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ABSTRACT

We examine the impact of the ECB's Securities Market Program (SMP) and the ECB's two Covered Bond Purchase Programs (CBPPs) on sovereign bond spreads and covered-bond prices, respectively, for five euro-area stressed countries -- Greece, Ireland, Italy, Portugal, and Spain. Our data are monthly and cover the period from 2004M01 through 2014M07. In contrast to previous studies, we use actual, confidential, intervention data. Our results indicate that the respective asset purchase programs reduced sovereign spreads and raised covered bond prices. The quantitative effects of the programs were modest in magnitude, but nevertheless significant. We also provide a simple theoretical model that explains why official asset purchases can reduce a country's default-risk spreads.

Keywords: Monetary-policy effectiveness, ECB's asset purchase programs, euro-area crisis.
JEL Classification: E43, E51, E52, E63, F33, F41, G01, G12

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1. Introduction

In response to the global financial crisis, which erupted in 2007 with the failure of the U.S. subprime market and then intensified in September 2008 with the collapse of Lehman Brothers, and the euro-area's sovereign debt crisis which broke-out in late-2009 and early-2010, the ECB's Governing Council adopted a number of non-standard measures to support financial conditions and credit flows to the euro-area economy over-and-above what could be achieved through reductions in key interest rates. Among those measures were two asset purchase programs -- a Covered Bond Purchase Program (CBPP) and a Securities Market Purchase Program (SMP).[3] The CBPP was comprised of two sub-programs -- a CBPP1 and a CBPP2. Under the CBPP1, the ECB committed to purchasing a total of € 60 billion during the period from June 2009 to June 2010.[4] Under the CBPP2 the targeted amount of purchases was € 40 billion during the period from November 2011 to October 2012. A primary aim of the CBPP was to revive the covered-bond market, which is a primary source of funding for banks in the euro area, by promoting a decline in money market term rates and easing funding conditions for credit institutions and enterprises. The SMP was launched in May 2010 as a response to the drying up of some secondary markets for government bonds. The aim of the SMP was to improve the functioning of the monetary-policy transmission mechanism by providing depth and liquidity in segments of the sovereign-bond market that had become dysfunctional.

We investigate the impacts of the two CBPPs and the SMP on prices on euro-area covered bonds and spreads on sovereigns bonds, respectively, for five stressed euro-area countries -- Greece, Ireland, Italy, Portugal and Spain. Our data are monthly and cover the period from 2004M01 through 2014M07. Our approach differs from the approaches undertaken in previous work in several ways. First, in contrast to many previous studies, which largely focused on global risk factors in the determination of spreads, we use fundamental economic variables of the countries under

[3] These asset purchase programs were part of the ECB's overall response to the two crises. For detailed review of the ECB's responses, see Cour-Thimann and Winkler (2013).

[4] The € 60 billion represented around 2.5 per cent of the total of the outstanding amount of covered bonds denominated in euro and issued in the euro area.

consideration to control for the effects of other factors that affect spreads, beyond those of the asset purchase programs. Second, in light of the effects of rating downgrades on spreads during the euro crisis, we introduce a measure of rating downgrades in our specifications. Third, whereas previous studies typically used dummy variables in an attempt to capture the effects of the asset purchase programs, we use the actual amounts of covered bonds and sovereigns purchased under the programs. These data are confidential, but were made available to us for use in this study by the ECB. The use of these actual intervention data allows us to shed light on the accuracy of previous findings that have relied on dummy variables.

The remainder of this study is comprised of four sections. Section 2 provides a brief literature review. Section 3 provides a simple theoretical framework that explains why official asset purchases can affect a country's default-risk spreads. Section 4 first presents some details about the particular asset purchase programs. The section then describes our data and our modeling approach, and presents our empirical findings. As mentioned, we use actual intervention data to capture the effects of the asset purchase programs. We also present results using dummy variables as a way of comparing our findings with those of previous studies. Section 5 concludes.

2. Literature Review

With interest rates close to, or at, their lower bound in the years following the outbreak of the global financial crisis, major central banks increasingly resorted to non-standard monetary-policy measures. Reflecting the prevalence of these non-standard measures, a literature has emerged that examines their effectiveness. In this connection, work by Peersman (2011) used a SVAR to examine the impact of non-standard measures on economic activity in the euro area. That author represented non-standard measures by using innovations to bank lending caused by monetary policy; these innovations were orthogonal to the policy rate. The author found that non-standard measures had an impact on economic activity similar to that of conventional monetary policy operating through the interest-rate channel.

Gambacorta, Hofmann and Peersman (2014) performed a similar analysis on a panel of eight industrial economies -- Canada, the euro area, Japan, Norway, Switzerland, Sweden, the United Kingdom, and the United States. They found that non-standard measures had an impact on economic activity for each of the counties considered, with the size of the impact depending on the country. Individual country results suggested that there were no major differences in the macroeconomic effects of unconventional monetary policies across countries, despite the heterogeneity of the measures that were taken.

Another line of research has focused on the impact of non-standard measures on yields in financial markets -- a line of research that we pursue in this study. Szczerbowicz (2012) examined the effects of a range of euro-area non-standard policies -- including the SMP, the CBPP1, the CBPP2 -- on euro-area covered-bond spreads and sovereign spreads. Using daily data from July 2007 to September 2012, the author used an event-based regression methodology under which dummies were used for each announcement of non-standard measures. Szczerbowicz found that the SMP reduced 10-year sovereign spreads by an average of 17 basis points for the euro area, with the impact on the five crisis countries ranging from 476 basis points in the case of Greece to 35 basis points for Italy. Eser and Schwaab (2013) focused on the SMP purchases over the period October 2008 to December 2011 (daily frequency). Along with the purchases made under the SMP, they also included two measures of global risk aversion (the US VIX Volatility Index and the change in the spread between AAA and BBB-rated corporate bonds). Their evidence showed that the SMP reduced both spreads and the volatility of spreads. Specifically, a € 1 billion purchase of sovereign bonds was associated with a fall in spreads of around 1-2 basis points in Italy to 17-21 basis points in Greece. Ghysels, Idier, Manganelli and Vergote (2014) and Rivolta (2014) obtained similar results.

Studies that focus on specific euro-area countries include Doran, Dunne, Monks and O'Reilly (2013), who examined the impact of the SMP on Irish sovereign yields, Casiraghi, Gaiotti, Rodano and Secchi (2013) who assessed the impact of the SMP, OMT and LTROs on the Italian economy, and Gibson, Hall and Tavlas (2014), who examined the determinants of Greek sovereign spreads. Doran, Dunne, Monks and O'Reilly found little evidence that SMP purchases had a significant effect on daily yields once the announcement effects were controlled for. They found that SMP effects are very visible when they are analysed using an intraday event-based methodology. Overall, they found substantial announcement effects and strong evidence that SMP interventions, on-average, halted declines in bond prices (rises in yields); the policy was, therefore, effective if the main objective of the SMP were interpreted as passive containment. In a study of the effects of the SMP and the OMT on Italian spreads, Casiraghi, Gaiotti, Rodano and Secchi (2013) provided evidence showing that the SMP and OMT operated to counteract increases in spreads; every € 1 billion of purchases reduced Italian spreads by between 2 and 5 basis points. Gibson, Hall and Tavlas (2014) found a small negative effect on Greek spreads from the SMP. They used monthly data on spreads,[5] which allowed them to control for the macroeconomic environment, something that previous researchers did not do. Since spreads were rising during the operation of the SMP, because of deteriorating fundamentals and continuous downgrades, it was difficult to isolate the impact of the SMP itself if the other factors affecting spreads are not included. The authors captured the SMP effect by using a dummy variable that took a value of 1 during the period (May 2010 to January 2011) when the Eurosystem was purchasing Greek bonds. They found that the SMP reduced the 10-year spread by about 300 basis points.

Turning to studies dealing with the effects of the CBPPs, Beirne *et al.* (2011) examined the effects of the CBPP1 on euro-area covered-bond yields using a cointegration framework. For control variables, the authors used the five-year overnight indexed euro swap rate and the spread between the U.K. covered-bond yield and the five-year Libor euro swap. In common with other studies, the authors used a zero-one dummy to capture the effect of the asset purchase program. The results showed that the CBPP had a dampening effect on euro-area covered-bond

[5] Studies that use daily data cannot assess the effects of the fundamentals.

yields of approximately 12 basis points. Szczerbowicz (2012) obtained similar results. That author found that the covered-bond programs reduced spreads by an average of 17 basis points, with the impact ranging from 36 basis points for Greece to 7 basis points for both Ireland and Portugal.

3. Theoretical considerations

The basic idea underlying our empirical framework is the following: the cost of defaulting on debt held by official creditors is greater than the cost of defaulting against debt held by private creditors. Why should this be the case? Dellas and Niepelt (2013) argue that is because the official creditors have larger enforcement powers than do private creditors. They construct a model in which default-risk premia are a function -- not only of the outstanding size of sovereign debt -- but also its composition between private and official creditors. If Greece, for example, defaults against debt held by private creditors, that country will surely suffer costs -- for example, exclusion from credit markets for a period of time and the inability to obtain credit to finance imports. If, however, Greece defaults against official (euro-area) creditors, the costs would likely be even greater. The costs could include exclusion from the euro area, or even exclusion from the European Union. Since the official creditors possess larger enforcement powers (because they can impose higher costs on the borrower), they are able to lend at lower rates than can the private lenders. Now assume that the quantity of Greek government debt is fixed and that an official creditor (the ECB) intervenes in the secondary market, purchasing Greek debt. Therefore, what changes is the identity of the holders of debt as private investors sell to an official holder. Since it is assumed (realistically) that the official holder has greater enforcement powers over the Greek government than does the private sector, the official sector can afford to hold Greek debt obligations at lower interest rates than the private sector. As a result, the change in the composition of debt resulting from official-sector intervention leads to a decline in interest-rate spreads on Greek debt.

The discussion has so far assumed that the level of government debt is fixed and that purchases by the official sector in the secondary market change the composition of the holders of the debt, resulting in a reduction of default risk. In early 2012, the Greek government defaulted on debt held by the private sector. Yet, in 2014 the Greek government was able to sell debt in the primary market to private creditors at much-lower interest rates than it could have a few years earlier. Why was the Greek government able to do so despite having defaulted on its debt in 2012? One reason is because the debt sold by the Greek government after 2012 contains *pari passu* clauses under which default against one class of creditors leads to default against all classes of creditors; that is, under *pari passu* all creditors are treated equally.[6] Consequently, private creditors were willing to purchase Greek government debt in the primary market in 2014 at reduced interest rates because the creditors benefitted from the indirect protection afforded by the involvement of the official sector (with its higher enforcement powers). In other words, when the ECB stepped in, it made default less likely for all holders of Greek government debt.

4. The effectiveness of the programs

To examine the effects of the SMP, and the CBPP1 and CBPP2 on sovereign bond spreads and covered-bond prices, respectively, we use monthly data. For the SMP, our empirical framework includes the effects of fundamental economic variables and rating agencies on spreads. The use of monthly data allows us to control for fundamentals and the behavior of ratings agencies.[7] For the CBPP1 and CBPP2, we use time-series estimation for reasons that we explain below. In contrast to previous studies, for both programs we use actual purchases rather than a zero-one dummy. The inclusion of actual purchases is important because the volumes of official purchases exhibited high volatility and varied significantly among countries. Some

[6] The new bonds issued by Greece after the 2012 default included *pari passu* clauses and were subject to a “co-financing” agreement that created a symmetry in servicing debt to the new bondholders and to the EFSF.
[7] The use of higher frequency data would preclude the use of many economic fundamental variables.

descriptive statistics on the purchases made under both purchase programs are presented in Annex 1.

4.1. Program descriptions

Table 1 provides some details about the programs. The SMP was announced on 10 May 2010 as part of a series of measures designed to address severe tensions in financial markets in the stressed countries that were causing those markets to malfunction, inhibiting the monetary transmission mechanism. The program initially focused on the purchase of Greek, Irish and Portuguese government bonds; from August 2011, Spanish and Italian government bonds were also purchased. The impact of the program should thus have been felt most in sovereign debt markets in the stressed countries, causing the prices of sovereigns in these countries to rise and, thus, spreads (over the German bund) to fall. Soon after the program had been announced, however, strong misgivings and opposition from within the ECB's Governing Council began to surface. In particular, the then-President of the Bundesbank, Axel Weber, publically criticized the program. When the program was expanded in August 2011, Jürgen Stark, a (German) member of the ECB's Executive Board at that time, publically stated that he was opposed; in early September 2011 he announced that he would resign from the Executive Board, effective later that year, citing his objection to the SMP. Such opposition to the program, especially since it came from members of the Governing Council who were from the euro-area's largest economy, may have affected its effectiveness. That opposition gave rise to press reports at the time which questioned the commitment of the Governing Council to the continuation of the SMP. Indeed, it is important to recall that the Irish bond market and the Portuguese bond market collapsed in November 2010 and April 2011, respectively, while the SMP was in operation. The collapse of the bond markets in those countries forced both Ireland and Portugal to seek official adjustment programs.

As noted above, the first CBPP was also designed to improve market functioning and, hence, the monetary policy transmission mechanism. The aim of the CBPPs was not only to improve market liquidity in covered-bond markets, but also to ease funding conditions for both banks and non-financial corporations, thereby encouraging banks to lend. Potential combined purchases under the two CBPPs amounted to € 100 billion; while the first program achieved its targeted purchases of € 60 billion, the second fell short, as less than € 17 billion of the € 40 billion available under the program was used.

4.2. Econometric Approach

Unlike previous studies, to examine the effects of the SMP we do not aim to find a 'best' equation to explain yield spreads or covered-bond prices. Instead, our objective is to investigate the question of the effectiveness of the 'unconventional monetary policy' pursued by the ECB. Specifically, we estimate several models in a panel data context; the panel is comprised of data for the countries in the euro area that have been most affected by the crises -- Spain, Italy, Ireland, Portugal and Greece. We believe that this approach is more informative and robust than the standard approach of reporting the results of the best-fitting model, which may have been chosen to support a particular conclusion.

Most of the panel-data models are based on a two-way fixed-effect framework; the framework includes both country fixed effects and time fixed effects. We believe that this is an important aspect of this study. One major problem in modeling the effects of ECB asset purchases is that spreads may be affected by important latent variables, which are difficult to capture. These latent variables include such factors as market sentiment. In normal circumstances, these latent variables could lead to serious omitted-variable problems and, thus, to misleading inferences about the impact of the non-conventional programs. The two-way fixed-effects model is able to account for many of these unobservable variables.

The basic model takes the following form

$$y_{it} = \beta_i + \gamma_t + \delta x_{it} + \omega_{it} \tag{7}$$

where y_{it} is our dependent variable, that is the sovereign bond spread for country i against Germany for period t, β_i is the country fixed effect, γ_t is the time fixed effect, x_{it} is a vector of (weakly) exogenous variables, δ is a pooled parameter on these variables, and ω_{it} is the error term. The time dummies can capture anything that is common across all countries in our sample, but changes over time.[8] In this way, we can capture general market sentiment and uncertainty. The country fixed effects can capture features that are specific to individual countries, but which do not change over time -- for example, culture, climate, location, etc. By also including additional variables, such as economic fundamentals and the behavior of ratings agencies, within this framework, we aim to minimize the omitted-variable problem. That is, we seek a robust range of results in order to address the issue of the effectiveness of the non-conventional policies.[9]

A fixed effects panel model is particularly important in this context since the SMP was applied for a limited number of months in each country; it was only active for a total of 6 months in Italy, 6 months in Spain, 9 months in Greece, 14 months in Ireland and 18 months in Portugal. Undertaking an analysis of a specific country would, therefore, stretch the limits of the information that we could reasonably expect to derive from the data. The pooled model allows us to combine observations, thereby obtaining a reasonably-large sample of months during which the SMP was in operation.

The impact of the CBPPs, under which the purchases were smaller in size than the SMP (see Table 1), needs to be assessed against an index of the price of covered bonds at the euro-area level. That is, the dependent variable was available only for the euro area as a whole. Consequently, the impact of the two CBPPs could not be

[8] An example is the general financial environment or the political situation in the euro area.
[9] Although not a formal application, this approach is clearly in the spirit of Leamer's (2008) extreme bounds analysis.

assessed at the country level. For this reason, we could not conduct panel estimates as under our SMP analysis. In order to compensate for the loss of richness, we used an ARMA model to investigate the impact of the CBPPs. The CBPPs were aimed at longer-term covered bond maturities; hence, their direct impact would have been felt at those longer maturities. However, the programs could also have had spillover effects to other maturities. Hence, we present results for two sets of maturities. Specifically, we focus on an index that captures maturities in excess of 10 years and an index that covers all maturities. (See Annex 2 for the specific indices used).

Our modeling approach is as follows. For the SMP, we begin by estimating several specifications that aim to capture its effects on spreads. We first estimate two autoregressive models -- one in levels form and the other in first-differences -- of spreads. Next, we estimate a model in which spreads are determined by fundamental variables. To that specification, we then add a variable that accounts for the effects of ratings by the rating agencies. In each of those specifications, we assess the independent effects of the SMP. Then, we turn to the effects of the two CBPPs. As mentioned, in this case, the empirical methodology involves the estimation of ARMA specifications.

4.3. Empirical results: SMP

Figure 1 plots sovereign spreads for Greece, Ireland, Italy, Portugal and Spain along with the dates of the SMPs. It is not clear from the figure that the SMP reduced spreads; indeed, quite the opposite seems to be the case as spreads rose almost continuously while the SMP was in operation. To investigate this issue further, we now present the results of a more formal analysis.

Table 2 provides the results from equations for both the level of spreads (Panel A) and the change (Panel B) in spreads regressed on lagged levels and lagged changes in spreads, respectively, and the actual amounts purchased under the SMP. The number of lags included is determined empirically; the way to think of this model is as a simple autoregressive model, based on the Wold decomposition, which captures all the regular behavior in spreads. This specification allows us to capture any unusual behavior during the SMP periods. The results, based on the pooling of the data from the five countries considered, and the inclusion of fixed effects and time dummies, suggest that the SMP had a negative impact effect on spreads. This result holds for both the levels and first-differences specifications. For example, under the levels specification, although the coefficients on the SMP are significant, they are small – a € 1 billion purchase in period *t* causes spreads to fall in the next period by only 3.34 basis points, a result which is consistent with the results obtained by Casiraghi, Gaiotti, Rodano, and Secchi (2013), as mentioned in Section 2 above.

As also mentioned above, the country and time fixed effects are important for absorbing the biases caused by omitted variables. To demonstrate, we carried out a series of *single country* estimates for the same form of dynamic equation as reported in Table 2.[10] Our estimated coefficient for the five countries ranged from 0.000013 to 0.000062 -- all positive (the wrong sign) and highly insignificant. This result is not surprising as spreads were rising at the time the SMP was implemented for each country; the individual country estimates captured this simple correlation. The use of the country and time fixed effects allowed us to partial out the effects of omitted factors so that we could obtain more sensible estimates of the effectiveness of the SMP.

We would expect that, assuming a reasonably-efficient financial market, the effect of an asset purchase programme would be instantaneous. Indeed, it is even possible that if the ECB exploited announcement effects (which it did not) the effect could even occur before the actual asset purchases. It is striking, therefore, that in both the results reported in Table 2, and those reported below, it is the first lag of the SMP variable that has the most powerful and significant effect. This finding is very robust. The finding does not, however, mean that the market is inefficient. The reason that we find a significant lagged effect reflects the construction of the data.

[10] These results are not reported, but are available from the authors.

Our data for spreads are based on monthly average interest rates, that is, the average daily rate for each month as a whole. We do not know the precise time or times of the month during which the SMP intervention took place. If, on average, the SMP purchases took place, say, in the middle of the month, the program would not have affected interest rates in the first half of the month; thus, its effect on the entire month would reflect (at most) half of its true value. If the intervention took place towards the end of the month, there would be virtually no effect on the monthly average for the month and the only effect would appear in the following month. That is, by using the lagged value we are able to capture the full effect of the intervention during the preceding month, whether that intervention took place in the early part of the month or in the latter part of the month. Although it is quite plausible that with the use of monthly data the main empirical effect from the SMP should appear with a one-month delay, we would stress that this result contains no implications for the efficient working of the market.

Next, we focus on the long-term relationship between spreads and their fundamental determinants; specifically, we omit lagged spreads as regressors, but we add fundamental variables to our specification. We continue to include both fixed effects and time dummies. In what follows, we first describe the fundamentals used and then we discuss their impact on spreads.

The fundamental variables used are as follows.[11] The fiscal condition of the countries is captured by two variables -- fiscal news and the general government debt-to-GDP ratio. The use of the government debt-to-GDP ratio is conventional in empirical work; everything else held constant, a rise in the ratio should increase spreads. The use of fiscal news (or fiscal surprise) variable is somewhat novel, however, and so we will describe it in some detail. Specifically, in order to capture the news (or surprise) element, we construct real-time fiscal data. Using the European Commission spring and autumn forecasts, we created a series of forecast revisions. We defined the

[11] The selection of these particular fundamentals is based on Gibson, Hall and Tavlas (2012; 2014; 2015).

revision in the spring 2001 forecasts, for example, as the 2001 deficit/GDP ratio in the spring compared to the forecast for 2001 made in the autumn of 2000. This procedure allows us to generate a series of revisions which, when cumulated over time, provides a cumulative fiscal news variable. If the fiscal deficit turns out to be higher than had been expected, spreads should rise; therefore, this variable should have a negative sign. Two other economic fundamentals were also used -- real economic growth, and competitiveness. Higher economic growth, as measured by the growth of real GDP, should improve debt sustainability and, therefore, is expected to reduce spreads. A deterioration in competitiveness, measured by the log of each country's price level relative to that of Germany, should reduce debt sustainability and, therefore, cause spreads to rise. Finally, we included a variable capturing political stability constructed by the IFO World Economic Survey. A rise in the index indicates greater stability in the country concerned; a rise should therefore reduce spreads. Annex 2 provides details on the definitions of the variables.

The main results, reported in Table 3, are as follows. (i) The sign of the fiscal news variable is negative, as expected, but it is not significant. (ii) An increase in the government debt-to-GDP ratio causes spreads to rise and the effect is significant. (iii) Higher real economic growth reduces spreads, as expected, but the impact is not significant, suggesting there is no independent role for growth beyond its impact on the debt-to-GDP ratio. (iv) A deterioration of competitiveness, represented by a rise in relative prices (that is, the log of the price level in each country relative to that of Germany), causes spreads to rise, and the effect is significant. (v) An increase in political stability -- a rise in the IFO index -- has, as expected, a negative impact on spreads, and the coefficient is significant. The coefficients on the present period and lagged SMP variable are both negative and significant (at the 10 per cent level). A €1 billion purchase lowers spreads (on average) by 22 basis points (14 basis points if we omit the present period form which, as mentioned, is significant at the 10 per cent level).

Next, we examine the SMP on spreads in a fundamentals' specification that includes the effects of sovereign ratings. In Table 4 (Panel A), we present results for spreads that include the residuals from an equation explaining ratings (Panel B). Our procedure is as follows. First, we relate sovereign ratings to the fundamentals – both economic and political – and the SMP purchases. As is evident in Panel B, ratings are related to fundamentals – the debt-to-GDP ratio, relative prices and political uncertainty. It also appears that the SMP helped to improve ratings (a rise in the rating represents a deterioration in ratings). We take the residuals from that equation and add them to the specification for spreads used in Table 3 to determine the impact of the SMP after controlling for any direct influence on spreads from ratings, purged of the effect of fundamentals. With the inclusion of the ratings variable, the macroeconomic fundamentals and the measure of political uncertainty retain their significance. In addition, however, ratings play a role in determining the level of spreads. A downgrade, even when the fundamentals are unchanged, causes spreads to rise. A one-point downgrade leads to a rise in spreads of 130 basis points. The effect can be characterised as large since it occurs in an environment in which the fundamentals are unchanged. In the equation with ratings, the impact of the SMP remains negative and significant. The size of the effect is the same as that reported in Table 3, which excludes the ratings variable; a € 1 billion purchase under the SMP lowers spreads by 22 basis points.

Finally, we examine the impact on sovereign spreads of the statement by ECB President, Mario Draghi, on 26 July 2012 that the ECB would "do whatever it takes" to preserve the euro. To capture that effect, we include a dummy variable which takes a value of 1 from August 2012 onwards. The results are presented in Table 5. The dummy has a significant, negative impact on spreads. Indeed, the coefficient suggests that the statement reduced spreads by just under 750 basis points. The SMP variables (in current period and lagged forms) remain significant. The total impact of the SMP is 18 basis points for each € 1 billion purchased. The other results reported in Table 5 include the following. Deteriorating fundamentals and downgrades (especially in Greece, Ireland and Portugal) pushed spreads upwards. A

10 percentage point rise in the debt-to-GDP ratio causes spreads to rise by 78 basis points; a 5 per cent deterioration in relative prices results in a rise of 356 basis points in spreads. Fiscal news has a small effect: 3 percentage points of cumulative fiscal bad news causes spreads to rise only slightly, by just under 2 basis points. The effect of changes in political stability is also sizeable: a 1 point increase in political uncertainty (in an index that goes from 0 to 10) causes spreads to rise by 87 basis points. Finally, a one-notch downgrade with fundamentals unchanged causes spreads to rise by 130 basis points.

Table 6 presents the range of possible effects from the SMP based on the models presented here, along with average monthly purchases and averages spreads in each country during the months in which purchases were made. The effect of a € 1 billion purchase of sovereign bonds in the models ranges from 3 basis points to 22 basis points. These findings are in accord with those of previous studies, including those of Szczerbowicz (2012), Eser and Schwaab (2013), and Casiraghi, Gaiotti, Rodano, and Secchi (2013), that used a dummy-variable approach to assess the effects of the SMP.

To shed additional light on the issue of the use of dummy variables versus actual quantities purchased, we also estimated regressions with a zero-one dummy for the SMP instead of the actual interventions. Table 7 presents the fundamentals' specification, the results of which were reported in Table 3, but with the dummy variable taking the place of the actual intervention variables; the SMP variable is in both present-period form and lagged form in both the specification in Table 3 and that in Table 7. As shown in Table 7, the present-period SMP dummy is insignificant (as it was in Table 3), but it is significant and negative in lagged form (as it also was in the specification reported in Table 3). The combined coefficients on the SMP dummies indicate that the SMP lowered spreads in the five crisis countries by an average of 221 basis points per month during which the SMP was in operation. As pointed out above, the specification reported in Table 3, which uses actual intervention purchases, indicates that the effect of a € 1 billion SMP intervention lowered spreads by an average of 22 basis points. If we use the mean level of SMP purchases reported in Annex 1 -- that is, € 4.6 billion -- the average effect of the SMP per month of operation was a reduction of spreads of 101 basis points. Thus, if the actual SMP variable is evaluated at its sample average, the effects are similar using either the actual interventions or the dummy variable. The regression statistics and the coefficients on the other variables in the two regressions reported in Tables 3 and 4 are also similar.

Given the average monthly purchases in each country, we can present the impact of the program on spreads on each country in terms of basis points. We use average monthly purchases (in the months in which purchases occurred), and not total purchases because, since the impact on spreads is not permanent, it would be inappropriate to use cumulative purchases. The impact on Greece lies within the range 17 to 116 basis points. The effects on Portuguese and Irish spreads are even smaller – between 18 and 35 basis points. The largest effects are for Italian spreads; however, we need to be careful in making comparisons among the countries because the responsiveness of spreads is an average responsiveness across countries.

4.4. Empirical results: CBPP

Figure 2 plots the evolution of the two covered bond maturities used in this study. The figure also shows the two periods when the programs were running along with President Draghi's (July 2012) statement that the ECB would do whatever it takes to preserve the euro. The figure suggests that covered-bond prices were positively affected by the programs. However, a striking aspect in the figure is the impact of the Draghi intervention. The significant improvement in financial market conditions in the euro area is clear, just as it was for the case of sovereign spreads.

Turning to the effects of the CBPPs on bond prices, the results are reported in Table 8 and 9. Both tables use an ARMA (3,2) specification. Table 8 is compared of two panels -- A and B. Panel A uses an index of covered bonds with a maturity in excess of 10 years as the dependent variable. Panel B uses an index of covered bonds of all maturities as the dependent variable. The results for both dependent variable indicate that the CBPPs had a significantly-positive, although modest, effect on bond prices; the coefficient on the CBPP variable for maturities of over 10 years is almost double that of the intervention variable on bond prices of all maturities, suggesting that the CBPPs had their greatest impact at longer maturities. In Table 9, we add a "Draghi" dummy to the ARMA (3,2) specification that includes a bond price index at maturities greater than 10 years as the dependent variable. The "Draghi" effect appears to have led to a sharp rise in covered-bond prices, while the coefficient on the CBPP intervention variable remains positive and significant.

Turning to the quantitative impact of the CBPPs, the impact appears to have been quite small. Prices rise on impact by less than 1 per cent. However, the presence of the lagged dependent variable (up to 3 lags) implies that the cumulative impact would be greater (although it is important to note that most of the lagged dependent variables are not significant at conventional levels). We calculated the cumulative impact of the purchases using the coefficients on the lags. The results suggest that cumulatively the impact could reach 15 per cent[12], but this is clearly a maximum effect.

5. Conclusions

We examined the impact of the SMP and two CBPPs on sovereign-bond spreads and covered-bond prices for five euro-area stressed countries using actual intervention data. We also provided a simple theoretical framework that explains why official asset purchases can affect a country's default-risk spreads. Our results indicate that the SMP modestly reduced spreads on 10-year sovereign bonds. The "Draghi" effect appears to have had significantly larger effect than the SMP. This result could be a

[12] It is possible to interpret the price effect in terms of yields by means of a simply example. If a long bond has a price of 100 and a coupon of 5, then the yield is 5 per cent. If the price then rises to 115, then the yield would fall to 4.3 per cent.

consequence of the open-ended nature of the statement, in contrast to the SMP which had set-down clear limits from the outset and was accompanied by conflicting statements from some Eurosystem officials. Our results, based on actual intervention data, are very much in line with the results of previous studies that used a dummy-variable approach to measure the effects of the SMP on sovereign spreads. Analogous results were found for CBPP1 and CBPP2; the covered-bond purchases appear to have modestly raised covered-bond prices. In sum, our results for the SMP and CBPP1 and CBPP2 suggest that central banks can effectively intervene in markets, especially where there is evidence of overshooting and/or market malfunctioning.

Annex 1: SMP and CBPP1 and CBPP2 Interventions: Descriptive Statistics*
(monthly data in millions of euros)

	SMP	CBPP1 and CBPP2
Mean	4580.981	1959.162
Median	969.0000	1875.204
Maximum	47590.00	3937.750
Minimum	10.00000	129.1500
Standard Deviation	8553.856	786.6734
Skewness	3.138422	0.191767
Kurtosis	14.40191	3.840712
Jarque-Bera	367.0384	0.853895
Probability	0.000000	0.652498
Sum	238211.0	47019.88
Sum of Squared Deviations	3.73E+09	14233667
Observations	52	24

*For non-zero observations only

Annex 2: data sources and information

Spreads (in percentage points). 10-year benchmark German government bond yield minus 10-year benchmark Greek government bond yield – ECB Statistical Data Warehouse – monthly average.

Covered-bond price indices. Euro area covered-bond price indices for bonds with any maturity and for those with greater than 10 years to maturity. Source: Thomson-Reuters DataStream.

Ratings. We take the ratings of each of the major credit rating agencies - Fitch, Moody's, and Standard & Poor's (S&Ps) – and construct a single series based on the agency that moved first. Ratings are mapped to a cardinal series running from 1 (AAA) to 22 (default).

Relative prices. Log difference of the monthly seasonally adjusted harmonised index of consumer prices (HICP) between each of the five countries and Germany – Thomson-Reuters DataStream.

Debt-to-GDP ratio. The ratio of the general government debt to GDP – quarterly data interpolated to monthly – Thomson-Reuters DataStream.

***Political stability*.** We use the IFO World Economic Survey Index of Political Stability which takes values of between 0 and 10. A rise in the index implies greater stability.

Fiscal news. We construct real-time fiscal data, using the revisions to forecast general government budget deficits published in the European Commission Spring and Autumn forecasts. Thus, for example, the revision to the Spring 2006 forecast is the forecast 2006 deficit/GDP ratio in the Spring compared to the forecast for 2006 made in the Autumn of 2005. This procedure allows us to generate a series of revisions (in percentage points), which, when cumulated over time, provides a real time cumulative fiscal news variable. We interpolate the series in such a way that news does not appear in the variable before it actually came out.

Economic activity. The rate of change of real GDP is interpolated to a monthly frequency – Thomson-Reuters DataStream.

SMP and CBPP. ECB.

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Table 1: details related to the SMP and the CBPP			
Program	**Duration**	**Size**	
CBPP1	July 2009-June 2010	€ 60 billion	Purchases in primary and secondary markets of covered bonds eligible for use as collateral for Eurosystem credit operations.
SMP	May 2010-March 2011 and August 2011-February 2012	c.€ 240 billion	Interventions in euro-area public and private debt securities markets; interventions were sterilised so as not to affect the monetary policy stance.
CBPP2	November 2011-October 2012	€ 40 billion	As in CBPP1 but focusing on covered bonds with a residual maturity of 10.5 years.
Source: Press releases of the ECB			

Table 2: The impact of the SMP on sovereign spreads: Autoregressive specifications

Panel A: Levels

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.145	0.051	2.8	0.000
SMP (lagged one period)	-3.34E-05	1.25E-05	-2.67	0.006
Spread (lagged one period)	1.359	0.069	19.5	0.000
Spread (lagged two periods)	-0.637	0.11	-5.6	0.000
Spread (lagged three periods)	0.465	0.118	4.0	0.000
Spread (lagged four periods)	-0.411	0.118	-3.5	0.000
Spread (lagged five periods)	0.354	0.114	3.1	0.000
Spread (lagged six periods)	-0.178	0.069	-2.5	0.010

R-squared	0.98	Mean dependent var	2.66
Adjusted R-squared	0.98	S.D. dependent var	4.43
S.E. of regression	0.65	Akaike info criterion	2.16
Sum squared resid	199.07	Schwarz criterion	3.15
Log likelihood	-525.45	Hannan-Quinn criter.	2.55
F-statistic	206.24	Durbin-Watson stat	1.98
Prob(F-statistic)	0.00	Robust standard errors and 't' statistics	

Standard errors were estimated using the Newey-West procedure.
Sample: 2004M02 2014M07
Total (unbalanced) observations: 608

Panel B: First Differences

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.025	0.027	0.93	0.351
SMP (lagged one period)	-2.65E-05	1.25E-05	-2.12	0.03
Change in spread (lagged one period)	0.406	0.07	5.7	0.000
Change in spread (lagged two periods)	-0.278	0.074	-3.8	0.000
Change in spread (lagged three periods)	0.238	0.074	3.2	0.000
Change in spread (lagged four periods)	-0.226	0.074	-3.03	0.000
Change in spread (lagged five periods)	0.193	0.074	2.6	0.000
Change in spread (lagged six periods)	-0.105	0.070	-2.5	0.13

R-squared	0.46	Mean dependent var	0.02
Adjusted R-squared	0.31	S.D. dependent var	0.79
S.E. of regression	0.66	Akaike info criterion	2.19
Sum squared resid	204.50	Schwarz criterion	3.18
Log likelihood	-533.33	Hannan-Quinn criter.	2.58
F-statistic	2.99	Durbin-Watson stat	2.00
Prob(F-statistic)	0.00	Robust standard errors and 't' statistics	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M07
Total (unbalanced) observations: 608

Table 3: The SMP and spreads – including fundamentals

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1.04	1.55	-0.67	0.50
SMP	-7.94E-05	4.75E-05	-1.67	0.09
SMP (lagged one period)	-0.00014	4.74E-05	-3.0	0.003
Fiscal news	-0.0003	0.001	-0.27	0.79
Debt-to-GDP	0.087	0.014	6.31	0.000
Real growth	-22.5	23.3	-0.96	0.33
Political stability	-0.88	0.1	-8.5	0.000
Relative prices	66.6	8.8	7.6	0.000

R-squared	0.80	Mean dependent var	2.65
Adjusted R-squared	0.75	S.D. dependent var	4.49
S.E. of regression	2.27	Akaike info criterion	4.67
Sum squared resid	2376.44	Schwarz criterion	5.65
Log likelihood	-1259.47	Hannan-Quinn criter.	5.05
F-statistic	14.12	Durbin-Watson stat	0.17
Prob(F-statistic)	0.00	Robust standard errors and ‘t’ statistics	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M03
Total pool (unbalanced) observations: 592

Table 4: The SMP and spreads – impact of ratings

Panel A: Specification with ratings

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-0.504	1.37	-0.38	0.72
SMP	-8.04E-05	4.1E-05	-1.96	0.05
SMP (lagged one period)	-0.00014	4.1E-05	-3.5	0.00
Fiscal news	-0.002	0.0009	-2.06	0.04
Debt-to-GDP	0.078	0.012	6.4	0.000
Political stability	-0.873	0.09	-9.88	0.000
Relative prices	72.9	7.5	9.7	0.000
Ratings equation residuals	1.300	0.1	12.4	0.000

R-squared	0.88	Mean dependent var	2.67
Adjusted R-squared	0.85	S.D. dependent var	4.50
S.E. of regression	1.74	Akaike info criterion	4.14
Sum squared resid	1388.24	Schwarz criterion	5.12
Log likelihood	-1092.29	Hannan-Quinn criter.	4.52
F-statistic	26.54	Durbin-Watson stat	0.36
Prob(F-statistic)	0.00	Robust standard errors and 'y' statistics	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M03
Total(unbalanced) observations: 592

Panel B: Determinants of ratings

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1.47	0.80	-1.8	0.06
SMP	-7.76E-05	2.8E-05	-2.7	0.007
SMP (lagged one period)	-7.15E-05	2.86E-05	-2.5	0.01
Relative prices	36.576	4.1	8.8	0.000
Debt-to-GDP	0.097	0.007	13.9	0.000
Political stability	-0.346	0.056	-6.1	0.000

R-squared	0.94	Mean dependent var	5.73
Adjusted R-squared	0.93	S.D. dependent var	4.21
S.E. of regression	1.11	Akaike info criterion	3.24
Sum squared resid	590.90	Schwarz criterion	4.19
Log likelihood	-853.14	Hannan-Quinn criter.	3.61
F-statistic	63.04	Durbin-Watson stat	0.34
Prob(F-statistic)	0.00	Robust standard errors and 't' statistics	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M03
Tota (unbalanced) observations: 607

Table 5: The SMP, spreads and the "Draghi" effect

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	2.244	1.265	1.78	0.075
SMP	-8.04E-05	3.58E-05	-2.247	0.03
SMP (lagged one period)	-0.0001	3.57E-05	-3.99	0.000
Fiscal news	-0.0018	0.0008	-2.25	0.025
Debt-to-GDP	0.078	0.011	7.42	0.000
Political stability	-0.873	0.077	-11.27	0.000
Relative prices	73.008	6.46	11.3	0.000
Ratings equation residual	1.300	0.088	14.7	0.000
DRAGHI	-7.4813	1.35	-5.5	0.000

R-squared	0.88	Mean dependent var	2.67
Adjusted R-squared	0.85	S.D. dependent var	4.50
S.E. of regression	1.74	Akaike info criterion	4.14
Sum squared resid	1387.63	Schwarz criterion	5.12
Log likelihood	-1092.16	Hannan-Quinn criter.	4.52
F-statistic	26.55	Durbin-Watson stat	0.36
Prob(F-statistic)	0.00	Robust standard errors and 't' statistics	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M03
Total (unbalanced) observations: 592

Table 6: The impact of the SMP: range of estimates

			SMP effect (in basis points) from model of:			
	Average Monthly Purchases (€bn)	**Average spreads during purchases**	**Table 2**	**Table 3**	**Table 4**	**Table 5**
€1 billion purchase			3.34	14.3	22.3	18.0
Greece	5.2	797	17.4	74.4	116.2	93.8
Portugal	1.6	620	5.3	22.9	35.7	28.9
Ireland	1.3	487	4.3	18.6	29.0	23.5
Spain	8.8	348	29.4	125.8	196.6	158.8
Italy	20.4	413	68.1	291.7	455.7	368.0

Table 7: Sovereign Spreads: Effect of SMP dummy

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-2.67	1.52	-1.76	0.08
SMP dummy	0.097	0.71	0.14	0.92
SMP dummy (lagged one period)	-2.31	0.70	-3.28	0.00
Fiscal news	0.00035	0.001	0.33	0.74
Debt-to-GDP	0.103	0.014	7.52	0.00
Real growth	-20.48	23.35	-0.88	0.38
Political stability	-0.83	0.103	-8.00	0.00
Relative prices	65.27	8.76	7.45	0.00

R-squared	0.80	Mean dependent var	2.67
Adjusted R-squared	0.74	S.D. dependent var	4.50
S.E. of regression	2.28	Akaike info criterion	4.68
Sum squared resid	2387.19	Schwarz criterion	5.67
Log likelihood	-1252.74	Hannan-Quinn criter.	5.07
F-statistic	13.98	Durbin-Watson stat	0.16
Prob(F-statistic)	0.00		

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2004M02 2014M03
Total pool (unbalanced) observations: 592

Table 8: The impact of the CBPPs

Panel A: Maturities in excess of 10-years

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-4.720	4.18	-1.12	0.26
EUROBOND (lagged one period)	0.279	0.511	0.55	0.58
EUROBOND (lagged two periods)	0.323	0.47	0.68	0.49
EUROBOND (lagged three periods)	0.449	0.35	1.27	0.20
CBPP	0.0007	0.0003	2.60	0.01
Moving Average (one lag)	0.864	0.51	1.7	0.09
Moving Average (two lags)	0.512	0.34	1.5	0.14

R-squared	0.96	Mean dependent var	100.10
Adjusted R-squared	0.96	S.D. dependent var	10.23
S.E. of regression	2.05	Akaike info criterion	4.32
Sum squared resid	716.91	Schwarz criterion	4.441386
Log likelihood	-374.96	Hannan-Quinn criter.	4.366718
F-statistic	699.17	Durbin-Watson stat	1.980172
Prob(F-statistic)	0.00	Robust standard errors and ‘t’ statistics	
Inverted MA Roots	-.43-.57i	-.43+.57i	

Panel B: All Maturities

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	3.023	3.68	0.82	0.41
EUROBOND_ALL (lagged one period)	-0.90	0.185	-4.87	0.00
EUROBOND_ALL (lagged two periods)	0.156	0.17	0.91	0.36
EUROBOND_ALL (lagged three periods)	0.717	0.16	4.5	0.000
CBP	0.0004	0.00	3.3	0.012
Moving Average (one lag)	0.961	0.19	4.9	0.000
Moving Average (two lags)	0.707	0.17	4.1	0.001

R-squared	0.96	Mean dependent var	100.67
Adjusted R-squared	0.96	S.D. dependent var	4.12
S.E. of regression	0.87	Akaike info criterion	2.57
Sum squared resid	124.96	Schwarz criterion	2.69
Log likelihood	-220.34	Hannan-Quinn criter.	2.62
F-statistic	650.58	Durbin-Watson stat	1.88
Prob(F-statistic)	0.00	Robust standard errors and ‘t’ statistics	
Inverted MA Roots	-.48-.69i	-.48+.69i	

Standard errors were estimated using the Newey-West procedure.
Sample (adjusted): 2000M04 2014M12
Included observations: 177

Table 9: The CBPPs and the "Draghi" effect: Maturities in excess of 10-years

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.227	1.55	0.145	0.88
EUROBOND (lagged one period)	1.974	0.033	58.5	0.000
EUROBOND (lagged two periods)	-1.913	0.05	-35.0	0.000
EUROBOND (lagged three periods)	0.936	0.034	27.4	0.000
CBPP	0.0005	0.0001	2.8	0.005
DRAGHI	1.547	0.42	3.7	0.000
Moving Average (one lag)	-0.956	0.015	-60.7	0.000
Moving Average (two lags)	0.983	0.011	93.1	0.000

R-squared	0.97	Mean dependent var	100.10
Adjusted R-squared	0.97	S.D. dependent var	10.23
S.E. of regression	1.89	Akaike info criterion	4.16
Sum squared resid	605.63	Schwarz criterion	4.30
Log likelihood	-360.02	Hannan-Quinn criter.	4.22
F-statistic	709.67	Durbin-Watson stat	1.98
Prob(F-statistic)	0.00	Robust standard errors and 't' statistics	

Inverted MA Roots .48-.87i .48+.87i

Standard errors were estimated using the Newey-West procedure.

Sample (adjusted): 2000M04 2014M12

Included observations: 177 after adjustments

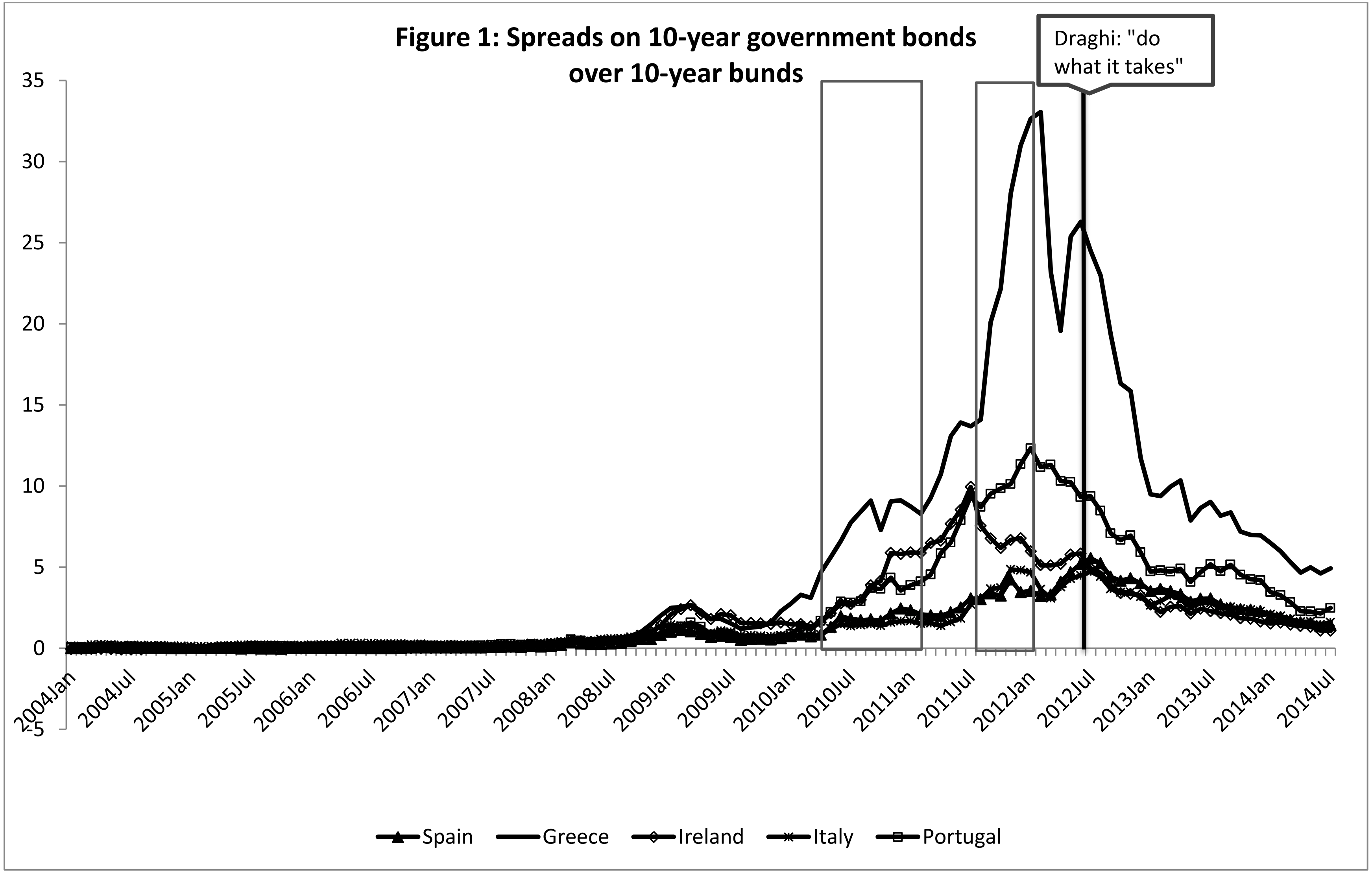
Figure 1: Spreads on 10-year government bonds over 10-year bunds
Draghi: "do what it takes"
35
30
25
20
15
10
5
0
-5
2004Jan
2004Jul
2005Jan
2005Jul
2006Jan
2006Jul
2007Jan
2007Jul
2008Jan
2008Jul
2009Jan
2009Jul
2010Jan
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Ireland
Italy
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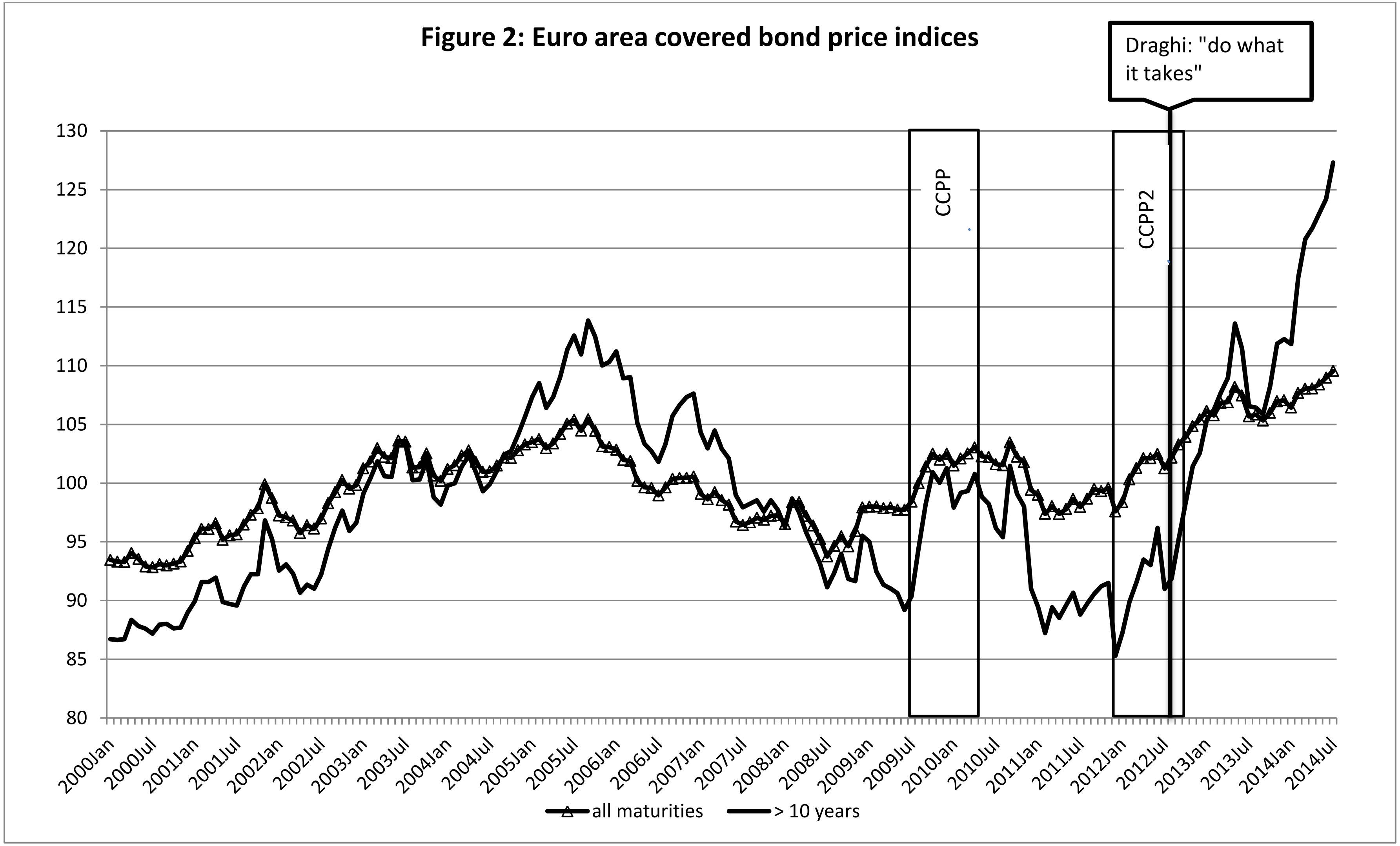

Figure 2: Euro area covered bond price indices
Draghi: "do what it takes"
CCPP
CCPP2
130
125
120
115
110
105
100
95
90
85
80
2000Jan
2000Jul
2001Jan
2001Jul
2002Jan
2002Jul
2003Jan
2003Jul
2004Jan
2004Jul
2005Jan
2005Jul
2006Jan
2006Jul
2007Jan
2007Jul
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2011Jul
2012Jan
2012Jul
2013Jan
2013Jul
2014Jan
2014Jul
all maturities
> 10 years