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Robert Goodhead

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The Effect of ECB Policy Announcements on Sovereign Yields: A Return to Normal Transmission?

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This letter quantifies the effects of ECB policy announcements on sovereign yields by studying movements in forward contracts on meeting days of the Governing Council. The pre-crisis, crisis, and post-crisis periods are studied. The analysis focuses on the cases of Germany, France, Italy and Spain. A breakdown of the transmission of ECB policy to sovereign yields for the Italian and Spanish cases is documented during the crisis period, with transmission to the German and French bonds largely unaffected. Transmission for the two stressed economy cases is found to have reverted to that of "normal" times in the post-crisis data.

Introduction

During the financial and sovereign debt crises policymakers became concerned that widespread market disruption might have led to impairment of the transmission mechanisms of monetary policy. This impairment may have come about via several interlinked mechanisms. Most directly, policymakers have argued that poorly functioning financial markets, which became fragmented along national lines during the crisis period, may have limited arbitrage between short-term and long-term rates (Cœuré, 2013). Further, movements in sovereign yields may have had less to do with changes in monetary policy stance, and more to do with changes in expectations regarding the sustainability of the fiscal policies of respective governments, the probability of the collapse of their banking systems (which were themselves exposed to sovereign debt), and the probability of exit from the euro and redenomination of currency.[1] Sovereign yields were also subject to self-sustaining movements, since rises in yields themselves increased the probability of both sovereign default and banking crises, leading to further rises in yields. For this reason, prices likely moved in ways that were unrelated to fundamentals, meaning that changes in ECB policy may not have translated to long-term rates in a regular manner for the stressed economies.

With these considerations in mind, this letter addresses two questions: (1) did the trans-

[*]Central Bank of Ireland, robert.goodhead@centralbank.ie. The views expressed in this paper are those of the author only and do not necessarily reflect the views of the Central Bank of Ireland. I thank Mark Cassidy, Giuseppe Corbisiero, Robert Kelly, Rebecca Stuart, and members of the ECB Monetary Policy Committee Task Force for the Operational Framework in the Long-Run, for valuable advice and feedback. I thank Conor Parle for excellent research assistance.

[1]See González-Páramo (2011) for a summary of these channels. See Illes and Lombardi (2013) for an empirical quantification of impairment for the Euro Area periphery.

mission of monetary policy to long-term rates change during the financial and European sovereign debt crises? (2) did any changes recorded persist into the post-crisis period? Transmission is studied for the cases of Germany, France, Italy and Spain. The cost of borrowing for the Italian and Spanish governments rose dramatically during the period from late 2010 until the third quarter of 2012 – it would be useful for any future crisis episode to quantify the extent to which ECB policy was able to influence yields for these countries. Further, there exists the potential for long-term changes in European sovereign debt markets as a consequence of the crisis. Given the multiple re-evaluations of the credit rating of the Italian and Spanish governments following the onset of the crisis, and the large reallocations of investor funds from the government bonds of stressed countries to those of non-stressed countries, market participants may have permanently altered how they assess sovereign risk. Though the end of the most acute phase of the sovereign debt crisis came about relatively swiftly, with dramatic falls in yields of the stressed countries following the announcement of Outright Monetary Transactions (OMT) by ECB President Mario Draghi in the summer of 2012, it would be of interest to establish whether transmission to European sovereign yields operates now in the same manner it did pre-crisis.[2]

More specifically, this study quantifies the effects of monetary policy announcements by the ECB on sovereign yields during the time-periods of interest. To do this an event-study approach is employed: daily differences in the prices of financial contracts on ECB Governing Council announcement days are used as measures of a monetary policy shock. Given this monetary policy shock series, the effect of policy on yields is obtained by regressions at daily frequency.

The study takes its place within the literature on the high-frequency identification of monetary policy shocks. The paper of Kuttner (2001) introduced the insight that measuring the changes in prices of certain futures contracts on announcement days of the Federal Reserve could provide a means to quantify monetary policy surprises. Certain financial contracts essentially allow market participants to "bet" on future monetary policy. By efficient markets, the prices of such contracts should embody all information available to investors at that time. Therefore, observed changes in futures prices in response to monetary policy news on meeting days ought to reflect only the unpredictable component of such announcements, and provides a suitable measure of a monetary policy surprise. To more precisely isolate monetary policy surprises in US data, Gürkaynak et al. (2005) used intra-daily movements (as opposed to daily changes) in futures contracts. The authors also offered the first decomposition of such movements into surprises relating to actions, as well as surprises relating to communication by policymakers regarding the future path of policy. The latter "path" shock was found to explain a greater fraction of the variation in longer-term rates.

Subsequent studies applied such approaches to the case of the ECB. Brand et al. (2010) extracts monetary policy surprises from intra-daily movements in futures contracts on meeting days of the Governing Council for a sample period covering November 2000 until July

[2]De Santis and Stein (2016) report that Italian and Spanish credit spreads fell by 160-200 basis points compared to a record peak in July 2012 of around 500-600 basis points (with the spreads measured against the overnight indexed swap with the same maturity in place of the risk-free rate).

2007. The authors study multi-dimensional measures of monetary policy, in the manner of Gürkaynak et al. (2005), and also find that announcements can be restricted to two separate types of monetary surprise.[3] Communication by the ECB has strong effects on medium- to long-term interest rates, while news about policy decisions has an effect only on shorter-term rates, thereby confirming that the principal results of Gürkaynak et al. (2005) extend to euro area data.

Jardet and Monks (2014) is the most closely related paper to this study, performing a similar analysis with a sample period from 2002 until 2013 – they are therefore also able to study the euro area sovereign debt crisis. The authors also find that two types of monetary policy surprise are sufficient to explain variation in the data. This result is somewhat surprising given that many non-standard monetary policy measures were announced during the period, in addition to conventional policies. The authors find that a large part of the variation of sovereign bond yields during announcement windows are explained by the two factors. For the German and French cases this result is robust across sample periods. However, for the Italian and Spanish cases the ability of the surprises to explain variation falls markedly during the period after the financial crisis, implying a breakdown in the transmission of monetary policy to these economies. This study documents similar patterns, but extends the analysis to cover the post-crisis period.

The paper of Saskia ter Ellen and Midthjell (2017) examines a sample period covering 2001 to 2015 to quantify the transmission of ECB actions and communication to Norwegian financial variables. The authors find a hump shape response of the yield curve to surprise communication, consistent with findings from the U.S.[4] Kedan and Stuart (2014) construct shock-series in the style of Kuttner (2001) for the euro area and for Switzerland, with the aim of determining the relative effectiveness of adopting overnight rates as operational monetary policy targets (as the ECB is generally considered to do), as opposed to three-month rates (as targeted by the Swiss National Bank).[5] Thus, in general, high-frequency identification studies for the ECB to date have confirmed the findings reported for papers using U.S. data. However, the methods provide a useful means to investigate specifically the crisis in European sovereign debt markets of 2010-2012 and its aftermath.

[3] Specifically, they follow Gürkaynak et al. (2005) and test for the number of factors in the financial contract movements, using the Cragg-Donald test to reject the null of 3 factors, but not the null of two. Brand et al. (2010) also exploit the fact that ECB press conferences commence 45 minutes after the rate decision is conveyed to market participants, using an alternate window designed to capture such communication only, with similar results.

[4] The paper of Andrade and Ferroni (2016) introduces a hybrid approach to identification using both high-frequency jumps in interest rate forwards in response to news, as well as sign restrictions, to isolate the effects of the transmission of information relating to macroeconomic developments by the ECB to markets (in addition to surprise immediate rate changes and surprise communication). Their focus is on the effects of these shocks on industrial production and inflation, as well as inflation expectations.

[5] For event-studies focusing on the ECB's unconventional policy announcements during the crisis period, see Falagiarda and Reitz (2015), Szczerbowicz (2015), and Krishnamurthy et al. (2017). Of course there are many studies on monetary policy transmission to euro area sovereign yields that do not use the event-study approach, for recent examples see Ghysels et al. (2016) or De Santis and Holm-Hadulla (2017). The literature review of this letter focuses exclusively on event-study papers for reasons of brevity.

Methodology

The approach followed in this study comprises two steps: 1) collect measures of monetary policy shocks by studying high-frequency changes in interest rate swap contracts around announcement days of the Governing Council of the ECB; 2) perform regressions on the sample of meeting days in order to quantify transmission from the shock to long-term rates. The analysis is performed on different sub-samples to account for changes in the nature of policy transmission in the pre-crisis, crisis, and post-crisis periods.

The contracts studied are overnight-index swap (OIS) contracts of two different maturities. At the baseline, differences of EONIA OIS contracts of a one-year maturity are used. An EONIA OIS contract is an agreement between two parties to exchange a stream of interest payments at a value fixed in advance (this is referred to as the "fixed leg") for the sequence of interest payments derived from the realized future values of the EONIA (the "floating leg"). The party holding the fixed leg is therefore hedged against rises in interest rates. By efficient markets, the price of the fixed leg ought to represent an average of the market expectations regarding the future path of the EONIA.

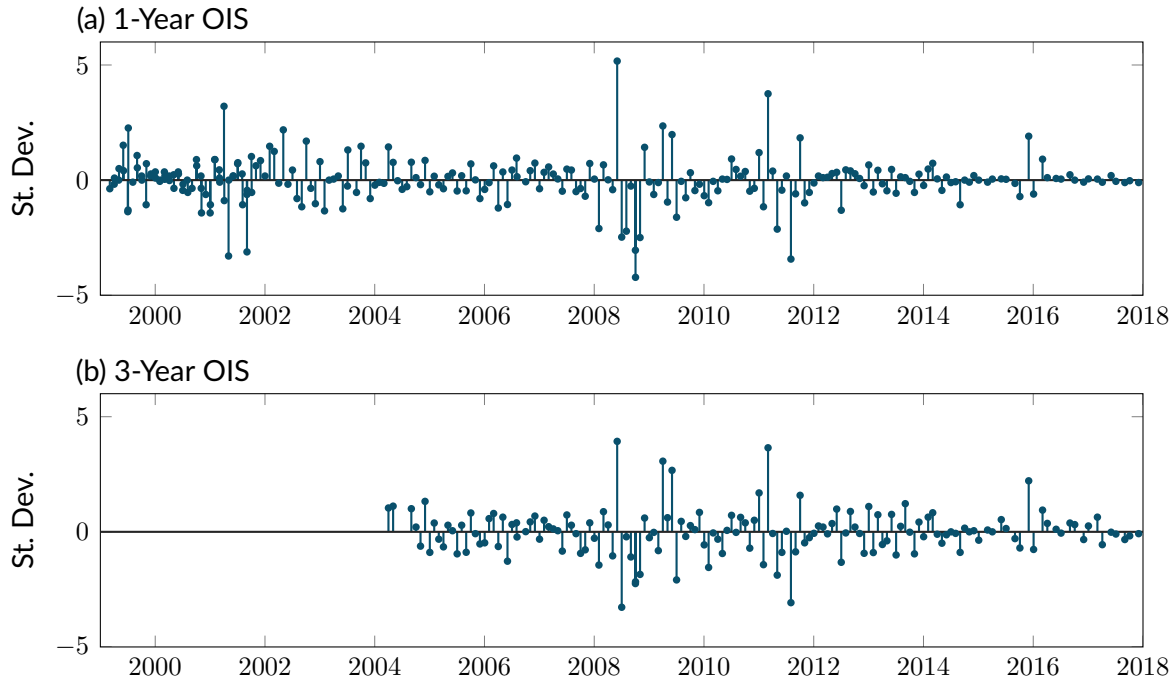
A daily difference in the end-of-day settlement price of the fixed leg of such contracts on meeting days of the ECB Governing Council ought to capture the updating of overnight interest rate expectations in response to policy news. Importantly, a surprise can still be recorded even in the case that the ECB did not actually announce a policy change, since it is entirely possible that the absence of change was unanticipated. A second shock is computed using the three-year EONIA OIS contract for robustness, with an aim to account for potential effects of ECB statements on longer-term interest rate expectations. The use of a longer-horizon shock should also allow for the identification of surprises relating to the explicit forward guidance policy followed by the ECB since July 2013, which could plausibly have implications for market interest rate forecasts at this horizon.[6] The shocks were then normalized to have a standard deviation of one.[7]

The shock series are plotted in Figure 1. We can see several large expansionary shocks during the 2008 credit crunch. Surprise contractionary movements are in evidence for 2011, when the ECB raised interest rates. We see a notable decrease in the volatility of the shock series in the most recent years of the sample, as the ECB has managed to communicate to markets that shorter-term interest rates will be kept low for the foreseeable future. The

[6] In the July 2013 press release the Governing Council stated that it expected "key interest rates to remain at present or lower levels for an extended period of time". The forward guidance was later explicitly linked to APP, with the addition of the sub-clause "and well past the horizon of the net asset purchases". With respect to the horizon of influence: the study of Picault (2017) found that ECB forward guidance lowered overnight index swap rates for maturities within 10 months to 3 years; Hubert and Labondance (2017) also find a maximum significant effect of 3 years in their baseline specification, though alternate specifications document significant effects at longer maturities.

[7] The one-year OIS shock series begins in 18/03/1999. The three-year OIS shock series begins in 01/04/2004. Both series end on 14/12/2017. For the one-year OIS shock, the OIS series meeting of 03/03/1999 was omitted on account of missing data for the day before. For the three-year OIS shock, the meetings of 03/06/2004, 01/07/2004 and 05/08/2004 were omitted on account of missing data.

Figure 1 | Monetary Policy Shock Series



shock derived from the three-year OIS contract displays greater volatility in the most recent period, as one might expect given that at further horizons markets would have likely priced in greater probabilities of rises in the EONIA, and would update these more frequently in response to ECB statements.

Results

To assess the effect of our shocks on sovereign bond yields, we then employ simple OLS regressions at daily frequency, restricting the sample to meeting days of the Governing Council. For each country, we regress the daily difference in sovereign bond yields of interest, x_t, onto our shock series ϵ_t^{mpol}:

$$x_t = \beta_c + \beta \epsilon_t^{mpol} + u_t,$$

where β_c is a constant. We do this respectively for our two shock measures. The equation is estimated only for meeting days.

Baseline results are displayed in Table 1 for a positive one-year OIS shock. Note that the coefficient estimates can be interpreted as showing the effects of a monetary policy shock of one standard deviation, since the shock series were normalized. The full sample extends from 18th March 1999 to 14th December 2017 for this case. Monetary policy shocks are shown to raise the yield of German, French and Italian bonds in the full sample case, almost in every case at high statistical significance. For the Spanish case results are somewhat less significant, at the 5% level (excluding the coefficient for the 10-year yield which is not significant).

Turning to the breakdowns of results by period, the results for the pre-crisis sample (18th

March 1999 to pre-8th October 2008) are typically comparable to those from the full sample for Germany, France and Italy.[8] The responses for the Spanish case become highly significant for the 3-year, 5-year and 10-year bonds.

We turn next to the financial and sovereign debt crisis sample, which ends with the announcement of the details of OMT (i.e. 8th October 2008 to 6th September 2012 inclusive). The coefficients for the German and French cases remain comparable to the values for the entire sample and pre-crisis samples, in fact generally with higher R^2. However for both the Italian and Spanish cases the coefficients become insignificant and very small, sometimes showing perverse negative signs. The R^2 for the Italian and Spanish crisis-period case are very small, mostly less than one hundredth of a percentage point. These results are close to those reported by Jardet and Monks (2014) in their similar exercise, and also lead to the conclusion that for stressed economies there was a severe breakdown in the ability of the ECB to affect sovereign yields by changing expectations regarding short-term interest rates.

Turning to the post-sovereign debt crisis sample (after 6th September 2012 to 14th December 2017) we record a restoration of transmission, for the Italian and Spanish cases, at high levels of significance. The only exception is the one-year Spanish government bond yield, which is partially significant at 10%. In fact the coefficients are larger for all countries in the post-crisis sample, with tests indicating that the differences are typically highly statistically significant. This indicates that the impaired transmission has largely vanished, with the apparent resolution of the European sovereign debt crisis, and that transmission may even be stronger now than it was before.

Further, Table 2 shows that results are robust to the use of the three-year OIS shock. The main real difference between the results is that, for the full sample as well as the crisis sample, results are insignificant for the Italian and Spanish cases. This will likely be due to the smaller number of observations pre-crisis for these two economies, since the three-year OIS series begins in 2004, reducing the ability for the full sample to deliver significant coefficients. For the post-crisis sample, with the exception of the Spanish one-year yield, results are always positive and highly significant for all economies using the three-year shock.

To assess the appropriateness of the selection of sub-sample periods, Chow tests were conducted at the pre-selected sample break dates (8th October 2008 and 6th September 2012). Tests were conducted for both the cases of one structural break (at either of the dates), as well as structural breaks at both dates. Results are displayed in Table 3. Interestingly, with respect to the test for two breaks, representing the onset of the financial crisis and the announcement of OMT, we can see a rejection of the null of no break for all the countries in our sample at yields beyond the one-year maturity. This supports the choice of sub-sample periods used in the analysis. Although these results appear to indicate some structural change in transmission for the German and French sovereign bond markets over the period, the changes in coefficients recorded for the two stressed economies are much starker, in terms of variation in economic and statistical significance.

[8] 8th October 2008 is chosen to mark the onset of the crisis following Jardet and Monks (2014), who choose this date since it marks the ECB announcement of a fixed-rate full allotment policy.

One limitation of the analysis conducted thus far is that the ECB Governing Council also conducted many unconventional policies during the period, with announcements regarding the introduction of such policies, or adjustments to old ones, taking place frequently during the scheduled Governing Council meetings. Many of these policies were designed to affect long-term bond yields (for example the SMP, or Expanded Asset Purchase Programme related purchases). These features are not controlled for in the previous regressions. If announcements relating to such unconventional policies affect long-term rates, but do not change market expectations of the future path of the EONIA within the given horizon of the shock, then the coefficients obtained would likely be over-estimates. In fact, over-estimation should not affect the general conclusions implied by the baseline results, given the principal finding is that monetary policy transmission was very *low* for Italy and Spain during the crisis, before its restoration in the post-crisis period.

However, it remains of interest to examine whether the surprises associated with announcements relating to unconventional monetary policies are driving findings. To this end, the analysis is repeated, this time omitting shocks from dates for which asset purchase schemes were announced (or changes to existing ones). The exact dates omitted are the scheduled meetings listed in Table 5. Table 4 displays results for the one-year OIS shock. German and French coefficients and their significance remain comparable. For the Italian case, the finding of the resumption of the previous transmission relationship is robust to the exclusion of asset purchase announcement days. For the Spanish case the significance of transmission in the post-crisis period is admittedly reduced, particularly for the shorter-horizon bond yields.[9]

Generally one can conclude from such findings that the inclusion of asset purchase announcement dates is important for the high statistical significance of post-crisis transmission in the Spanish case only. Results for Germany, France and Italy are robust. In any event, dropping asset purchase dates provides only a crude means to distinguish between the effects of ECB policy regarding short-term rate changes, and ECB policy regarding purchases of assets with longer-horizon yields. Changes to statements concerning asset-purchase policies will have implications for market expectations of short-term rates, given that the two were explicitly connected in the "sequencing" of ECB forward guidance during the period.[10] Additionally, even on days where no new measures or re-calibrations were announced, markets could still be surprised by the absence of any change to unconventional monetary policy. Thus, all the monetary policy shocks obtained in the crisis and post-crisis periods could be responses to either conventional or unconventional policy, and the resumption of transmission in the post-crisis period documented in this study cannot be attributed solely to one measure or the other.

[9] Results are robust to the use of shock measure. Results for the three-year OIS shock are available from the author upon request.

[10] Markets were told that policy rates would not rise until asset purchases had ceased.

Conclusion

A breakdown in the transmission of ECB policy announcements to the sovereign bond yields of Italy and Spain during the financial and European sovereign debt crisis is shown to have reverted to "normal" post-crisis, in the sense that transmission is shown to be comparable to the pre-crisis experience, if not stronger. Results therefore indicate that the impairment in evidence during the crisis for stressed economies has not persisted beyond the sharp falls in sovereign bond yields and volatility that followed the ECB Governing Council's announcement of the OMT programme. While the analysis was conducted using sub-samples for different time-periods, future analysis would benefit from a full time-varying parameter specification, allowing changes in the structure of monetary policy transmission to be studied in greater detail.

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Table 1 | European Sovereign Yield Responses to 1-Year OIS Shock

	GERMANY				FRANCE			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
1Y Shock	0.028***	0.025***	0.021***	0.015***	0.045***	0.038***	0.031***	0.019***
	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.003
R^2	0.429	0.344	0.246	0.114	0.553	0.545	0.427	0.175
Pre-Financial Crisis Sample:								
1Y Shock	0.022***	0.018***	0.015***	0.010***	0.044***	0.036***	0.030***	0.019***
	0.003	0.003	0.003	0.003	0.004	0.003	0.003	0.003
R^2	0.319	0.220	0.145	0.066	0.482	0.516	0.454	0.223
Financial and Sovereign Debt Crisis Sample:								
1Y Shock	0.035***	0.031***	0.027***	0.019***	0.046***	0.036***	0.028***	0.014**
	0.004	0.004	0.004	0.005	0.004	0.004	0.005	0.006
R^2	0.625	0.596	0.466	0.208	0.706	0.609	0.413	0.116
Post-Sovereign Debt Crisis Sample:								
1Y Shock	0.066***	0.075***	0.080***	0.079***	0.060***	0.073***	0.081***	0.083***
	0.006	0.006	0.008	0.013	0.006	0.007	0.009	0.014
R^2	0.715	0.750	0.653	0.431	0.672	0.702	0.612	0.430
Test: Pre-Crisis = Post-Crisis								
F(2,196)	10.28***	15.69***	17.17***	15.78***	0.70	5.76***	11.39***	13.74***
	ITALY				SPAIN			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
1Y Shock	0.020***	0.017***	0.015***	0.011**	0.009**	0.009**	0.009**	0.005
	0.005	0.005	0.005	0.004	0.004	0.004	0.004	0.004
R^2	0.063	0.054	0.043	0.025	0.017	0.019	0.018	0.005
Pre-Financial Crisis Sample:								
1Y Shock	0.024***	0.021***	0.019***	0.014***	0.008*	0.012***	0.012***	0.008***
	0.002	0.002	0.002	0.003	0.004	0.003	0.002	0.002
R^2	0.421	0.358	0.283	0.163	0.024	0.130	0.141	0.087
Financial and Sovereign Debt Crisis Sample:								
1Y Shock	0.007	0.003	-0.001	-0.005	0.007	-0.002	-0.004	-0.010
	0.017	0.015	0.014	0.013	0.013	0.014	0.013	0.013
R^2	0.003	0.001	0.000	0.003	0.007	0.000	0.002	0.012
Post-Sovereign Debt Crisis Sample:								
1Y Shock	0.067***	0.084***	0.095***	0.101***	0.030*	0.067***	0.084***	0.094***
	0.020	0.020	0.021	0.023	0.017	0.020	0.022	0.022
R^2	0.192	0.263	0.289	0.288	0.059	0.183	0.231	0.275
Test: Pre-Crisis = Post-Crisis								
F(2,196)	6.60***	12.73***	16.33***	18.43***	0.88	9.56***	15.11***	21.12***

Notes: Results shown for regressions of the daily difference in sovereign bond yields on the shock measure, for the indicated maturities of bond. Regressions estimated with a constant, estimate not displayed. The full sample (18/03/1999 to 14/12/2017) has 248 observations, the pre-financial crisis sample (18/03/1999 to pre-08/10/2008) has 149 observations, the financial and sovereign debt crisis sample (08/10/2008 to 06/09/2012) has 48 observations and the post-sovereign debt crisis sample (post-06/09/2012 to 14/12/2017) has 51 observations. Also displayed are test statistics under the null of identical coefficients in pre-crisis and post-crisis samples. Significance: $p^{***} < 0.01$, $p^{**} < 0.05$, $p^{*} < 0.1$.

Table 2 | European Sovereign Yield Responses to 3-Year OIS Shock

	GERMANY				FRANCE			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
3Y Shock	0.034***	0.033***	0.031***	0.027***	0.049***	0.044***	0.040***	0.030***
	0.002	0.002	0.002	0.003	0.003	0.002	0.003	0.003
R^2	0.563	0.602	0.526	0.326	0.672	0.720	0.630	0.360
Pre-Financial Crisis Sample:								
3Y Shock	0.024***	0.020***	0.016***	0.011***	0.056***	0.047***	0.040***	0.026***
	0.004	0.004	0.004	0.004	0.005	0.004	0.003	0.004
R^2	0.439	0.385	0.292	0.143	0.752	0.784	0.738	0.491
Financial and Sovereign Debt Crisis Sample:								
3Y Shock	0.037***	0.036***	0.034***	0.028***	0.046***	0.039***	0.034***	0.023***
	0.004	0.003	0.004	0.005	0.005	0.004	0.004	0.005
R^2	0.634	0.721	0.662	0.420	0.648	0.673	0.559	0.274
Post-Sovereign Debt Crisis Sample:								
3Y Shock	0.045***	0.057***	0.064***	0.068***	0.039***	0.055***	0.064***	0.070***
	0.005	0.004	0.005	0.008	0.005	0.004	0.005	0.008
R^2	0.658	0.830	0.804	0.615	0.567	0.760	0.748	0.605
Test: Pre-Crisis = Post-Crisis								
F(2,99)	5.60***	21.61***	30.78***	25***	2.48*	0.93	7.41***	13.81***
	ITALY				SPAIN			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
3Y Shock	0.012	0.011	0.010	0.008	0.011	0.002	0.002	0.003
	0.008	0.007	0.007	0.007	0.007	0.007	0.007	0.007
R^2	0.015	0.014	0.013	0.010	0.017	0.001	0.001	0.001
Pre-Financial Crisis Sample:								
3Y Shock	0.017***	0.015***	0.014***	0.011***	0.008	0.007**	0.007**	0.011***
	0.004	0.003	0.003	0.003	0.007	0.003	0.003	0.004
R^2	0.295	0.281	0.246	0.183	0.027	0.076	0.082	0.136
Financial and Sovereign Debt Crisis Sample:								
3Y Shock	-0.001	-0.005	-0.007	-0.010	0.009	-0.011	-0.014	-0.018
	0.018	0.016	0.015	0.013	0.014	0.014	0.014	0.013
R^2	0.000	0.002	0.005	0.013	0.009	0.014	0.022	0.037
Post-Sovereign Debt Crisis Sample:								
3Y Shock	0.048***	0.060***	0.069***	0.074***	0.023*	0.046***	0.057***	0.066***
	0.014	0.014	0.015	0.016	0.012	0.015	0.016	0.016
R^2	0.191	0.264	0.292	0.296	0.066	0.165	0.207	0.262
Test: Pre-Crisis = Post-Crisis								
F(2,99)	3.61**	7.05***	9.16***	10.39***	0.54	4.91***	7.65***	8.34***

Notes: Results shown for regressions of the daily difference in sovereign bond yields on the shock measure, for the indicated maturities of bond. Regressions estimated with a constant, estimate not displayed. The full sample (01/04/2004 to 14/12/2017) has 151 observations, the pre-financial crisis sample (01/04/2004 to pre-08/10/2008) has 52 observations, the financial and sovereign debt crisis sample (08/10/2008 to 06/09/2012) has 48 observations and the post-sovereign debt crisis sample (post-06/09/2012 to 14/12/2017) has 51 observations. Also displayed are test statistics under the null of identical coefficients in pre-crisis and post-crisis samples. Significance: $p^{***} < 0.01$, $p^{**} < 0.05$, $p^{*} < 0.1$.

Table 3 | Tests for Structural Break (1-Year OIS)

	GERMANY				FRANCE			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
One Break at 08/10/2008:								
$\chi^2(1)$	16.05	16.33	13.15	7.04	0.50	0.57	0.42	0.20
p	0.000	0.000	0.000	0.008	0.479	0.449	0.517	0.659
One Break after 06/09/2012:								
$\chi^2(1)$	14.58	25.28	28.33	25.33	1.25	11.16	20.89	25.12
p	0.000	0.000	0.000	0.000	0.263	0.001	0.000	0.000
Two Breaks at 08/10/2008 and after 06/09/2012								
$\chi^2(2)$	25.09	34.69	34.88	27.66	1.43	11.12	21.12	25.88
p	0.000	0.000	0.000	0.000	0.489	0.004	0.000	0.000
	ITALY				SPAIN			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
One Break at 08/10/2008:								
$\chi^2(1)$	1.16	1.21	1.13	0.81	0.12	0.62	0.75	0.79
p	0.282	0.271	0.288	0.368	0.732	0.431	0.387	0.373
One Break at 06/09/2012:								
$\chi^2(1)$	3.84	8.72	13.23	19.44	0.95	7.66	12.6	19.88
p	0.050	0.003	0.000	0.000	0.330	.006	0.000	0.000
Two Breaks at 08/10/2008 and after 06/09/2012								
$\chi^2(2)$	6.62	12.71	17.96	24.5	0.95	10.22	16.31	24.96
p	0.037	0.002	0.000	0.000	0.621	0.006	0.000	0.000

Notes: Table shows results for Chow (Wald) tests for structural breaks in the regression of the daily difference in sovereign bond yields on the 1-Year OIS shock measure, for the indicated maturities of bond. A constant is included in the regression. The specific break dates tested are indicated. $\chi^2(n)$ indicates the value of the test statistic, with appropriate chi-squared limiting distribution, with degree of freedom n. The row marked p shows the p-value. All 248 observations are included in the regression.

Table 4 | European Sovereign Yield Responses to 1-Year OIS Shock, Omitting Asset Purchase Announcement Days

	GERMANY				FRANCE			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
1Y Shock	0.027***	0.023***	0.020***	0.013***	0.045***	0.037***	0.030***	0.018***
	0.002	0.002	0.002	0.003	0.003	0.002	0.002	0.003
R^2	0.410	0.325	0.228	0.099	0.531	0.525	0.408	0.159
Financial and Sovereign Debt Crisis Sample:								
1Y Shock	0.036***	0.032***	0.027***	0.018***	0.044***	0.035***	0.027***	0.013**
	0.005	0.004	0.004	0.005	0.005	0.005	0.005	0.006
R^2	0.611	0.596	0.480	0.224	0.669	0.569	0.374	0.100
Post-Sovereign Debt Crisis Sample:								
1Y Shock	0.062***	0.072***	0.078***	0.079***	0.046***	0.066***	0.079***	0.086***
	0.008	0.009	0.012	0.019	0.009	0.011	0.015	0.021
R^2	0.578	0.612	0.490	0.296	0.385	0.481	0.420	0.299
	ITALY				SPAIN			
	1Y	3Y	5Y	10Y	1Y	3Y	5Y	10Y
1Y Shock	0.020***	0.017***	0.014***	0.009**	0.010**	0.009**	0.008*	0.004
	0.005	0.005	0.005	0.004	0.005	0.004	0.004	0.004
R^2	0.062	0.050	0.039	0.022	0.020	0.017	0.016	0.004
Financial and Sovereign Debt Crisis Sample:								
1Y Shock	0.009	0.004	-0.000	-0.006	0.012	0.000	-0.002	-0.007
	0.019	0.017	0.015	0.012	0.014	0.015	0.014	0.012
R^2	0.006	0.001	0.000	0.005	0.018	0.000	0.001	0.008
Post-Sovereign Debt Crisis Sample:								
1Y Shock	0.081**	0.095***	0.103***	0.103***	0.012	0.063*	0.078**	0.074**
	0.032	0.032	0.034	0.034	0.028	0.033	0.035	0.032
R^2	0.135	0.173	0.186	0.184	0.004	0.082	0.110	0.114

Notes: Results shown for regressions of the daily difference in sovereign bond yields on the shock measure, for the indicated maturities of bond, omitting announcement days associated with news relating to asset purchases. Regressions estimated with a constant, estimate not displayed. The full sample (18/03/1999 to 14/12/2017) has 235 observations, the financial and sovereign debt crisis sample (08/10/2008 to 06/09/2012) has 43 observations and the post-sovereign debt crisis sample (post-06/09/2012 to 14/12/2017) also has 43 observations. The results for the pre-financial crisis are identical to those from Table 1 and are not displayed. Significance: $p^{***} < 0.01$, $p^{**} < 0.05$, $p^{*} < 0.1$.

Table 5 | Key Policy Announcements Relating to Asset Purchases in the Eurozone

Date	Scheduled?	Programme	Description
7 May 2009	Yes	CBPP1	The Governing Council of the ECB announces its decision to purchase covered bonds.
4 Jun. 2009	Yes	CBPP1	The ECB publishes detailed modalities for the CBPP1, including information on volume and eligibility.
10 May 2010	No	SMP	The Governing Council announces the SMP as part of a package with other measures to address increased tensions in euro area financial markets.
7 Aug. 2011	No	SMP	Draghi announces the reactivation of the SMP, targeting Italian and Spanish bonds in particular.
6 Oct. 2011	Yes	CBPP2	The Governing Council announces the launch of the CBPP2, including details on volume and length.
3 Nov. 2011	Yes	CBPP2	The ECB announces detailed modalities for the CBPP2.
26 Jul. 2012	No	OMT	Draghi announces that the ECB is "ready to do whatever it takes to preserve the euro".
2 Aug. 2012	Yes	OMT	The Governing Council announces is consideration of outright open market operations.
6 Sep. 2012	Yes	OMT	The Governing Council announces the OMT programme, including detailed modalities.
4 Sep. 2014	Yes	ABSPP/CBPP3	The Governing Council announces its decision to launch the ABSPP and the CBPP3.
2 Oct. 2014	Yes	ABSPP/CBPP3	The ECB publishes detailed modalities for the ABSPP and the CBPP3.
22 Jan. 2015	Yes	PSPP	The Governing Council announces an expanded asset purchase programme, encompassing the new PSPP as well as the formerly launched ABSPP and the CBPP3. Purchases of €60 billion intended to be carried out until end-September 2016 or beyond, if necessary.
9 Mar. 2015	No	PSPP	The PSPP is implemented.
3 Dec. 2015	Yes	APP	The ECB extends the APP, with the monthly purchases of €60 billion intended to run until the end of March 2017, or beyond if necessary.
10 Mar. 2016	Yes	APP	The ECB extends the APP, with the monthly purchases of €60 billion increased to €80 billion.
2 Jun. 2016	Yes	CSPP	The Eurosystem announced it would buy corporate sector bonds under the corporate sector purchase programme.
8 Dec. 2016	Yes	APP	The ECB announced that from April 2017, net asset purchases are intended to continue at a monthly pace of €60 billion until the end of December 2017, or beyond if necessary.
26 Oct. 2017	Yes	APP	The ECB announced that from January 2018 the net asset purchases are intended to continue at a monthly pace of €30 billion until the end of September 2018, or beyond if necessary.

Notes: Table extends Table 1 of Watfe (2015) (pp. 13), using the chronologies contained in the annexes to Gambetti and Musso (2017) (Annex II pp. 37), and information from the ECB website. The "Scheduled?" column refers to whether the announcement was made during a scheduled ECB Governing Council policy announcement. The unscheduled announcements are not included in the baseline dataset and are included for reference. Glossary: "CBPP" – Covered Bond Purchase Programme, "SMP" – Securities Market Programme, "OMT" – Outright Monetary Transactions, "ABSPP" – Asset Backed Securities Purchase Programme, "PSPP" – Public Sector Purchase Programme, "APP" – Asset Purchase Programme, "CSPP" – Corporate Sector Purchase Programme.