test that rejects the hypothesis of equality at 5% level. These tests suggest that placebo studies do not create gaps of magnitude similar the ones estimated for EMU countries. We can conclude that EMU membership has, on average, statistically significant effect on 10-year government bond yields.

The in-time placebo study is conducted by rerunning the original analysis for the case when the official announcement of monetary unification is reassigned in the year 1993, five years earlier than the announcement actually occurred. Figures 5 and 6 display these studies for 10-year government bond yields and yield spreads to USA. The average pre-intervention fit between actual and synthetic yields and yield spreads is lower than in original analysis. For the most of countries the fit is still reasonably good. More importantly, the actual yields and synthetic counterparts do not diverge considerably during the 1993-1997 period. In contrast to the actual 1998 monetary unification, this 1993 placebo has no perceivable effects.

Placebo studies support the conclusion that EMU membership has affected on government bond yields. In order to evaluate the significance of the estimates for individual countries, I do t-test for the equality of pre- and post-treatment mean differences between the actual and synthetic for each EMU country. This test is done for both 10-year government bond yield and yield spread to USA. The mean difference is quite conservative estimate for the treatment effect. If the effect turns its direction during the sample period, averaging demeans the magnitude and significance of estimator. Hence, the equality of pre- and post-MSPEs is also

tested. MSPE is more robust measure for the treatment effect, but the information on the average sign and magnitude of the effect is harder to interpret. The results are reported in table 2.

At 5% significance level, t-test rejects the hypothesis of equality of pre- and post-treatment means for Austria, Belgium, France, Germany, Italy and Netherlands. For others countries, results are mixed or insignificant. In a case of Finland, mean MSPE for 10-year government bond is highly significant since the fit between actual synthetic yields is much better in pre-treatment than in pre-treatment period. Spain`s mean MSPEs are significant at 10% level for both yield and spread but mean yield and mean spread are not. This might be due to fact that Spain`s actual yield was below the synthetic and climbed above after 2008. In addition, there seems to be some anticipation that might lower the statistical significance of Spain`s estimator.

5. CONCLUSIONS

The objective of this paper is to figure out how the EMU has affected on its member's sovereign risk-premiums and long-term government bond yields. The estimation of this effect is based on the synthetic control method.

This paper offers strong evidence for positive and substantial euro-premium in 10-year government bonds of Austria, Belgium, France, Germany and Netherlands. Synthetic counterfactual analysis supports the general understanding that during first years EMU membership lowered yields in Southern-European countries. After the latest financial crisis, euro-premium has turned to positive in all member countries that were analyzed.

This paper claims that euro has not benefitted its members in sovereign debt markets. Investors perceive monetary union as a factor that increases sovereign risk. Positive euro-premium has been priced to the majority of member countries, clearly before the current Eurozone crisis, since the adoption of single currency.

From the sovereign borrowing viewpoint, it would be beneficial for a country to maintain own currency and monetary policy. However, existing literature suggest that monetary unification may benefit countries in other fields (trade, capital market integration, resource

allocation). The net effect of the EMU to overall economic development is still an open question.

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Figure 1. 10-year government bond yields in the Eurozone, 1985-2011

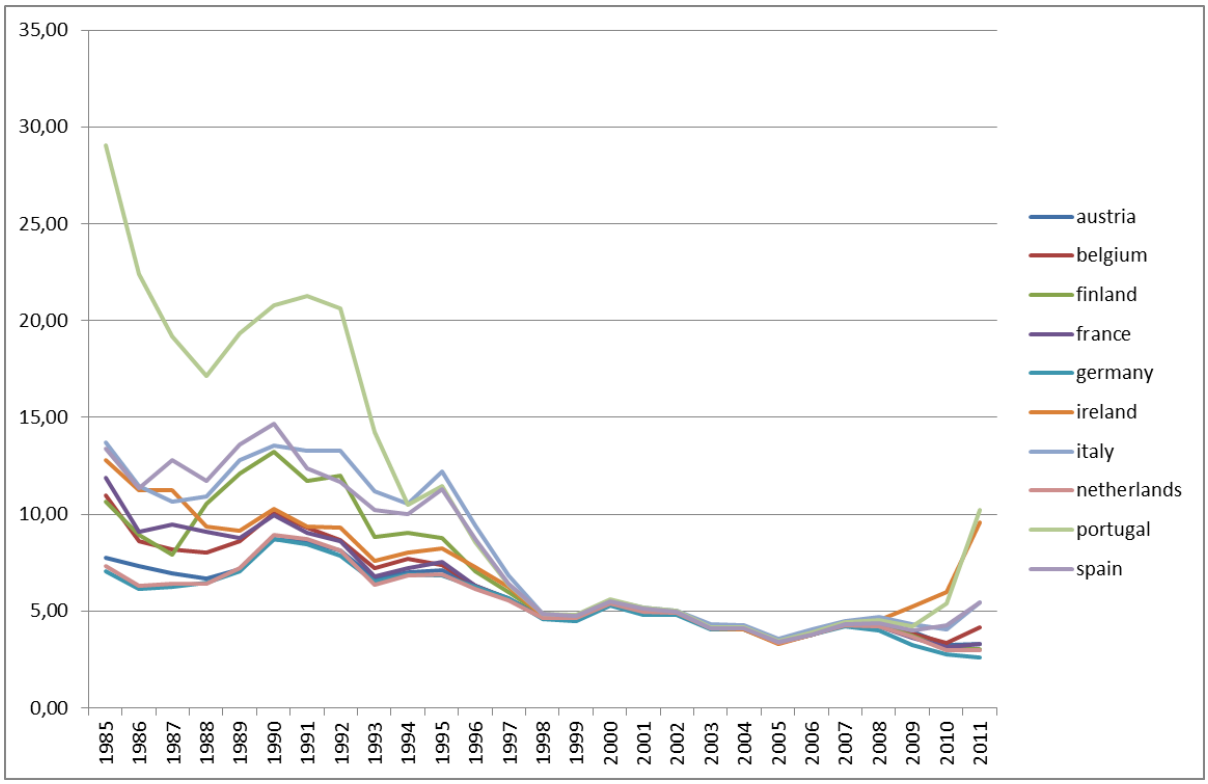

Figure 2. 10-year government bond yield EMU and OECD (non-EMU) average, 1985-2011

Figure 3. 10-year government bond yields, actual and synthetic

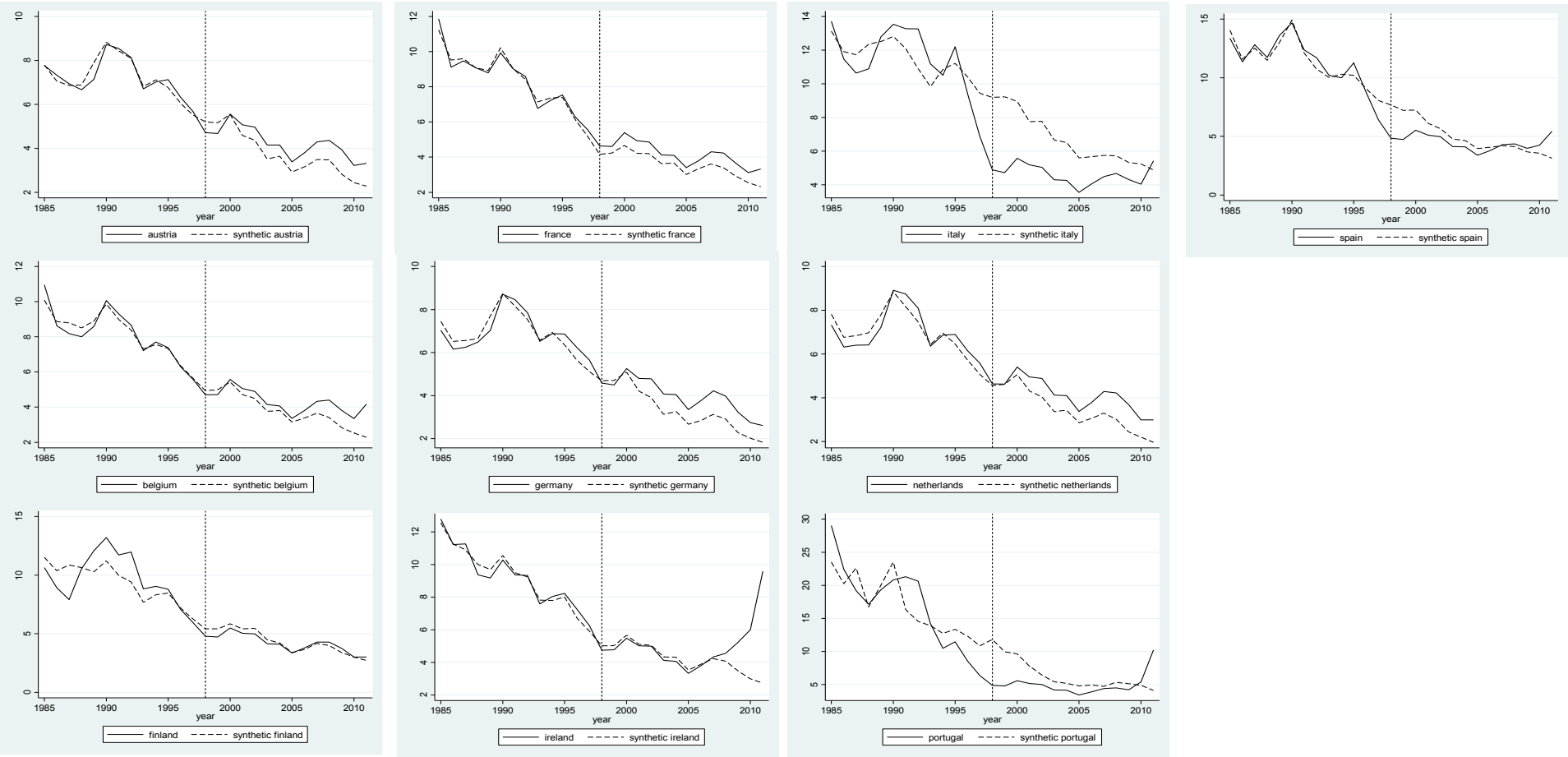

Figure 4. Yield spread to USA in 10-year government bonds, actual and synthetic

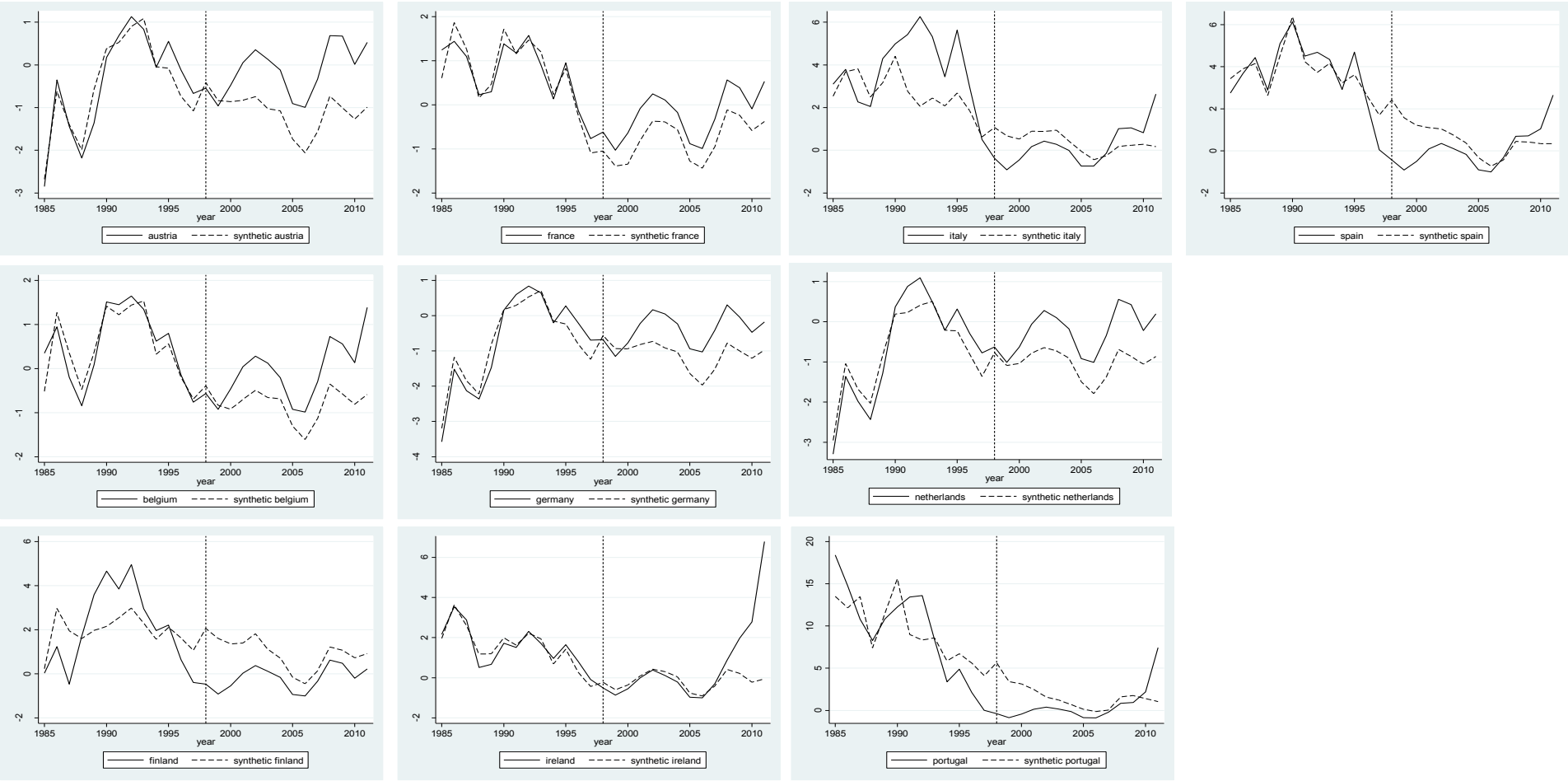

Figure 5. Placebo in-time, 10-year government bond yield

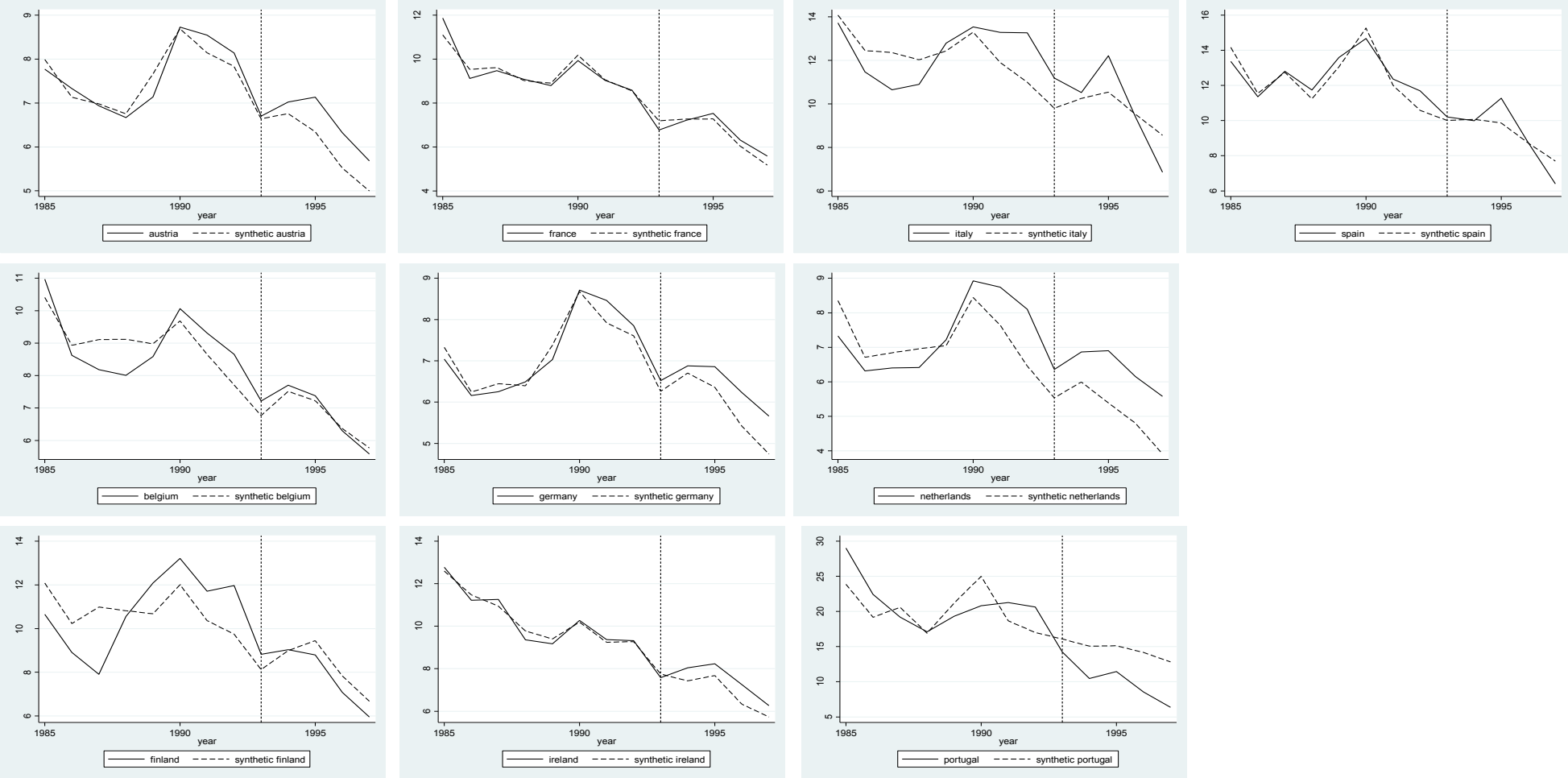

Figure 6. Placebo in-time, yield spread to USA in 10-year government bonds

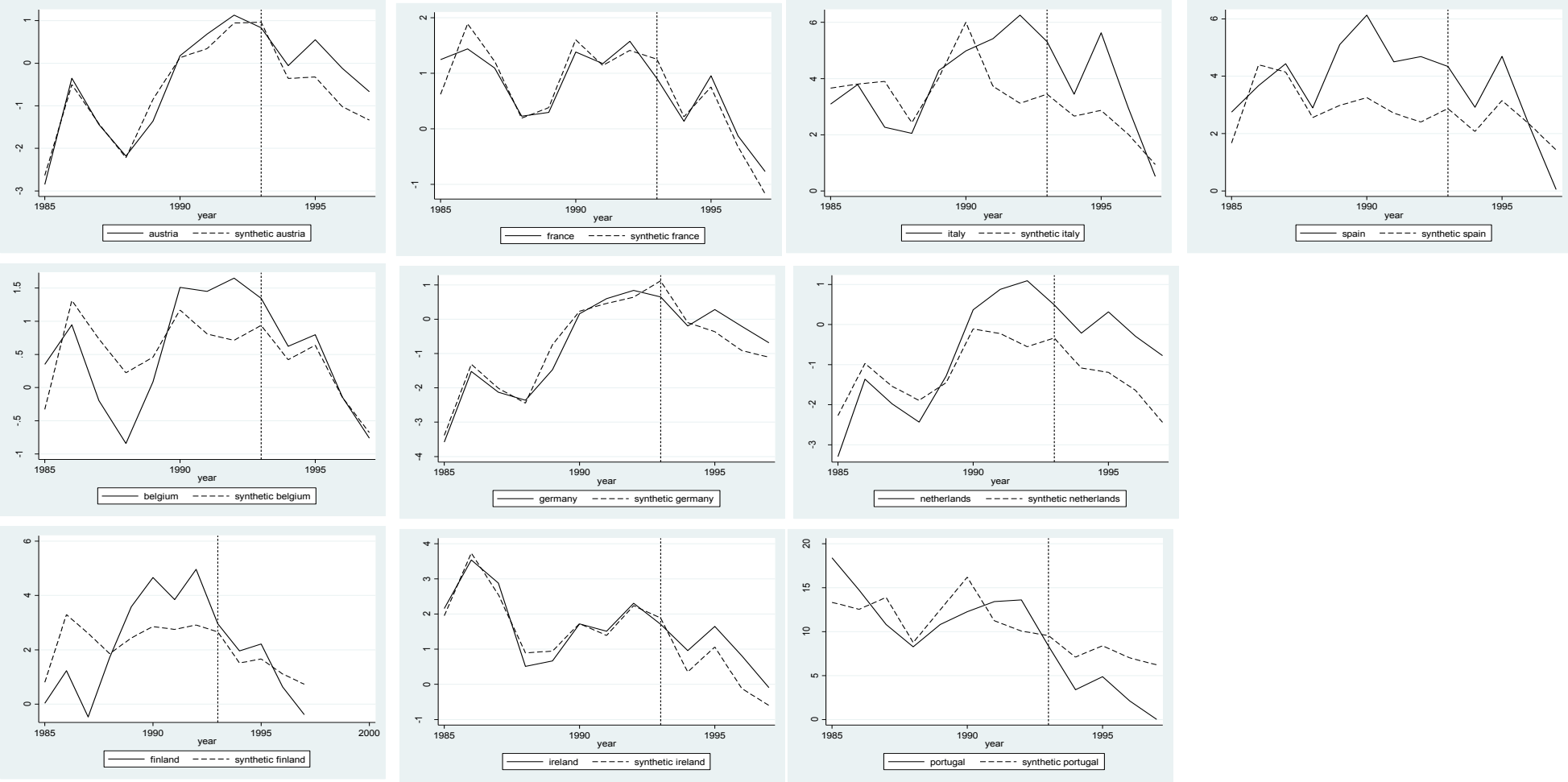

Table 1. Post-EMU differences between actual country and synthetic

Country	10-year government bond yield				yield spread to USA in 10-year government bonds			
	Average 1998-2011	2001	2006	2011	Average 1998-2011	2001	2006	2011
Austria	0,499	0,486	0,641	1,039	0,947	0,883	1,070	1,518
Belgium	0,499	0,355	0,425	1,889	0,711	0,742	0,626	1,976
Finland	-0,128	-0,362	0,121	0,285	-1,162	-1,375	-0,553	-0,698
France	0,615	0,720	0,453	1,001	0,519	0,692	0,411	0,850
Germany	0,661	0,584	0,921	0,782	0,683	0,610	0,944	0,800
Ireland	0,757	-0,090	-0,095	6,853	0,565	-0,219	-0,204	6,641
Italy	-2,126	-2,561	-1,619	0,541	-2,115	-2,549	-1,612	0,552
Netherlands	0,702	0,644	0,723	1,023	0,761	0,718	0,781	1,064
Portugal	-1,453	-2,628	-1,024	6,126	-1,117	-2,346	-0,737	6,400
Spain	-0,510	-1,008	-0,280	2,309	-0,510	-1,008	-0,280	2,309

Table 2. T-test for the equality of pre- and post EMU mean differences (between actual and synthetic)

Country		10-year government bond yield				yield spread to USA in 10-year government bonds			
		mean dif	std error	mspe mean	std error	mean dif	std error	mspe mean	std error
Austria	pre	-0.002770	0.080298	773.8165	444.0322	0.049978	0.109627	1467.154	548.7788
	post	0.499464	0.133410	4808.429	944.3430	0.947424	0.148512	11843.38	2252.748
	t-test	-3.164340	***	-3.769440	***	-4.800774	***	-4.323558	***
Belgium	pre	-0.000703	0.107436	1385.100	611.1319	0.013590	0.103294	1282.213	560.9923
	post	0.499309	0.148577	5362.866	2499.425	0.710635	0.141703	7660.372	2634.749
	t-test	-2.690953	**	-1.493604		-3.923472	***	-2.285420	**
Finland	pre	0.342499	0.429890	23349.71	7583.106	0.143402	0.414951	20867.74	6054.205
	post	-0.128144	0.093194	1293.284	391.7048	-1.161519	0.187905	18081.34	5745.974
	t-test	1.107910		3.018384	***	2.936109	***	0.334023	
France	pre	-0.004216	0.081409	795.4691	306.8963	-0.005311	0.080165	771.4453	335.9571
	post	0.615228	0.049028	4097.539	650.2717	0.519083	0.043030	2935.178	477.6548
	t-test	-6.629289	***	-4.477531	***	-5.881784	***	-3.652738	***
Germany	pre	0.013942	0.112362	1516.969	404.6786	0.058575	0.109281	1467.395	417.7955
	post	0.660992	0.112066	6001.753	1049.810	0.682847	0.111855	6289.292	1088.079
	t-test	-4.071928	***	-3.871565	***	-3.982840	***	-4.017947	***
Ireland	pre	0.016928	0.099397	1188.437	350.8533	-0.009080	0.095698	1099.797	333.4208
	post	0.756553	0.532471	42582.05	33495.99	0.564726	0.532473	40047.69	31359.99
	t-test	-1.317081		-1.189072		-1.022883		-1.195020	
Italy	pre	0.042115	0.374991	16891.93	5755.225	0.056008	0.374869	16894.56	5735.416
	post	-2.126412	0.363250	62369.83	17076.51	-2.114557	0.362455	61792.08	16927.45
	t-test	4.152784	***	-2.446328	**	4.162088	***	-2.435222	**
Netherlands	pre	-0.002214	0.130526	2044.494	359.4486	0.100877	0.123543	1933.305	431.3098
	post	0.701678	0.099873	6220.228	1312.111	0.761274	0.097341	7027.171	1370.500
	t-test	-4.320380	***	-2.968335	***	-4.231012	***	-3.433705	***
Portugal	pre	0.016617	1.010868	122625.2	33946.88	-0.057349	0.934055	104727.9	25430.56
	post	-1.453093	0.797383	103771.4	42384.65	-1.116805	0.752265	86039.81	37017.18
	t-test	1.150238		0.343823		0.889445		0.409905	
Spain	pre	0.010580	0.198621	4735.145	2122.599	0.010580	0.198621	4735.145	2122.599
	post	-0.510323	0.349198	18456.44	7239.414	-0.510323	0.349198	18456.44	7239.414
	t-test	1.270064		-1.760115	*	1.270064		-1.760115	*

Inference: singnificant at *** 1⁄ level, ** 5⁄ level and * 10⁄ level.

Table 3. Unit placebo, 10-year government bond yield

Austria	MSPE ratio
austria	**5,577361**
australia	1,766072
canada	2,50309
chile	0,029769
denmark	1,744308
japan	3,347185
mexico	0,011062
new zealand	1,96604
norway	0,408576
singapore	1,580732
southafrica	1,154849
southkorea	0,272006
sweden	2,175948
switzerland	0,496525
taiwan	4,976197
uk	3,861468
usa	0,367905

Belgium	MSPE ratio
taiwan	4,821775
belgium	**4,311422**
japan	3,347185
uk	2,725026
sweden	2,178907
canada	2,109667
new zealand	2,067491
usa	1,687303
singapore	1,580732
denmark	1,570295
southafrica	1,479049
australia	1,250427
norway	0,566319
switzerland	0,496525
southkorea	0,272006
chile	0,029769
mexico	0,011062

Finland	MSPE ratio
taiwan	4,97619737
japan	3,34718468
canada	2,52392125
uk	2,40858005
new zealand	1,97725848
singapore	1,58073244
sweden	1,25681307
norway	0,90568605
southafrica	0,66687496
australia	0,63240243
switzerland	0,49652517
usa	0,45130745
denmark	0,35376373
southkorea	0,27438144
finland	**0,04940667**
chile	0,02976948
mexico	0,01106243

France	MSPE ratio
taiwan	4,976197
france	**4,661879**
japan	3,347185
uk	2,563709
sweden	2,230683
new zealand	1,984802
australia	1,936188
singapore	1,580732
southafrica	1,214053
usa	0,628415
norway	0,589688
canada	0,580014
switzerland	0,496525
denmark	0,281585
southkorea	0,272006
chile	0,029769
mexico	0,011062

Germany	MSPE ratio
taiwan	6,477265
germany	**4,55314**
japan	3,347185
uk	2,70432
sweden	2,178534
australia	2,079043
new zealand	1,745994
singapore	1,580732
canada	1,506562
usa	0,839795
southafrica	0,818163
norway	0,561892
denmark	0,329337
southkorea	0,272006
switzerland	0,199326
chile	0,029769
mexico	0,011062

Ireland	MSPE ratio
ireland	**39,76567**
denmark	26,26176
taiwan	3,525766
japan	3,347185
uk	2,680655
australia	2,609982
singapore	1,580732
new zealand	1,015188
usa	0,939959
southafrica	0,6833
canada	0,615205
norway	0,566319
switzerland	0,496525
southkorea	0,268569
sweden	0,036379
chile	0,029769
mexico	0,011062

Italy	MSPE ratio
taiwan	4,97619737
japan	3,34718468
southafrica	2,49594443
sweden	2,10644102
australia	2,0979722
italy	**1,82446167**
new zealand	1,7592299
singapore	1,58073244
uk	1,55406949
denmark	1,39926756
canada	1,37461255
usa	0,82379762
norway	0,56906453
switzerland	0,49652517
southkorea	0,27200642
chile	0,02976948
mexico	0,01106243

Netherlands	MSPE ratio
taiwan	6,401374
netherlands	**3,518642**
uk	3,468375
canada	3,39041
japan	3,347185
new zealand	1,967253
usa	1,874772
australia	1,771093
singapore	1,580732
denmark	1,328996
southafrica	0,650632
norway	0,424913
southkorea	0,270743
switzerland	0,189477
sweden	0,115701
chile	0,029769
mexico	0,011062

Portugal	MSPE ratio
taiwan	4,976197
japan	3,347185
uk	2,685849
new zealand	2,337084
canada	1,983507
australia	1,912498
singapore	1,580732
sweden	1,423106
southafrica	1,091133
denmark	0,798475
portugal	**0,503922**
switzerland	0,496525
norway	0,424913
usa	0,35987
southkorea	0,272006
chile	0,094254
mexico	0,011062

Spain	MSPE ratio
taiwan	4,778455
japan	3,347185
australia	2,593927
uk	2,037558
new zealand	1,96604
southafrica	1,952884
singapore	1,580732
canada	1,379944
spain	**1,339676**
switzerland	0,496525
norway	0,424913
usa	0,419832
denmark	0,413501
southkorea	0,274381
sweden	0,051026
chile	0,029769
mexico	0,011062

Table 4. Predictor balance and unit weights, 10-year government bond

Austria

	Treated	Synthetic
debt	69,375	42,415
deficit	-3,702	-2,025
gdpgr	2,172	2,171
inflation	2,357	3,446
liquidity	0,975	0,983
dif_libor	-2,326	-2,323
receipts	50,351	31,658
payments	2,928	1,601

Unit	Weight
australia	0
canada	0,113
chile	0
denmark	0,079
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0,086
south-korea	0
sweden	0
switzerland	0,485
taiwan	0,237
uk	0
usa	0

Belgium

	Treated	Synthetic
debt	129,115	62,977
deficit	-6,846	-2,712
gdpgr	2,074	2,495
inflation	2,595	2,595
liquidity	2,201	2,196
dif_libor	-1,368	-1,367
receipts	47,077	40,326
payments	9,537	3,005

Unit	Weight
australia	0
canada	0,355
chile	0
denmark	0,296
japan	0,024
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,129
taiwan	0,196
uk	0
usa	0

Finland

	Treated	Synthetic
debt	33,302	45,763
deficit	-0,466	-0,450
gdpgr	1,702	2,210
inflation	3,542	3,992
liquidity	0,256	0,719
dif_libor	0,179	-0,173
receipts	53,977	49,202
payments	-0,546	0,161

Unit	Weight
australia	0
canada	0
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0,331
singapore	0
south-africa	0,039
south-korea	0
sweden	0,395
switzerland	0,123
taiwan	0,113
uk	0
usa	0

France

	Treated	Synthetic
debt	46,821	72,366
deficit	-3,684	-1,974
gdpgr	1,618	1,967
inflation	2,591	2,622
liquidity	4,654	5,302
dif_libor	-1,158	-1,154
receipts	48,419	48,007
payments	2,395	2,954

Unit	Weight
australia	0
canada	0,177
chile	0
denmark	0,387
japan	0,252
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0,184
switzerland	0
taiwan	0
uk	0
usa	0

Germany

	Treated	Synthetic
debt	44,155	44,872
deficit	-4,188	-2,684
gdpgr	2,018	2,850
inflation	2,195	2,542
liquidity	6,480	1,536
dif_libor	-2,633	-2,647
receipts	44,085	31,368
payments	2,669	1,645

Unit	Weight
australia	0
canada	0,296
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,369
taiwan	0,335
uk	0
usa	0

Ireland

	Treated	Synthetic
debt	96,838	80,312
deficit	3,332	-1,701
gdpgr	5,724	1,974
inflation	2,895	2,689
liquidity	0,372	1,552
dif_libor	-0,328	-0,335
receipts	41,127	51,255
payments	7,070	4,171

Unit	Weight
australia	0
canada	0,227
chile	0
denmark	0,73
japan	0
mexico	0
new zealand	0
norway	0
singapore	0,042
south-africa	0
south-korea	0
sweden	0
switzerland	0
taiwan	0
uk	0
usa	0

Italy

	Treated	Synthetic
debt	107,031	68,983
deficit	-10,022	-4,623
gdpgr	2,109	0,533
inflation	5,854	6,856
liquidity	7,684	2,599
dif_libor	1,953	1,911
receipts	42,178	34,417
payments	9,597	4,748

Unit	Weight
australia	0
canada	0,615
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0,385
south-korea	0
sweden	0
switzerland	0
taiwan	0
uk	0
usa	0

Netherlands

	Treated	Synthetic
debt	88,058	53,395
deficit	-6,965	-2,860
gdpgr	2,339	2,340
inflation	1,465	2,513
liquidity	2,294	2,289
dif_libor	-2,544	-2,542
receipts	50,624	33,541
payments	4,363	2,139

Unit	Weight
australia	0
canada	0,4
chile	0
denmark	0
japan	0,023
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,355
taiwan	0,222
uk	0
usa	0

Portugal

	Treated	Synthetic
debt	59,868	58,069
deficit	-6,002	-0,208
gdpgr	3,618	3,610
inflation	10,231	10,218
liquidity	0,329	0,601
dif_libor	7,430	7,413
receipts	34,378	34,484
payments	5,228	3,681

Unit	Weight
australia	0
canada	0,038
chile	0,326
denmark	0,296
japan	0
mexico	0,054
new zealand	0
norway	0
singapore	0,218
south-africa	0,068
south-korea	0
sweden	0
switzerland	0
taiwan	0
uk	0
usa	0

Spain

	Treated	Synthetic
debt	56,498	56,474
deficit	-5,933	-3,411
gdpgr	2,712	2,715
inflation	6,033	5,434
liquidity	1,861	1,895
dif_libor	1,835	1,825
receipts	37,520	37,517
payments	3,347	2,930

Unit	Weight
australia	0
canada	0,391
chile	0,091
denmark	0
japan	0
mexico	0,006
new zealand	0
norway	0
singapore	0
south-africa	0,076
south-korea	0
sweden	0,204
switzerland	0
taiwan	0,232
uk	0
usa	0

Table 5. Predictor balance and unit weight, yield spread to USA

Austria

	Treated	Synthetic
debt	69,375	40,907
deficit	-3,702	-2,330
gdpgr	2,172	3,332
inflation	2,357	2,564
liquidity	0,975	1,054
dif_libor	-2,326	-2,378
receipts	50,351	32,266
payments	2,928	1,483
exchange	-3,806	-2,093

Unit	Weight
australia	0
canada	0,157
chile	0
denmark	0,128
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,304
taiwan	0,412
uk	0

Belgium

	Treated	Synthetic
debt	129,115	53,046
deficit	-6,846	-2,403
gdpgr	2,074	3,236
inflation	2,595	2,665
liquidity	2,201	3,361
dif_libor	-1,368	-1,382
receipts	47,077	38,817
payments	9,537	2,457
exchange	-3,689	-2,356

Unit	Weight
australia	0
canada	0,137
chile	0
denmark	0,309
japan	0,125
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,028
taiwan	0,266
uk	0,135

Finland

	Treated	Synthetic
debt	33,302	34,055
deficit	-0,466	-0,506
gdpgr	1,702	1,836
inflation	3,542	5,407
liquidity	0,256	0,448
dif_libor	0,179	0,034
receipts	53,977	35,973
payments	-0,546	0,614
exchange	-1,124	0,572

Unit	Weight
australia	0
canada	0
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0,338
singapore	0
south-africa	0,249
south-korea	0
sweden	0
switzerland	0,281
taiwan	0,133
uk	0

France

	Treated	Synthetic
debt	46,821	64,132
deficit	-3,684	-1,242
gdpgr	1,618	1,755
inflation	2,591	3,208
liquidity	4,654	4,640
dif_libor	-1,158	-1,153
receipts	48,419	47,221
payments	2,395	2,327
exchange	-3,104	-2,708

Unit	Weight
australia	0
canada	0
chile	0
denmark	0,299
japan	0,247
mexico	0
new zealand	0,068
norway	0
singapore	0
south-africa	0,025
south-korea	0
sweden	0,262
switzerland	0,099
taiwan	0
uk	0

Germany

	Treated	Synthetic
debt	44,155	44,105
deficit	-4,188	-2,632
gdpgr	2,018	2,858
inflation	2,195	2,536
liquidity	6,480	1,489
dif_libor	-2,633	-2,690
receipts	44,085	31,169
payments	2,669	1,586
exchange	-3,812	-1,756

Unit	Weight
australia	0
canada	0,282
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,379
taiwan	0,338
uk	0

Ireland

	Treated	Synthetic
debt	96,838	77,307
deficit	3,332	-0,989
gdpgr	5,724	2,175
inflation	2,895	3,187
liquidity	0,372	1,018
dif_libor	-0,328	-0,321
receipts	41,127	50,047
payments	7,070	3,960
exchange	-2,580	-2,490

Unit	Weight
australia	0
canada	0,077
chile	0
denmark	0,756
japan	0
mexico	0
new zealand	0
norway	0
singapore	0,12
south-africa	0,048
south-korea	0
sweden	0
switzerland	0
taiwan	0
uk	0

Italy

	Treated	Synthetic
debt	107,031	69,077
deficit	-10,022	-4,624
gdpgr	2,109	0,538
inflation	5,854	6,834
liquidity	7,684	2,606
dif_libor	1,953	1,897
receipts	42,178	34,455
payments	9,597	4,747
exchange	-0,240	3,675

Unit	Weight
australia	0
canada	0,617
chile	0
denmark	0
japan	0
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0,383
south-korea	0
sweden	0
switzerland	0
taiwan	0
uk	0

Netherlands

	Treated	Synthetic
debt	88,058	52,157
deficit	-6,965	-2,757
gdpgr	2,339	2,365
inflation	1,465	2,496
liquidity	2,294	2,319
dif_libor	-2,544	-2,647
receipts	50,624	33,259
payments	4,363	2,025
exchange	-3,828	-1,681

Unit	Weight
australia	0
canada	0,372
chile	0
denmark	0
japan	0,031
mexico	0
new zealand	0
norway	0
singapore	0
south-africa	0
south-korea	0
sweden	0
switzerland	0,372
taiwan	0,226
uk	0

Portugal

	Treated	Synthetic
debt	59,868	58,755
deficit	-6,002	-0,575
gdpgr	3,618	3,374
inflation	10,231	8,791
liquidity	0,329	0,626
dif_libor	7,430	7,489
receipts	34,378	41,486
payments	5,228	3,929
exchange	1,381	2,581

Unit	Weight
australia	0
canada	0
chile	0,338
denmark	0,575
japan	0
mexico	0,032
new zealand	0
norway	0
singapore	0,024
south-africa	0
south-korea	0
sweden	0
switzerland	0
taiwan	0,018
uk	0,012

Spain

	Treated	Synthetic
debt	56,498	56,474
deficit	-5,933	-3,411
gdpgr	2,712	2,715
inflation	6,033	5,434
liquidity	1,861	1,895
dif_libor	1,835	1,825
receipts	37,520	37,517
payments	3,347	2,930
exchange	-0,720	1,588

Unit	Weight
australia	0
canada	0,391
chile	0,091
denmark	0
japan	0
mexico	0,006
new zealand	0
norway	0
singapore	0
south-africa	0,076
south-korea	0
sweden	0,204
switzerland	0
taiwan	0,232
uk	0

Table 6. Test for equality of means of MSPE, EMU countries and placebo units

EMU	Count	Mean	Std. Dev.	Std. Err. of Mean
0	160	1.650551	2.400366	0.189766
1	10	6.610558	11.80505	3.733086
All	170	1.942316	3.769936	0.289141

	df	Value	Probability
t-test	168	-4.233574	0.0000

Table 7. Test for equality of medians of MSPE , EMU countries and placebo units

EMU	Count	Median	> Overall Median	Mean Rank	Mean Score
0	160	1.351804	78	83.16250	-0.049109
1	10	3.915032	7	122.9000	0.855285
All	170	1.389606	85	85.50000	0.004090

	Value	Probability
Wilcoxon/Mann-Whitney	2.473564	0.0134

The **Aboa Centre for Economics (ACE)** is a joint initiative of the economics departments of the Turku School of Economics at the University of Turku and the School of Business and Economics at Åbo Akademi University. ACE was founded in 1998. The aim of the Centre is to coordinate research and education related to economics.

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