EFFECTS OF ASSET PURCHASES AND FINANCIAL STABILITY MEASURES ON TERM PREMIA IN THE EURO AREA

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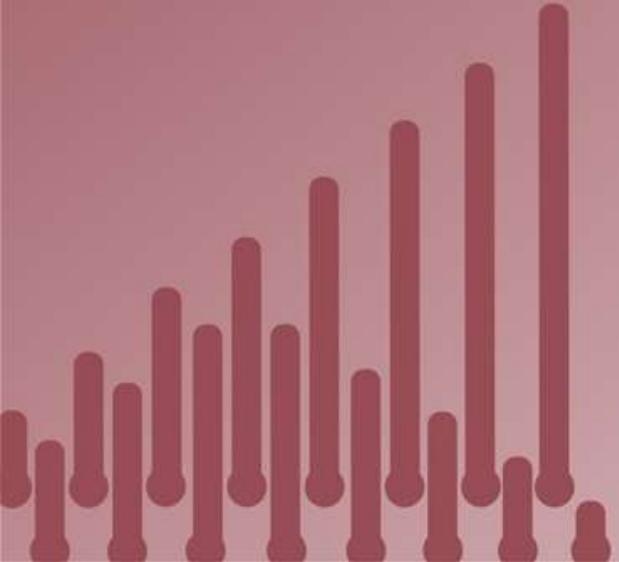
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Effects of asset purchases and financial stability measures on term premia in the euro area

Richhild Moessner

Abstract

We study the effects of the announcements of ECB asset purchases and of financial stability measures in the euro area in the wake of the global financial crisis and the euro area sovereign debt crisis on ten-year government bond term premia in eleven euro area countries. We find that the term premia of euro area countries with higher sovereign risk, as measured by sovereign CDS spreads, decreased more in response to the announcements of asset purchases and financial stability measures. Term premia of countries with lowest sovereign risk either increased as in Germany, or were not significantly affected or fell slightly, as in the Netherlands and Finland.

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1   Introduction

In the wake of the global financial crisis of 2008-09, several central banks in advanced economies, including the European Central Bank (ECB), introduced large-scale asset purchases as unconventional monetary policy measures in order to reduce long-term interest rates and stimulate the economy. In the wake of the euro area sovereign debt crisis of 2010-11, financial stability measures were introduced in Europe in order to help preserve financial stability in Europe. In this paper we aim to study how effective these unconventional monetary policy and financial stability measures have been in reducing the term premia, which include credit risk and liquidity risk, of long-term government bonds in different euro area countries. One transmission channel of asset purchases, besides the signalling channel affecting interest rate expectations, is that large-scale purchases of government bonds can lead to a reduction in term premia of government bonds. Studying the effects of asset purchases on term premia in the euro area allows us to investigate whether this has been a relevant transmission channel of these unconventional monetary policy measures in the euro area.

We study the effects of the ECB's asset purchase announcements on term premia in eleven euro area countries. We consider the announcement effects of all the asset purchase programmes introduced by the ECB since 2009 in the wake of the global financial crisis and the euro area sovereign debt crisis, consisting of the first three covered bond purchase programmes (CBPP1, CBPP2 and CBPP3), the Securities Markets Programme (SMP), the Outright monetary transactions programme (OMT), the Asset-backed securities purchase programme (ABSPP) and the Public sector purchase programme (PSPP). The CBPP3, ABSPP and PSPP combined are referred to as the expanded asset purchase programme (APP). We also consider the effects of announcements of important financial stability measures in the euro area. We use novel estimates of term premia (which include liquidity and credit risk premia) of ten-year government bonds at the daily frequency for eleven euro area countries, namely Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal and Greece. Moreover, we relate the announcement effects of the asset purchase programmes and of the financial stability measures to

sovereign risk in each country, as measured by sovereign CDS spreads.

Our study of the effects of the announcements of asset purchase programmes by the ECB is related to earlier studies of the effects of a number of these programmes on government bonds, which are described in the following. Beirne et al. (2011) find that the CBPP1 reduced the spreads of covered bonds over the yields of French and German government-guaranteed agency bonds. Markmann and Zietz (2017) find that the CBPP1 reduced the spread of euro-denominated covered bonds against those issued by British banks, but they find that by contrast CBPP2 and CBPP3 led to an increase. Gerlach-Kristen (2015) finds that the CBPP1 and the SMP reduced CDS spreads of governments and banks. Gibson, Hall and Tavlas (2016) find that the CBPP1, CBPP2 and the SMP reduced the spreads over German government bond yields of ten-year government bond yields in Greece, Ireland, Italy, Portugal, and Spain. Pattipeilohy et al. (2013) find that changes in the SMP only had a visible downward effect on government bond yields in the Summer of 2011, when the program was reactivated for Italy and Spain, but that this effect dissipated within a few weeks. Eser and Schwab (2016) find that the SMP reduced government bond yields in five euro area countries. Ghysels et al. (2014) find that SMP interventions succeeded in reducing government bond yields of the countries under the programme, using intraday data.

A number of papers studied the effects of the OMT announcement on government bond yields. Altavilla et al. (2014) find that the OMT announcement reduced two-year government bond yields in Italy and Spain by about 2 percentage points, while leaving them unchanged in Germany and France. Acharya et al. (2015) find that the OMT announcement reduced government bond yields of peripheral euro area countries. Ehrmann and Fratzscher (2015) find, using ten-year government bond yields, that flight to quality was present at the height of the euro area sovereign debt crisis, but largely dissapeared after the OMT announcement. By contrast, they find that the ten-year government bond yields of Italy and Spain became more interdependent after the OMT announcement, providing evidence of greater contagion between these two countries.[1]

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[1]Using data on CDS spreads, Blasques et al. (2016) find that spillovers within the euro area decreased with the ECB's OMT. Falagiarda et al. (2015) find some evidence of spillover effects of the ECB's asset

Fratzscher et al. (2014) find that the SMP and OMT announcements decreased government bond yields in peripheral euro area contries. Szczerbowicz (2015) finds that the SMP and OMT announcements were particularly effective in reducing the government bond yields of peripheral euro area countries with high sovereign risk, wheras the French spread reacted very little if at all. Falagiarda and Reitz (2015) study the effects of the SMP and OMT announcements on spreads over German government bonds of ten-year government bonds in Greece, Ireland, Italy, Portugal, and Spain, and they find that the SMP reduced all these spreads, whereas the OMT only reduced those of Italy and Spain. Watfe (2015) finds that the SMP reduced spreads of five-year government bond yields over those of Germany across the euro area, and that the announcements regarding the OMT programme reduced government bond spreads in peripheral euro area countries. Kilponen et al. (2015) find that the SMP and OMT reduced ten-year government bond spreads over German government bonds of several euro area countries.

Several papers studied the effects of the ECB's APP. Andrade et al. (2016) study the effects of the ECB's APP on ten-year government bond yields in 2015. They find that the January 2015 announcement of the APP reduced long-term government bond yields.[2] De Santis (2016) finds that vulnerable euro area countries benefited most from the ECB's APP, studying the effects on ten-year government bond yields. For the period of January 2014 to March 2015, Altavilla et al. (2015) study the effects of the ECB's APP announcements on ten-year government bond yields, using dummy variable event regressions. They also consider a broader set of the ECB's official communication interventions which could have conveyed information about the APP. They consider CDS-adjusted government bond yields, and spreads of government bond yields of euro area countries over those of German government bonds. They find that the ECB's APP significantly lowered yields in a broad set of market segments, with effects generally being larger for more risky

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purchases on asset prices in economies in central and Eastern Europe. Georgiadis and Gräb (2015) present some evidence of spillovers from the 22 January 2015 announcement of the APP on international asset prices.

[2]Andrade et al. (2016) also study the effects of the ECB's APP on inflation expectations, and Moessner (2015) srudies the effects of the ECB's unconventional monetary policy measures, including of asset purchases, on inflation expectations.

assets.[3]

Krishnamurthy et al. (2014) study the effects of the SMP and OMT announcements on term premia in Italy, Spain and Portugal. They find that the SMP and OMT reduced government bond yields in Italy, Spain and Portugal. They conclude that default risk and sovereign bond segmentation effects were the dominant channels through which the SMP and the OMT affected sovereign bond yields of Italy and Spain, and that redenomination risk may have been a third channel in the case of Spain and Portugal, but not for Italy. Dewachter et al. (2016) study the effects of the ECB's SMP, OMT and APP announcements on government bond term premia in Belgium, France, Italy and Spain, and find that they generally reduced term premia.

Our study fits into the literature on the effects of the ECB's asset purchase programmes more generally, for which Melnic (2017) and Pattipeilohy et al. (2013) provide overviews. The role of unconventional monetary policy after the financial crisis, based on surveys of central bank governors and academics, is discussed in Blinder et al. (2016). Our study also fits more broadly into the literature on the effects of central bank communication more generally, for which an overview is provided in Blinder et al. (2008).

Our study of the effects of the announcements of financial stability measures in the euro area is related to earlier studies of their effects on government bonds. Kilponen et al. (2015) find that announcements of financial assistance programs in the euro area typically increased somewhat the spreads of government bond yields in the guarantor countries, while reducing the spreads of government bond yields in the countries receiving funding, over those of German government bonds. Schwendner et al. (2015) find that the spreads of yields of peripheral euro area government bonds over those of core euro area government bonds decreased since the European Financial Stability Facility (EFSF) and the European Stability Mechanism (ESM) were established, and also that market-implied spillover risks decreased. Attinasi et al. (2009) find that announcements of government rescue packages for banks during the global financial crisis from July 2007 to March 2009 contributed to higher government bond yield spreads over those of Germany in ten euro area countries.

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[3]Altavilla et al. (2015) also present a theoretical model for the effects of asset purchases on term premia.

They conclude that the stress in the national banking sector was transferred to the public sector through governments' rescue packages.

Several economies have engaged in large-scale asset purchases as unconventional monetary policy measures in the wake of the global financial crisis, at a time when their policy rate had reached the effective lower bound, including the euro area, the United States, the United Kingdom and Japan. Our paper provides evidence for the importance of term premia for the transmission of unconventional monetary policy in the form of asset purchases in the euro area. This finding is consistent with earlier results for the United States, the United Kingdom and Japan. D'Amico et al. (2012) study the effects of the Federal Reserve's large-scale asset purchase programmes (LSAPs) on term premia of US government bond yields. They find that a \$100-billion surprise in LSAPs translates into a reduction of 8 basis points in the term premia of 10-year US government bonds. D'Amico et al. (2012) conclude that the term premium component of interest rates and the channels affecting this component are important for the transmission mechanism of unconventional monetary policy, and that they should therefore be incorporated in traditional macro/monetary economic models, where usually monetary policy operates only through the expectation component of interest rates. Wu (2014) also finds that the Federal Reserve's LSAPs led to a reduction in term premia of ten-year US government bonds, of around 113 basis points. For the United Kingdom, Diez de los Rios and Shamloo (2012) find that the launch of the Bank of England's quantitative easing programme in March 2009 led to a reduction in term premia of ten-year UK government bonds. For Japan, Fukunaga and Kato (2015) find that the Bank of Japan's purchases of Japanese government bonds led to a reduction in their term premia through net supply effects from January 2013 to September 2014.

One contribution of our paper is to study the announcement effects of the asset purchase programmes introduced by the ECB since 2009, on government bond term premia for a wide range of (eleven) euro area countries, using novel term premia estimates from term structure models by NIESR at the daily frequency (Chadha et al., 2017).[4] These were calculated by applying the method of Adrian et al. (2013), who applied it to US Treasuries, to government bonds of countries in the euro area. The model of Adrian et al.

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[4]See Chadha et al. (2014) regarding term structure modelling more generally.

(2013) applied to the euro area in the NIESR term premia estimates used in this paper, allows a decomposition of government bond yields into risk neutral yields and term premia at the daily frequency. The model used is a five-factor affine no-arbitrage term-structure model. According to such affine term structure models, the yield to maturity of a government bond with a maturity of n years at time t can be decomposed into an expectation component, which reflects the average of the expected path of short-term interest rates over the life of the government bond, and a term premium component, which is the extra return that investors require to hold a longer-term government bond with a maturity of n years (D'Amico et al., 2012). The term premium is the difference between the nominal government bond yield and the expected future short-term interest rates. The term premium is determined by the sensitivity of the government bond yield to the product of the quantity and market-price of risk (D'Amico et al., 2012). Adrian et al. (2013) show that the US government bond term premium estimate and a measure of implied volatilities from options on US government bond futures, namely the Merrill Lynch Option Volatility Estimate (MOVE) index, exhibit a strong correlation, which provides evidence that the term premium estimate reflects the risk of holding government bonds.

Daily estimates of term premia as used in this paper allow to conduct event studies for determining the effects of announcements of asset purchases and financial stability measures. Most earlier papers that have conducted event studies for the effects of asset purchases using daily time series for term premia have been done for countries outside the euro area, especially the United States (eg D'Amico et al., 2012; Wu, 2014; Diez de los Rios and Shamloo, 2012). For the euro area, only few papers have used estimates of daily time series of term premia, and then mostly only for a few countries, with Krishnamurthy et al. (2014) and Dewachter et al. (2016) considering four countries each, none of them Germany. Most term premia estimates for the euro area are only available at monthly frequency (Hördahl and Tristani, 2014; Montfort et al., 2015). The novelty of the term premia estimates from NIESR used in our paper is that they have been derived at the daily frequency for a large number of euro area countries, including Germany.

One earlier paper which studied the effects of the ECB's asset purchase announcements on term premia, by Krishnamurthy et al. (2014), only considered the SMP and OMT, and

only four peripheral euro area countries. Another earlier paper which studied the effect of the ECB's asset purchases on term premia, Dewachter et al. (2016), only considered Belgium, France, Italy and Spain.

Another contribution of our paper is to study the effects of announcements of important financial stability measures in the euro area on government bond term premia in eleven euro area countries. We are not aware of any previous paper to have studied the effects of the announcements of financial stability measures in the euro area on term premia of government bonds in a range of euro area countries.

We relate the announcement effects of the ECB's asset purchase programmes and of the financial stability measures in the euro area on term premia to sovereign risk in each country, as measured by sovereign CDS spreads. We find that the term premia of euro area countries with higher sovereign risk, as measured by sovereign CDS spreads, decreased more in response to the announcements of asset purchases and financial stability measures, than those of countries with lower sovereign risk. We find that in response to the announcements of asset purchases and financial stability measures, the term premia of countries with lowest sovereign risk either increased as in Germany, or were not significantly affected or fell slightly, as in the Netherlands and Finland.

The increase in term premia of German government bonds in response to asset purchase announcements could partly be due to some reversal of a flight to quality into German government bonds. Another factor behind this increase could be higher perceived sovereign risk in Germany based on concerns that purchases of government bonds from peripheral euro area countries could lead to transfers from Germany, if one of the peripheral euro area countries should default on its government debt, leading to losses for the Eurosystem which could be shared among Eurosystem central banks according to the ECB's capital key. Similarly, some reversal of a flight to quality into German government bonds with the announcements of financial stability measures could have contributed to the increase in term premia of German government bonds in response to the announcements of these measures, and higher perceived sovereign risk in Germany due to concerns that use of EFSF/ESM funds could lead to transfers from Germany to recapitalise these funds may also have contributed.

The paper is organised as follows. Section 2 presents the data, and Section 3 presents the method and results. Finally, Section 4 concludes.

2   Data

We use calculations by the National Institute of Economic and Social Research (NIESR) of a decomposition of government bond yields into term premia and expected interest rates at the ten-year maturity for eleven euro area countries, applying the method of Adrian et al. (2013) for US government bonds to government bonds in euro area countries (Chadha et al., 2017). The term premia include liquidity and credit risk premia. Higher term premia indicate that investors require an extra return to hold ten-year government bonds of a country. The eleven euro area countries are Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal and Greece.

Figure 1 shows the developments of term premia in individual euro area countries over the sample period of 1 October 2008 to 30 December 2015. Term premia in Greece, Portugal and Ireland rose very strongly during the euro area sovereign debt crisis of 2010-2011, as concerns about sovereign risk in peripheral euro area countries increased (Allen and Moessner, 2013), and those in Spain and Italy also rose. Term premia in Greece, Portugal, Ireland, Spain and Italy fell back somewhat in the course of 2012, as the severity of the euro area sovereign crisis moderated and concerns about sovereign risk diminished. The latter was partly due to unconventional monetary policy measures by the ECB, including an important speech by ECB president Draghi on 26 July 2012 mentioning that "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough" (Draghi, 2012), and partly due to euro area financial stability measures, including relating to the EFSF and ESM. By contrast, term premia in Germany fell somewhat over the period 2010-2011, as increased concern about sovereign risk in Italy, Spain and peripheral euro area countries led to some flight to safety into German government bonds, reducing their term premia.

[Figure 1 about here]

The announcement dates of the ECB's asset purchase programmes are shown in Table 1. The CBPP1 and CBPP2 announced in May 2009 and October 2011, respectively, were for purchases of covered bonds issued by euro area banks. Purchases of the CBPP1 amounted to €60 billion in 2009, and purchases of CBPP2 amounted to € 16 billion purchases when it ended in 2012, while the intended amount was €40 billion when CBPP2 was announced in 2011 (Altavilla et al., 2015). The SMP was first announced in May 2010 for purchases of public sector securities from distressed euro area countries during the euro area sovereign debt crisis of 2010-2011, amounting to around €210 billion at its peak (Altavilla et al., 2015). The OMT was announced in July 2012 and was for purchases of government bonds, but it was never triggered. The ABSPP was first announced in June 2014 and involved purchases of asset-backed securities (ABS). The CBPP3 was announced in September 2014 and was for purchases of covered bonds. The PSPP was announced in January 2015 and was for purchases of public sector assets. The ABSPP and CBPP3 were subsumed in the APP, consisting of the CBPP3, ABSPP and PSPP.

[Table 1 about here]

The announcement dates of important financial stability measures in the euro area are shown in Table 2. They include the creation of the European Financial Stability Facility (EFSF) in May 2010, the authorisation for the EFSF and the European Stability Mechanism (ESM) to intervene in the government debt primary market in March 2011, an increase in the ceiling of the EFSF/ESM in March 2012, and enabling the use of EFSF/ESM funds to recapitalize Spanish banks in June 2012.

[Table 2 about here]

We control for conventional monetary policy by including in the regressions surprises in the ECB's policy rate, as measured by daily changes in the one-month euro overnight index swap (OIS) rate on the dates when the ECB's governing council announced its policy rate decisions. We also use data on 5-year sovereign credit default spreads (CDS) for euro area countries.

We also control for the effect of macroeconomic news on term premia by including Citigroup economic surprise indices for the euro area. Citigroup economic surprise indices measure economic surprises relative to market expectations (actual releases minus Bloomberg median survey expectations); they are calculated daily in a rolling three-month window and are defined as a weighted series of data surprises (Boesler, 2013). A positive reading suggests that data releases have on balance been higher than median survey expectations, which implies that on average, economic data has been more positive than expected, i.e. that the economy has outperformed expectations. The indices use a time-decay function to account for the limited memory of financial markets; the weights of different economic indicators are given by the relative high-frequency spot foreign exchange effects of one-standard deviation data surprises (Boesler, 2013).

3 Method and results

We regress daily changes in term premia of ten-year government bonds for country i (in basis points), $y(t)$, for eleven euro area countries, $i = 1, ..., 11$, on a dummy variable for the announcements of the ECB's asset purchase programmes, $d_{ap}(t)$, on a dummy variable for the announcements of important financial stability measures in the euro area listed in Table 2, $d_{fs}(t)$, surprises in the ECB's policy rate, $pol^{sur}(t)$, to control for conventional monetary policy changes, and on daily changes in the Citigroup economic surprise index for the euro area, $esi(t)$, to control for the effects of economic data surprises. For each country i, the regression equation takes the form

$$\Delta y(t) = c + \beta_{ap} d_{ap}(t) + \beta_{fs} d_{fs}(t) + \gamma pol^{sur}(t) + \delta \Delta esi(t) + \varepsilon_t \qquad (1)$$

where Δ is the first difference operator, $d_{ap}(t)$ takes the value of 1 on the days of announcements of the ECB's asset purchase programmes listed in Table 1, and zero otherwise, $d_{fs}(t)$ takes the value of 1 on the days of announcements of the financial stability measures listed in Table 2, and zero otherwise. The variable $pol^{sur}(t)$ measuring surprises in the ECB's policy rate equals daily changes in the one-month euro overnight index swap (OIS) rate on the dates when the ECB's governing council announced its policy rate de-

cisions, and is zero otherwise. We use Newey-West adjusted standard errors to control for serial correlation and heteroskedasticity.

[Table 3 about here]

The results of equation (1) are shown in Table 3. We find that the term premia of Italy and the peripheral euro area countries Spain, Ireland and Portugal decreased significantly in response to the announcements of asset purchases, by between 13 and 25 basis points on average per announcement. We also find that the term premia of Italy, Spain and Ireland decreased significantly in response to the announcements of financial stability measures, by between 23 and 49 basis points on average per announcement.[5] Term premia in Austria, France and Belgium fell by 3 to 6 basis points on average per announcement in response to asset purchase announcements, and by 3 to 11 basis points in response to announcements of financial stability measures. In response to the announcements of asset purchases, the term premia of countries with lowest sovereign risk either increased significantly as in Germany, by 4 basis points on average per announcement, or they were not significantly affected, as in the Netherlands and Finland. In response to the announcements of financial stability measures, the increase in term premia in Germany of 3 basis points on average per announcement is just barely insignificant at the 10% level (with a p-value of 0.11), but as shown below the increase of 5 basis points over a 5-day window is significant. In response to the announcements of financial stability measures, term premia did not change significantly in Belgium, and fell slightly in the Netherlands, but as shown below the change in the Netherlands over a 5-day window is not significant.

These results provide evidence for the importance of term premia in the transmission of unconventional monetary policy in the form of asset purchases in the euro area. This implies that this channel has been relevant in the transmission of these unconventional monetary policy measures, as has been the case in the United States, the United Kingdom

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[5]Due to a restructuring of Greek sovereign debt on 9 March 2012, which led to a large fall in Greek government bond yields, the results for Greece reported in Table 3 are less reliable, which might explain that we find no significant effect of the announcement of asset purchases or financial stability measures on Greek term premia.

and Japan (D'Amico et al., 2012; Wu, 2014; Diez de los Rios and Shamloo, 2012; Fukunaga and Kato, 2015).

Some reversal of a flight to quality into German government bonds with the introduction of asset purchases may have been partly behind the increase in term premia of German government bonds in response to asset purchase announcements. This would be consistent with evidence of some reversal of flight to quality following the OMT announcement found by Ehrmann and Fratzscher (2015). The increase in term premia of German government bonds in response to asset purchase announcements could also be due in part to higher perceived sovereign risk in Germany due to concerns that purchases of government bonds from peripheral euro area countries could lead to transfers from Germany, if one of the peripheral euro area countries should default on its government debt, leading to losses for the Eurosystem which could be shared among Eurosystem central banks according to the ECB's capital key.

We next investigate whether the response of term premia to the announcements of asset purchases and financial stability measures depends on a country's sovereign risk. We analyse this by regressing the coefficients on announcements of asset purchases from equation (1) for country i, β_{ap}^i, for all the countries included above, namely Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal and Greece, on a country's sovereign risk as measured by sovereign CDS spreads, CDS_{av}^i, on average over the period from October 2008 to December 2013, according to the following equation

$$\beta_{ap}^i = c + \alpha * CDS_{av}^i + \varepsilon^i \qquad (2)$$

We run the corresponding regression to equation (2) for the coefficients on announcements of financial stability measures from equation (1) for country i, β_{fs}^i,

$$\beta_{fs}^i = c + \alpha * CDS_{av}^i + \varepsilon^i \qquad (3)$$

The results of regressions (2) and (3) are are shown in Table 4 (columns 1 and 3). The relationship is also illustrated in Figure 2. We find that the coefficients for the announcements of asset purchases are significantly negatively related to sovereign CDS spreads in each country. This implies that term premia of countries with higher sovereign

13

risk fell by more in response to asset purchase announcements than those of countries with lower sovereign risk. We also find that the coefficients for the announcements of financial stability measures are significantly negatively related to sovereign CDS spreads in each country. This implies that term premia of countries with higher sovereign risk fell by more in response to the announcements of financial stability measures than those of countries with lower sovereign risk.

For robustness, we also run the regressions of equations (2) and (3) using the sovereign CDS spreads on average in December 2013 in each country, instead of on average over the longer period, and the results are shown in columns 2 and 4 of Table 4. The results are robust to using this different CDS average, with the coefficients all remaining significant, and even becoming more negative in all cases.

[Table 4 about here]

For robustness, we moreover repeat the regressions of equations (2) and (3) when excluding Greece, due to the restructuring of Greek sovereign debt on 9 March 2012 which makes the results for Greece less reliable. While the size of the coefficients changes somewhat when excluding Greece, even becoming more negative in the case of asset purchase announcements (see Table 4), they remain significant, and the results are robust to excluding Greece.

[Figure 2 about here]

Our results that the term premia of countries with higher sovereign risk fell by more in response to the asset purchase announcements are consistent with those of De Santis (2016) that the vulnerable euro area countries benefited most from the ECB's APP, and with those of Szczerbowicz (2015) that the SMP and OMT were particularly effective in reducing the government bond yields of peripheral euro area countries with high sovereign risk, wheras the French spread reacted very little if at all. They are also consistent with the findings by Altavilla et al. (2015) that the APP significantly lowered yields in a broad set of market segments, with effects generally being larger for more risky assets.

Our results that in response to the announcements of financial stability measures the term premia of countries with higher sovereign risk fell by more are consistent with those

14

of Schwendner et al. (2015) that the spreads of peripheral euro area government bond yields over those of core euro area government bond yields decreased since the EFSF and ESM were established. Our results are also consistent with the results of Kilponen et al. (2015) that announcements of financial assistance programmes in the euro area typically increased the perceived riskiness of long-term government bonds in the guarantor countries, while reducing the government bond spreads in the countries receiving funding.

Since we consider the euro area, we are able to study the heterogeneity of responses in term premia of government bond yields across member countries of the monetary union. Our result that in response to asset purchase announcements term premia fell more in euro area countries with higher sovereign risk is consistent with imperfect substitutability between government bonds from different euro area countries. Our results therefore suggest that such imperfect substitutability is a relevant factor in the transmission of asset purchases across countries in the euro area.

Our results for the relevance of term premia in the transmission mechanism of asset purchases in the euro area, compressing term premia more in countries with higher sovereign risk, suggest that if asset purchase programmes should be unwound at a time when there are still conditions of imperfect substitutability of government bonds from different euro area countries, term premia and therefore government bond yields are likely to increase more in countries with higher sovereign risk, which could adversely affect their macroeconomic conditions to a greater extent.

Our result that in response to euro-area wide financial stability measures, term premia fell more in euro area countries with higher sovereign risk implies that countries with higher sovereign risk are expected to be more likely to need and benefit from financial assistance in future than those with lower sovereign risk. The finding that term premia of German government bonds increased slightly in response to euro area-wide financial stability measures implies a higher perceived risk of transfers from Germany to euro area member countries with high sovereign risk. Our findings imply that the euro-area wide financial stability measures considered in this paper were perceived as providing some form of risk sharing among euro area member countries. We expect that these results would also be relevant for other monetary unions with heterogeneous sovereign risk of

member countries.

The findings that in response to the announcements of asset purchases and financial stability measures the term premia of government bonds of countries with higher sovereign risk fell by more, implies that those countries experienced a greater benefit in the form of a reduction in interest payments on their public debt going forward, which could in turn help to improve their fiscal positions and boost growth. Due to heterogeneity in macroeconomic performance among euro area countries, with higher sovereign risk partly associated with weaker growth in the wake of the global financial crisis, asset purchases and financial stability measures applied in a euro-area wide context likely helped to improve macroeconomic conditions in those countries most who needed it most to improve their growth going forward.

Next, we consider changes in term premia over longer periods of $n = 5$ and $n = 10$ days (ie one and two working weeks, respectively), instead of daily changes, in order to see whether the effects of the announcements of asset purchases and financial stabiltiy measures persist over longer periods, and are not just transitory. We do so by using n-day changes in term premia, the policy rate and economic surprise index in equation (1), instead of daily changes, according to the following equation,

$$\Delta_n y(t) = c + \beta_{ap} d_{ap}(t) + \beta_{fs} d_{fs}(t) + \gamma pol^{sur}(t) + \delta \Delta_n esi(t) + \varepsilon_t \tag{4}$$

where $\Delta_n y(t) = y(t + n - 1) - y(t - 1)$, denotes the operator for n-day changes in term premia, and similarly for other variables. Again, we use Newey-West adjusted standard errors to control for serial correlation and heteroskedasticity.

Results from equation (4) for 5-day changes are shown in Table 5. The pattern for the coefficients on asset purchase announcements is generally similar to that reported in Table 3 for 1-day changes, but fewer responses are significant. Again, the term premia of Italy and the peripheral euro area countries Spain, Ireland and Portugal decreased significantly in response to the announcements of asset purchases, by somewhat different amounts of between 19 and 39 basis points on average per announcement. We also again find that the term premia of Ireland decreased significantly in response to the announcements of financial stability measures, by 41 basis points on average per announcement, but the reponses for Italy, Spain and Portugal are no longer significant.

16

Again, we find that the term premia in Germany rose significantly in response to the announcements of asset purchases, by 7 basis points on average per announcement, but the increase in response to financial stability measures is now also significant, at 5 basis points on average per announcement. Some of the increase in term premia of German government bonds in response to the announcements of financial stability measures could have been brought about by some reversal of a flight to quality into German government bonds with the announcements of these measures. The increase in term premia of German government bonds in response to the announcements of financial stability measures could also be due to some extent to higher perceived sovereign risk in Germany based on concerns that use of EFSF/ESM funds could lead to transfers from Germany to recapitalise these funds.

For the 5-day window, term premia are again not significantly affected in the Netherlands and Finland in response to asset purchase announcements, and now responses also become insignificant in Austria and France. The response to asset purchase announcements remains significant in Belgium for the 5-day window. We therefore find that the pattern of results obtained for daily changes above is not just due to transitory effects, but is generally robust to using a longer window of a week, although coefficients for fewer countries remain significant. In response to the announcement of financial stability measures, only the decrease in term premia in Ireland and the increase in Germany are significant for the 5-day window.

Results from equation (4) for 10-day changes are shown in Table 6. The pattern for the coefficients on asset purchase announcements is again similar to that reported in Table 3 for 1-day changes, but much fewer responses are significant. Only the term premia of Italy and the peripheral euro area countries Spain and Portugal continue to decrease significantly in response to the announcements of asset purchases, by somewhat different amounts of between 26 and 36 basis points on average per announcement. The responses to the announcements of financial stability measures become insignificant in all countries for the 10-day event window.

For robustness, we also repeat regressions (2) and (3) using the coefficients for the 5-day window estimated via equation (4), instead of using coefficients for daily changes,

17

and the results are shown in Table 7. We can see that the results reported in Table 4 for daily changes generally remain robust to using a 5-day window. All the coefficients on sovereign CDS spreads remain negative and significant, except for one case, where it remains negative but just loses significance (with a p-value of 0.11). We therefore find that the results obtained for daily changes above that the term premia of euro area countries with higher sovereign risk fell by more in response to the announcements of asset purchases and financial stability measures are not just due to transitory effects, but are robust to using a longer window of a week.

4   Conclusions

We studied the effects of the announcements of ECB asset purchases and of financial stability measures in the euro area since 2009, in the wake of the global financial crisis and the euro area sovereign debt crisis, on ten-year government bond term premia in eleven euro area countries. We found that the term premia of euro area countries with higher sovereign risk, as measured by sovereign CDS spreads, decreased more in response to the announcements of asset purchases and financial stability measures, than those of countries with lower sovereign risk. We found that in response to the announcements of asset purchases and financial stability measures, the term premia of countries with lowest sovereign risk either increased slightly as in Germany, or were not significantly affected or fell slightly, as in the Netherlands and Finland.

The increase in term premia of German government bonds in response to asset purchase announcements could partly be due to some reversal of a flight to quality into German government bonds. Another reason for this increase could be higher perceived sovereign risk in Germany based on concerns that purchases of government bonds from peripheral euro area countries could lead to transfers from Germany, if one of the peripheral euro area countries should default on its government debt, leading to losses for the Eurosystem which could be shared among Eurosystem central banks according to the ECB's capital key. Similarly, some reversal of a flight to quality into German government bonds with the announcements of financial stability measures may have contributed to the

increase in term premia of German government bonds in response to the announcements of these measures, and higher perceived sovereign risk in Germany based on concerns that use of EFSF/ESM funds could lead to transfers from Germany to recapitalise these funds may have been another factor.

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Table 1: ECB asset purchase announcements

Date	ECB asset purchase announcements
7 May 2009	Covered bond purchase programme 1[a]
10 May 2010[b]	Securities market programme[c]
8 August 2011[d]	Securities market programme
6 October 2011	Covered bond purchase programme 2[e]
26 July 2012	Speech by ECB president Draghi mentioning "whatever it takes" (Outright monetary transactions programme, OMT)
6 September 2012	Technical features of OMT
5 June 2014	Asset-backed securities purchase programme[f]
4 September 2014	Asset-backed securities purchase programme and Covered bond purchase programme 3
22 January 2015	Public sector purchase programme
9 March 2015	Public sector purchase programme

Notes: [a]Announced together with 1-year longer-term refinancing operations (LTROs). [b]Announced on 9 May, a Sunday, so that incorporated into market prices on 10 May. [c]Announced together with 6-month LTROs and ECB Federal Reserve swap line. [d]Announced on 7 August, a Sunday, so that incorporated into market prices on 8 August. [e]Announced together with 1-year LTROs. [f]Announced together with targeted LTROs.

Sources: Draghi (2012), ECB (2014a), ECB (2014b), ECB (2015), Cœuré (2015), Moessner (2015).

Table 2: Announcements of euro area financial stability measures

Date	Announcements of euro area financial stability measures
10 May 2010	European Financial Stability Facility (EFSF) created
14 March 2011[a]	EFSF and European Stability Mechanism (ESM) authorised to intervene in government debt primary market
30 March 2012	EFSF/ESM ceiling increased
29 June 2012	Enable use of EFSF/ESM funds to recapitalize Spanish banks

Notes: [a] Announcement of Friday 11 March 2011 incorporated into market prices on Monday 14 March 2011 due to its timing.
Sources: Council of the European Union (2010), Heads of State or Government of the Euro area (2011), Eurogroup (2012), Euro area summit statement (2012), ESM (2014).

Table 3: Effects on ten-year government bond term premia from announcements of asset purchase and financial stability measures in the euro area

Country	c	d_{ap}	d_{fs}	pol^{sur}	Δesi	Adj. R^2	No. obs
Germany	-0.094	3.677***	2.742	0.252***	0.010	0.010	1813
Netherlands	-0.045	1.747	-2.902*	0.037	0.021	0.001	1813
Finland	-0.041	-2.051	-1.349	0.053	0.027	0.001	1813
Austria	-0.029	-3.159**	-3.206***	0.029	0.033	0.003	1813
France	-0.029	-2.876*	-3.607**	-0.004	0.033	0.003	1813
Belgium	-0.012	-5.874***	-11.010***	-0.065	0.025	0.014	1813
Italy	0.142	-21.568***	-23.210***	-0.264	0.021	0.057	1813
Spain	0.192	-24.550***	-28.442***	-0.332	0.041	0.074	1813
Ireland	0.128	-12.694**	-48.953**	0.166	0.063	0.060	1813
Portugal	0.230	-21.001**	-38.871	-0.155	0.038	0.026	1813
Greece	0.729	-44.253	-109.631	-1.300	0.137	0.005	1813

Dependent variable: Daily changes in term premia for maturity of 10 years (basis points)

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey-West adjusted standard errors. Sample period: 10/01/2008 to 12/30/2015.

Table 4: Regression of the coefficients for announcements of asset purchases and financial stability measures on a country's sovereign risk as measured by CDS spreads

Dependent variable[a]	Coefficient on asset purchases, β_{ap}	Coefficient on asset purchases, β_{ap}	Coefficient on financial stability measures, β_{fs}	Coefficient on financial stability measures, β_{fs}
All countries[b]				
c	-4.457	-1.587	-5.067	-0.002
$CDS_{Oct08\text{-}Dec13}$	-2.248***	-	-5.723***	-
CDS_{Dec13}	-	-6.906***	-	-16.098***
Adj. R^2	0.695	0.820	0.898	0.866
No. obs	11	11	11	11
Excluding Greece[c]				
c	1.069	-0.448	4.213	-2.331
$CDS_{Oct08\text{-}Dec13}$	-5.568***	-	-11.298***	-
CDS_{Dec13}	-	-8.255**	-	-13.337***
Adj. R^2	0.602	0.629	0.871	0.529
No. obs	10	10	10	10

Notes: Sovereign CDS spreads in percentage points. [a] Coefficients for regression of daily change in term premia of 10-year government bonds (basis points) on dummy variables for announcements of asset purchases or financial stability measures from equation (1) over the sample period 10/01/2008–12/30/2015 given in Table 3; [b] Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal, Greece. [c] Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal.
***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors.

Table 5: Effects on ten-year government bond term premia from announcements of asset purchase and financial stability measures in the euro area, 5-day changes

Country	c	d_{ap}	d_{fs}	pol^{sur}	Δ_5esi	Adj. R^2	No. obs
Dependent variable: 5-day changes in term premia for maturity of 10 years (basis points)
Germany	-0.402	6.568**	5.226*	-0.245	0.027	0.006	1803
Netherlands	-0.318	-2.357	3.254	-0.233	0.045*	0.005	1803
Finland	-0.279	-1.849	-1.009	-0.135	0.037	0.002	1803
Austria	-0.318	-3.973	-1.233	-0.358*	0.070***	0.010	1803
France	-0.291	-5.844	6.048	-0.293	0.064**	0.011	1803
Belgium	-0.265	-11.877***	-4.973	-0.287	0.078	0.010	1803
Italy	-0.041	-29.718***	2.876	-0.322	0.044	0.012	1803
Spain	0.138	-38.796***	0.505	-0.275	0.106**	0.022	1803
Ireland	-0.218	-18.538**	-40.748*	0.023	0.099	0.008	1803
Portugal	0.246	-37.383***	-11.219	-0.153	0.061	0.003	1803
Greece	1.945	-39.838	-92.420	-1.248	-0.210	-0.001	1803

*** , ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey-West adjusted standard errors. Sample period: 10/01/2008 to 12/30/2015.

Table 6: Effects on ten-year government bond term premia from announcements of asset purchase and financial stability measures in the euro area, 10-day changes

Dependent variable: 10-day changes in term premia for maturity of 10 years (basis points)						
Country	c	d_{ap}	d_{fs}	pol^{sur}	$\Delta_{10}esi$	Adj. R^2	No. obs
Germany	-0.693	5.409	-2.177	-0.259	0.039	0.005	1790
Netherlands	-0.602	-2.505	-1.803	-0.246	0.035	0.003	1790
Finland	-0.506	-2.077	-6.563	-0.165	0.029	0.002	1790
Austria	-0.606	-1.944	-6.075	-0.475	0.064**	0.010	1790
France	-0.585	-2.351	-3.475	-0.144	0.057*	0.007	1790
Belgium	-0.689	-9.168	-11.404	-0.036	0.077*	0.009	1790
Italy	-0.293	-26.945**	4.638	0.096	0.042	0.005	1790
Spain	-0.086	-26.140**	0.006	-0.181	0.107*	0.010	1790
Ireland	-0.660	-16.776	-24.448	0.439	0.111	0.003	1790
Portugal	0.645	-35.760*	17.917	0.410	0.069	0.000	1790
Greece	3.261	-48.493	-112.002	-2.146	0.100	-0.001	1790

***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. Newey-West adjusted standard errors. Sample period: 10/01/2008 to 12/30/2015.

Table 7: Regression of the coefficients for announcements of asset purchases and financial stability measures, using 5-day changes, on a country's sovereign risk as measured by CDS spreads

| Dependent variable[a]	Coefficient on asset purchases, β_{ap}	Coefficient on asset purchases, β_{ap}	Coefficient on financial stability measures, β_{fs}	Coefficient on financial stability measures, β_{fs}
All countries[b]				
c	-10.123*	-6.242	-4.981	-7.515
$CDS_{Oct08-Dec13}$	-1.944***	-	-5.071**	-
CDS_{Dec13}	-	-6.894***	-	-12.976***
Adj. R^2	0.327	0.563	0.867	0.673
No. obs	11	11	11	11
Excluding Greece[c]				
c	1.502	-0.698	6.282*	-0.032
$CDS_{Oct08-Dec13}$	-8.928***	-	-5.853	-
CDS_{Dec13}	-	-13.464***	-	-4.031**
Adj. R^2	0.656	0.713	0.323	-0.025
No. obs	10	10	10	10

Notes: Sovereign CDS spreads in percentage points. [a] Coefficients for regression of 5-day changes in term premia of 10-year government bonds (basis points) on dummy variables for announcements of asset purchases or financial stability measures from equation (4) over the sample period 10/01/2008–12/30/2015 given in Table 5; [b] Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal, Greece. [c] Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal.
***, ** and * represent significance at the 1%, 5% and 10% levels, respectively. White heteroskedasticity-consistent standard errors.

Appendix Table 1: List of abbreviations

Abbreviation	Refers to
ABSPP	Asset-backed securities purchase programme
APP	Expanded asset purchase programme
ECB	European Central Bank
CBPP1	Covered bond purchase programme 1
CBPP2	Covered bond purchase programme 2
CBPP2	Covered bond purchase programme 3
CDS	Credit default swap
EFSF	European Financial Stability Facility
ESM	European Stability Mechanism
LSAP	Large-scale asset purchase programme
LTROs	Longer-term refinancing operations
MOVE	Merrill Lynch Option Volatility Estimate
NIESR	National Institute of Economic and Social Research
OIS	Overnight index swap
OMT	Outright monetary transactions programme
PSPP	Public sector purchase programme
SMP	Securities market programme

Figure 1: Term premia for a maturity of 10 years derived from government bond yields, in percent
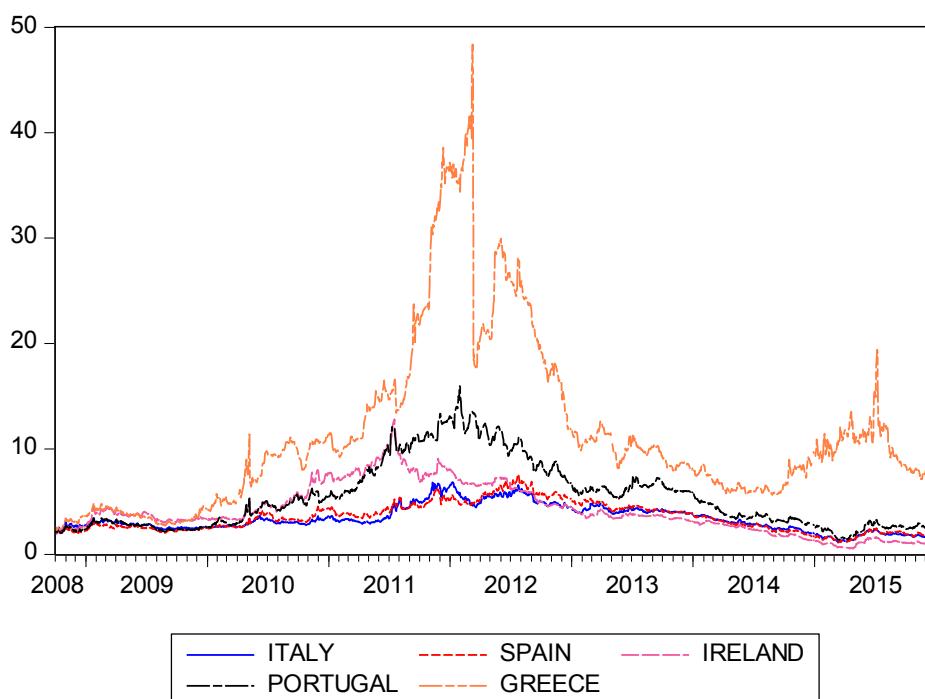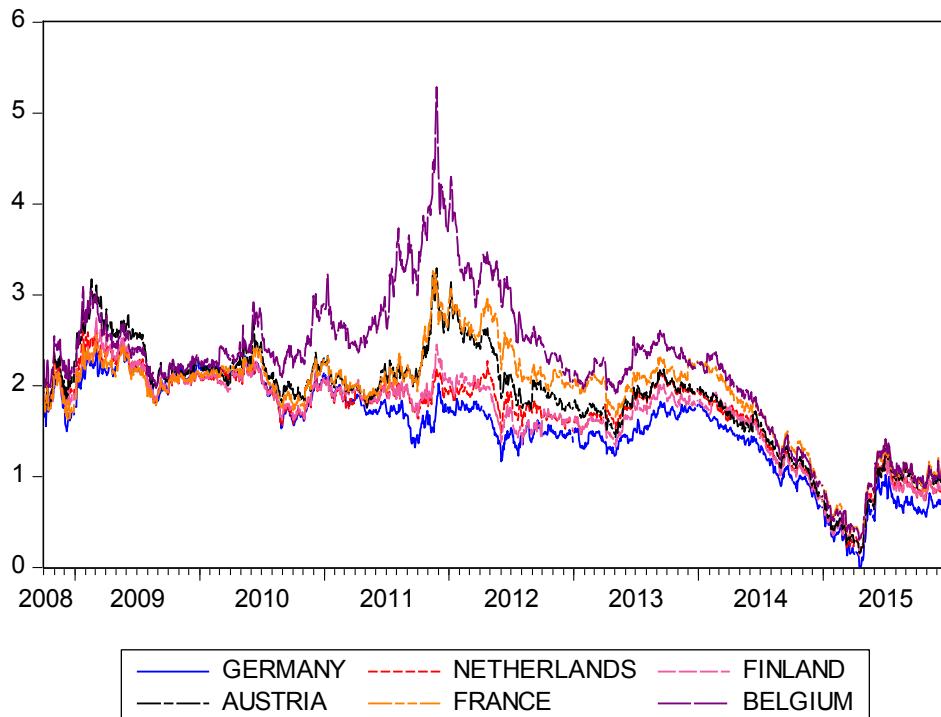
Source: NIESR calculations.

Figure 2: Relationship of coefficients for announcements of asset purchases and financial stability measures with a country's sovereign risk as measured by CDS spreads[a]

Coefficients on asset purchases

Coefficients on financial stability measures

Excluding Greece

Excluding Greece
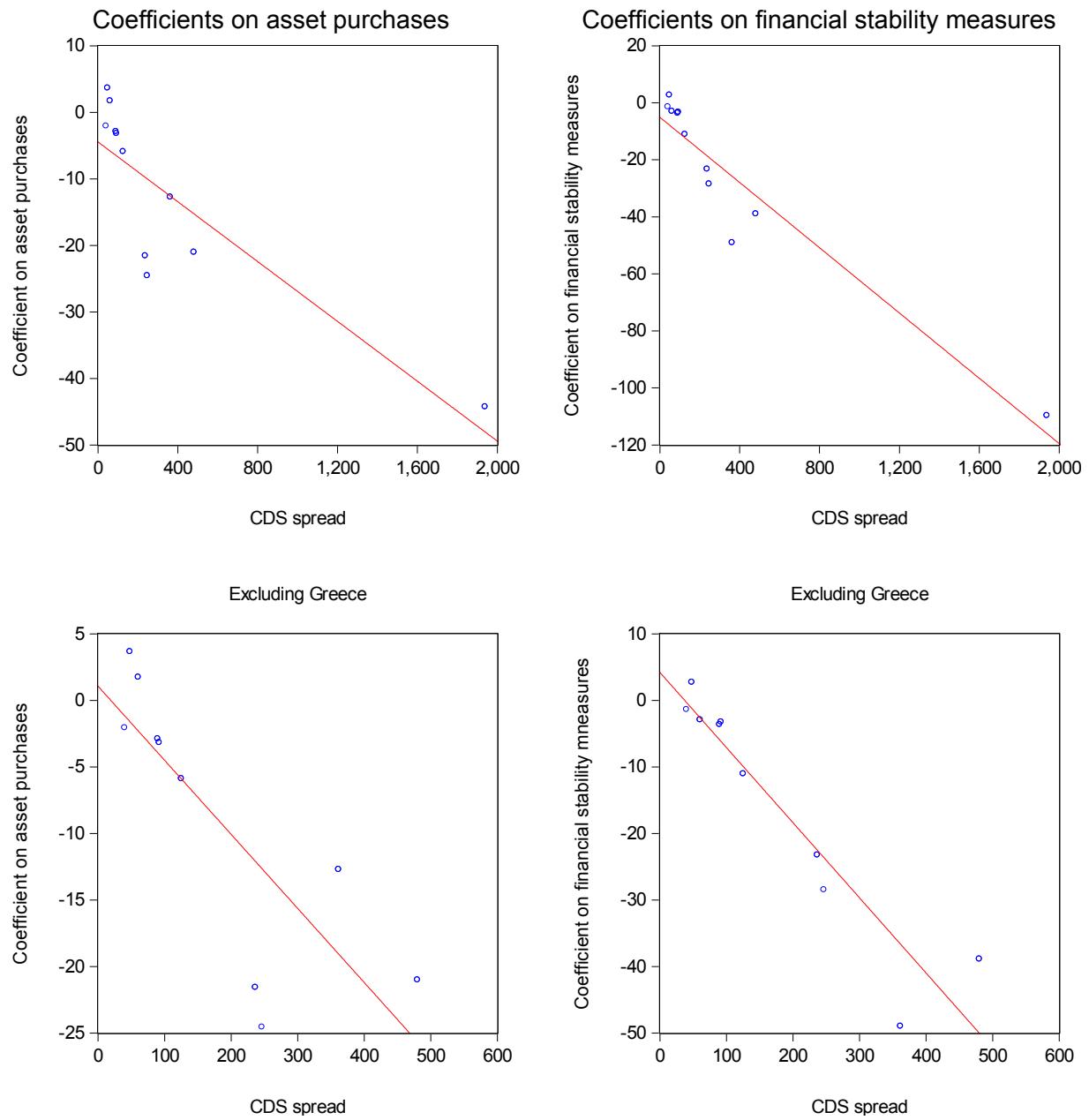
[a] Coefficients for regression of daily changes in term premia of 10-year government bonds (basis points) on dummy variables for announcements of asset purchases or financial stability measures from equation (1) over the sample period 10/01/2008−12/30/2015 given in Table 3 for Germany, the Netherlands, Finland, Austria, France, Belgium, Italy, Spain, Ireland, Portugal, Greece. Averages of sovereign 5-year CDS spreads (in basis points) over October 2008 to December 2013 for each country.