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ECB Policy and Eurozone Fragility: Was De Grauwe Right?

Orkun Saka, Ana-Maria Fuertes and Elena Kalotychou

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Abstract

Paul De Grauwe's fragility hypothesis states that member countries of a monetary union such as the eurozone are highly vulnerable to a self-fulfilling mechanism by which the efforts of investors to avoid losses from default can end up triggering the very default they fear. The authors test this hypothesis by applying an eclectic methodology to a time window around Mario Draghi's "whatever it takes" (to keep the eurozone on firm footing) pledge on 26 July 2012. This pledge was soon followed by the announcement of the Outright Monetary Transactions (OMT) programme (the prospective and conditional purchase by the European Central Bank of sovereign bonds of eurozone countries having difficulty issuing debt). The principal components of eurozone credit default swap spreads validate this choice of time frame. An event study reveals significant pre-announcement contagion emanating from Spain to Italy, Belgium, France and Austria. Furthermore, time-series regression confirms frequent clusters of large shocks affecting the credit default swap spreads of the four eurozone countries but solely during the pre-announcement period. The findings of this report support the fragility hypothesis for the eurozone and endorse the Outright Monetary Transactions programme.

Keywords: Sovereign debt; Eurozone; European Central Bank; Outright Monetary Transactions; Self-fulfilling panic.

JEL classification: E44, F36, G15, C52.

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You have large parts of the euro area in what we call a "bad equilibrium", namely an equilibrium where you may have self-fulfilling expectations that feed upon themselves and generate very adverse scenarios. (Mario Draghi)[1]

1. Introduction

Financial crises represent one of the toughest conundrums for economic policy-makers and financial economists. Following a crisis, the word 'contagion' proliferates in headlines, and blame is regularly put on investors' risk appetites. However, a financial crisis may also be sparked by the inherent features of an economic system. Investors' actions may amplify the effects of an exogenous shock to the economy, generating a still larger shock (Danielsson et al., 2013): in trying to avoid individual losses they might by their very nature trigger a market apocalypse (Shin, 2010). This so-called endogeneity constitutes a dimension of fragility in today's highly connected economies and may even threaten the functionality of modern free market mechanisms. Thus, it becomes critical for policy-makers to ask questions such as: Which economic structures are more prone to this type of market dysfunctionality? And what type of policy actions should be taken to break the vicious circle between investor actions and adverse market outcomes during financial crises?

Since 2009, when the debt problems of Greece came to light, the suddenness and magnitude of changes in eurozone bond yield spreads have sparked wide debate among economists regarding the likely causes. This debate resurrects two conflicting views of debt crises. The *fundamentalist* view is that widening yield spreads reflect serious deterioration in countries' macroeconomic fundamentals. The *multiple-equilibria* view contends instead that markets may not always function optimally, and therefore countries may find themselves in any one of a set of possible equilibrium conditions (i.e., distinct scenarios running the gamut from stability to full-blown crisis) without experiencing any major change in fiscal fundamentals.

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[1] Mario Draghi, 6 September 2012.
See www.ecb.europa.eu/press/pressconf/2012/html/is120906.en.html.

Thus, the decisions of panic-driven investors may lead a country to a crisis that otherwise would not have unfolded; this is termed self-fulfilling dynamics.

The idea that a monetary union lends itself to the devilish effects of self-fulfilling dynamics was originally promoted by the Belgian economist Paul De Grauwe, who summed it up in his *fragility hypothesis* (De Grauwe, 2011a,b). This hypothesis states that, by issuing debt in a currency that they cannot control, member states are more vulnerable to adverse investor sentiment and sudden halts in capital inflows and, hence, more prone to sovereign debt crises. De Grauwe's fragility hypothesis has as its main element the notion of self-fulfilling dynamics, namely, market pessimism[2] about a sovereign's ability to service its debt is likely to trigger higher interest rates, which will make it harder for the sovereign to roll over its short-term debt, creating a feedback effect between investor sentiments and interest rates that could trigger default.[3] Such a phenomenon is less likely to occur in a sovereign that maintains control over its currency, even though its fundamentals may be worse, because the markets recognise the presence of a central bank that stands ready to inject the necessary liquidity.[4] De Grauwe and Yuemei Ji (2013) note that countries with similar fiscal outlooks but different currency regimes (e.g., Spain and the United Kingdom) experienced notably different borrowing costs in the aftermath of the Greek crisis. This is interpreted as evidence that multiple equilibria can exist in the eurozone unless the European Central Bank (ECB) takes up the function of lender of last resort, injecting the necessary liquidity in a crisis.[5] Important steps have been taken in this direction.

The ECB resident announced on 27 July 2012 that the ECB was prepared to "do whatever it takes to preserve the euro".[6] On 6 September 2012, the Outright Monetary Transactions (OMT) programme was officially launched, under which the ECB would act as a lender of last resort () for countries applying to the European Stability Mechanism (ESM).[7] This change in policy stance provides an ideal laboratory that can serve to shed light on the

[2] The term 'market pessimism' is employed here to refer to expectations that investors might rationally harbour and might later see validated in a self-fulfilling way as a result of the interaction between market interest rates and government budget constraints (Calvo, 1988; Corsetti and Dedola, 2013).

[3] Guillermo A. Calvo (1988) was the first to employ the logic of multiple equilibria to rationalize sovereign debt crises in countries that issue debt in a foreign currency by explicitly incorporating the role of expectations into a government debt auction scheme. Multiple-equilibria models were proposed previously for explaining banking crises (Diamond and Dybvig, 1983) and currency crises (Obstfeld, 1984).

[4] Giancarlo Corsetti and Luca Dedola (2013) maintain that self-fulfilling debt crises are equally likely for a eurozone member and for a country that issues debt in its own currency. They also show that central banks have to get the fiscal support of their Treasury in order to provide a credible backstop against endogenous market expectations. Since such support is harder to get in a monetary union without political unity, one can therefore argue that eurozone countries are more prone to self-fulfilling dynamics than stand-alone countries.

[5] Thus, the ECB would have to intervene only when there is a real risk of solvency. Opponents assert that such a facility might sap governments' will to impose discipline on their fiscal operations, but that risk could be mitigated by the strict fiscal supervision attached to the ECB's liquidity mechanism. Multiple equilibria will cease to exist if the ECB can credibly commit to provide liquidity to a country that accepts conditionality and can credibly commit to stop the programme if the country ceases to abide by the stipulated conditions.

[6] Mario Draghi, 26 July 2012. See www.ecb.europa.eu/press/key/date/2012/html/sp120726.en.html.

[7] OMT is an ECB programme through which the central bank can make purchases (outright transactions) in the secondary bond markets of eurozone member states. Conditionality is attached to prevent moral hazard.

fundamentalist versus multiple-equilibria debate. A thorny issue is that the two schools share various that make them difficult to separate empirically.

There is mounting evidence of what are termed *wake-up calls* in the eurozone, namely, the phenomenon by which markets ignore deteriorating fiscal fundamentals during non-crisis periods but become highly sensitive to them in crises.[8] Carlos Caceres and coauthors (2010) weigh the relative impact of global risk aversion, regional spillovers and country-specific fiscal fundamentals on surges in eurozone sovereign bond interest spreads between late 2009 and early 2010, and they identify fundamentals as the main driving force. Michael G. Arghyrou and Alexandros Kontonikas (2012) show that eurozone markets were behaving according to a 'convergence-trade' model (trading with the expectation that the values of similar bonds across the currency area will converge) until the eruption of the global financial crisis in the United States, and fundamentals started to matter only after 2007. John Beirne and Marcel Fratzscher (2013) document wake-up call contagion as the primary channel through which the recent turmoil in eurozone sovereign debt markets was expressed. Paolo Manasse and Luca Zavalloni (2013) find that only in crisis periods is eurozone sovereign risk strongly linked to the real economy and the labour market.

Multiple-equilibria models predict that fundamentals matter in the sense that only very bad and very good fundamentals would precipitate a single outcome, default or no default, respectively; self-fulfilling dynamics have ample space to unfold in between these poles.[9] Hence, advocates of the multiple-equilibria view do not deny increased sensitivity to fundamentals such as real GDP growth, public debt ratios and current account to GDP ratios in the run-up to the eurozone debt crisis (Aizenman et al., 2013; Grauwe and Ji, 2013). Their key contention is instead that bond spreads of eurozone states considered to be on the periphery have been too high compared with otherwise similar countries outside the eurozone, even after allowing for increased sensitivity to fundamentals, which leaves a role for self-fulfilling dynamics in the region. In a nutshell, multiple-equilibria proponents hold that, although fundamentals matter, they are not the whole story. As Paul Krugman (2012) puts it, "So here's Europe's Big Delusion: it's the belief that Europe's crisis was essentially caused by fiscal irresponsibility … it is more complicated than that."

A growing literature investigates the phenomenon of financial contagion (loosely construed, with many nuances) among eurozone sovereign debt markets.[10] A popular definition of contagion, as originally proposed by Kristin J. Forbes and Roberto Rigobon (2002), is a significant increase in cross-market linkages following bad shocks to one market. The step-up in cross-market linkages can take place through channels such as financial institutions, shifts in portfolio investment or 'wake-up calls'; therefore, contagion is often the by-product of increased globalisation (Forbes, 2012). This means that contagion threats in the eurozone

[8] See Goldstein et al. (2000). This phenomenon is aligned with notions of 'rational inattention' by which investors may rationally choose to ignore some information when the cost of information acquisition/processing is too steep. Some also argue that that the perceived safety of government bonds in Europe before the crisis was attributable to the implicit bailout guarantee of the monetary union for its members' debt, but markets started to pay close attention to members' fiscal positions as soon as they realized that there was no such guarantee (Cochrane, 2010)

[9] For a simple theoretical model of debt crises with multiple equilibria, see De Grauwe (2011a). For more formal treatments, see Calvo (1988), Gros (2012), Corsetti and Dedola (2011; 2013).

[10] See Caceres et al. (2010), De Grauwe (2011a, b), Arghyrou and Kontonikas (2012), Caporin et al. (2013), De Grauwe and Ji (2013, 2014), Manasse and Zavalloni (2013), Alter and Beyer (2013), Mink and De Haan (2013), Beirne and Fratzscher (2013), Aizenman et al. (2013), Beetsma et al. (2013), De Santis (2014), among others.

necessarily go hand-in-hand with greater economic and financial integration among member states.

Marta Gómez-Puig and Simón Sosvilla-Rivero (2013) adduce evidence in this regard by documenting episodes of increased Granger causality (a test to determine whether one time series can predict another) between peripheral eurozone country bond yields during the post-2009 crises. Such episodes can be interpreted as contagion and are found to be related to increased banking linkages (financial integration) across countries.

This paper aims to contribute further empirical evidence on the validity of the fragility hypothesis originally articulated by De Grauwe. By using the OMT announcement as a 'laboratory', it tests the hypothesis that countries in a monetary union, lacking control over their currency, are vulnerable to 'unnecessary' (non- fundamental based) contagion of bad news in sovereign debt markets through panic that can become self-fulfilling. It represents the first attempt to shed light on the long-standing theoretical debate between fundamentalists and multiple-equilibria proponents by investigating whether the change in the ECB's policy stance (the OMT announcement) has effectively curbed the contagion in eurozone debt markets. The paper takes a cross-section of sovereign credit default swaps (CDS) contracts a representative sample of the 'periphery' versus 'core' eurozone countries, as well a European countries that remain outside the currency area. This allows for an assessment of the way that markets have discriminated (in terms of sovereign risk pricing) between eurozone 'periphery' and 'core' countries, and between European countries that control their own currency versus those that do not. The methodology is eclectic, deploying a principal component analysis, an event-study analysis and a residual 'herding contagion' analysis of CDS spreads.

The principal components analysis of eurozone CDS spreads suggests that the OMT announcement decreased the overall perception of sovereign risk and volatility for the eurozone as a whole and changed the way markets discriminate among sovereigns toward more emphasis on fundamentals. The event study reveals that the pre-announcement contagion effects from Spain-specific bad news largely receded following the OMT announcement. The residual analysis confirms that the OMT announcement alleviated the herding contagion previously seen in the region.

These findings support De Grauwe's fragility hypothesis. Contagion effects spreading from Spain to Italy, Belgium, France and Austria in the period before the OMT announcement are no longer apparent after the OMT announcement. Time-series models of sovereign spreads confirm the frequent clustering of substantial shocks (hence, the presence of herding contagion) for those countries where contagion effects were previously identified, but similar clusters were not observed in the post-announcement period. Overall these findings clearly support the multiple-equilibria view of the crisis, which does not overlook the importance of fundamentals but adds that, in times of massive economic adjustment, panic amplifies the initial exogenous shocks and can push an otherwise solvent country toward default. The evidence suggests that there is more to the post-2009 eurozone sovereign debt crises than the well-documented strengthening of the link between bond yields and fundamentals. In fact, the OMT policy has been effective in curbing 'unnecessary' contagion infecting eurozone credit risk – that is, the prospects of self-fulfilling fear leading to huge interest rates on European bonds have receded. Evidence presented in the pages to follow also indirectly refutes the belief that the eurozone crisis was solely caused by fiscal irresponsibility (Krugman, 2012).

Amid a heated debate on the OMT programme, 'core' members of the eurozone have expressed disapproval for the policy by arguing that such unlimited bond-buying promises may pave the way for feckless governments to postpone painful structural reforms and

austerity plans (in other words, moral hazard). They further argue that the OMT programme puts excessive risks on core members that had done nothing to deserve to pay for the misdemeanours of the 'periphery'.[11] In sharp contrast, various economists have applauded the OMT announcement as game-changer in the European sovereign debt markets (see, e.g., Krugman, 2011). The empirical findings from the eclectic methodology employed in this paper to investigate the dynamics of European sovereign CDS spreads serve to strengthen other supportive evidence from recent studies that find that the OMT programme has had a depressive effect on eurozone bond yield spreads and default risks (Falagiarda and Reitz, 2013; Lucas et al., 2013; Altavilla et al., 2014).

2. Data Description and Preliminary Analysis

2.1 Sovereign Credit Default Swaps

The raw data used for the analysis come from daily midpoint closing spread quotes on five-year sovereign credit default swap (CDS) contracts from 1 January 2008 to 25 July 2013 collected from *Datastream*. The CDS contracts correspond to four 'peripheral' eurozone countries (Ireland, Italy, Portugal and Spain), six 'core' eurozone countries (Austria, Belgium, Finland, France, Germany and the Netherlands), and four non-euro European countries (Denmark, Norway, Sweden and the United Kingdom).[12] CDS spreads are seen to capture default risk more accurately than bond yield spreads because the latter have a time-varying non-default component that is strongly related to measures of bond-specific illiquidity (Longstaff et al., 2005).

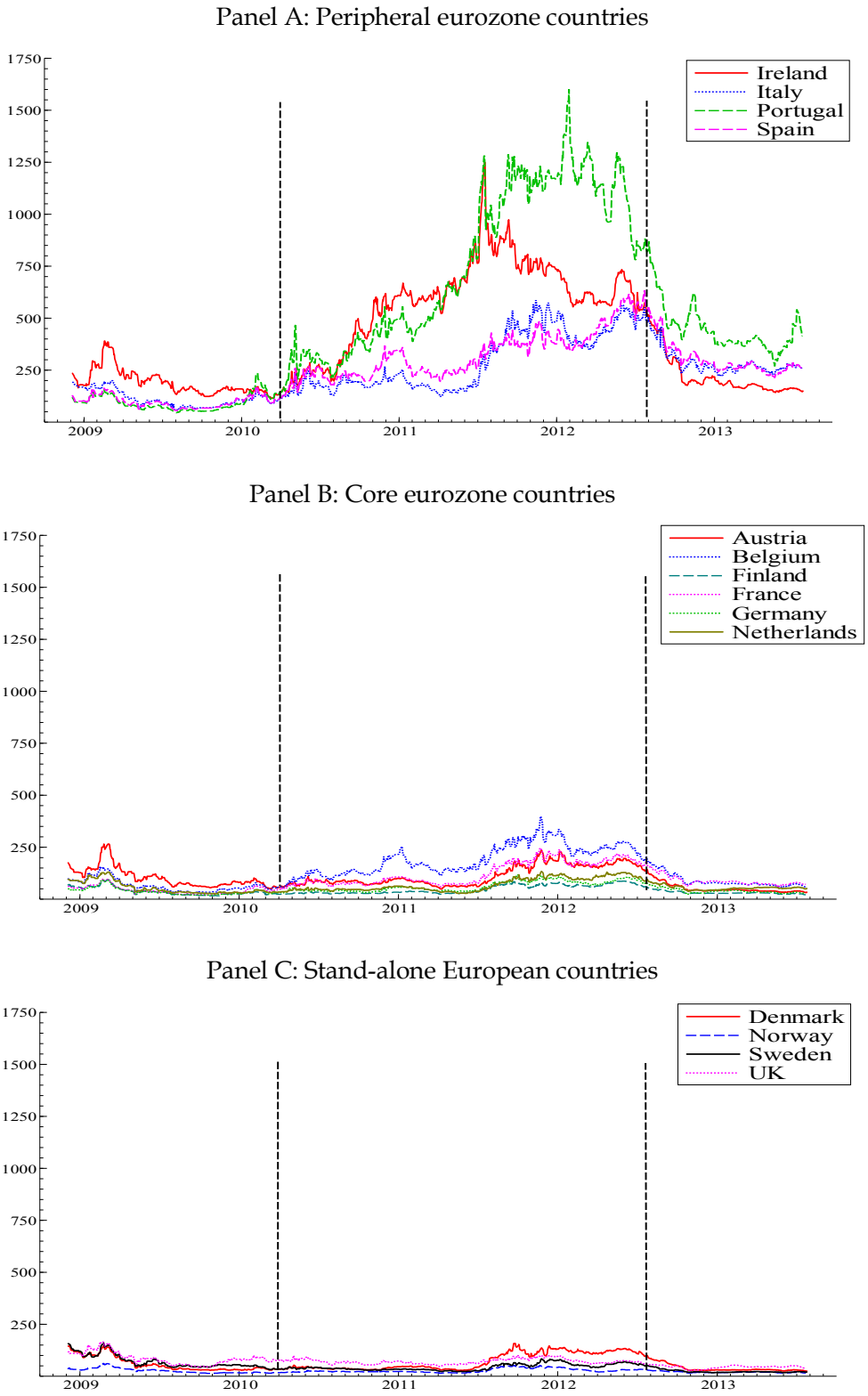
The evolution of daily CDS spreads, plotted in Figure 1, confirms a first notable bout of investor risk aversion and negative perceptions toward peripheral eurozone sovereigns around March 2010, when Greece was first rescued. Declines in all CDS spreads are seen after 26 July 2012, when ECB President Mario Draghi made it clear that ECB was prepared to "do whatever it takes to preserve the euro"; hereafter, this is called the implicit OMT announcement date, although the official announcement of the programme occurred only in early September 2012.

Table 1 summarises the distribution of CDS premiums (the rate paid by the recipient of credit insurance) over the 12-month window preceding the implicit OMT announcement (Panel A) and the 12-month post-announcement window (Panel B). All premiums are expressed in basis points. The buyer of the CDS contract (which serves as insurance on sovereign debt) pays in US dollars, based on dollar-denominated notional amounts. The last column reports the change in CDS spreads from the initial day to the last day of the corresponding window.

[11] See Hans-Werner Sinn, "Outright monetary infractions", *Project Syndicate*, 9 February 2014.

[12] Following the literature, EU Economic and Monetary Union countries that are recent entrants (such as Latvia) and other economically small countries (such as Estonia, Slovakia, Malta and Slovenia) are excluded from the periphery for the purposes of this paper; see, for instance, Arghyrou and Kontonikas (2012), Beirne and Fratzscher (2013), De Santis (2014), Beetsma et al. (2013), De Grauwe and Ji (2013, 2014). The exclusion of Greece from the analysis, which is driven by lack of CDS data from March 2012, is not material given that it has been shown that the systemic importance of Greece lessens notably in the more recent stages of the crisis (see González-Hermosillo and Johnson, 2014).

Figure 1. Evolution in daily sovereign CDS spreads from 5 December 2008 to 25 July 2013



Note: The CDS spreads reported in basis points pertain to 10 eurozone countries distinguished as core and peripheral using the standard classification and four European countries that have not adopted the euro. The first vertical line on 31 March 2010 marks the date of the first rescue package for Greece, and the second line on 26 July 2012 marks the date when the ECB declared that it was prepared to "do whatever it takes to preserve the euro", which is taken as implicit OMT announcement.

Table 1. Descriptive statistics for daily sovereign CDS spreads of European countries

	Panel A. *Pre-announcement* 26.07.2011 – 25.07.2012					Panel B. *Post-announcement* 26.07.2012 – 25.07.2013				
	Average	Stan. Dev.	Min.	Max.	ΔCDS	Average	Stan. Dev.	Min.	Max.	ΔCDS
Periphery eurozone countries										
Ireland	696.76	110.06	522.25	973.43	- 370.31	222.95	97.65	142.39	550.71	- 401.40
Italy	452.92	68.16	271.88	586.70	276.63	288.96	63.31	221.96	515.71	- 257.80
Portugal	1133.30	145.71	781.71	1601.00	- 125.39	453.77	120.28	269.42	881.56	- 465.33
Spain	435.54	78.32	314.91	634.35	294.89	306.69	80.52	213.72	583.56	- 332.86
Core eurozone countries										
Austria	164.72	28.42	86.91	236.13	50.47	50.92	21.12	31.60	127.89	- 94.11
Belgium	260.92	40.15	175.76	398.78	26.14	88.32	31.10	54.66	191.44	- 128.39
Finland	70.63	8.95	44.34	87.24	15.54	31.85	7.13	22.02	57.57	- 35.55
France	184.25	24.23	112.23	245.27	66.34	88.18	22.54	57.11	168.47	- 97.27
Germany	88.00	11.97	59.97	118.38	20.43	39.45	10.88	22.85	75.82	- 47.36
Netherlands	103.13	16.58	52.19	133.84	41.82	54.61	10.24	37.98	89.43	- 37.97
Non-eurozone countries										
Denmark	117.54	15.23	65.31	157.46	32.04	38.27	16.46	24.50	93.44	- 68.94
Norway	36.15	8.47	20.84	52.11	4.15	19.76	3.10	15.28	30.96	- 15.40
Sweden	58.71	10.29	32.69	84.23	19.77	23.61	7.27	17.04	50.99	- 30.63
United Kingdom	78.25	11.53	58.66	101.64	- 10.24	44.85	7.38	27.60	58.41	- 20.34

Notes: The table summarises the distribution of daily sovereign CDS spreads of 14 European countries over two 12-month periods surrounding the date of implicit OMT announcement on 26 July 2012. ΔCDS is the change from the initial day to the last day of the corresponding period. CDS spreads are in basis points.

The pre-announcement period witnessed a sharp rise in the level and volatility of CDS spreads; Ireland and Portugal stood out as exceptions since they had by then received bailout packages.[13] In the post-announcement period, the CDS spreads of all countries experienced an overall decrease from the first day (27 July 2012) to the last (25 July 2013).

2.2 Commonality in credit risks of eurozone sovereigns

A principal component (PC) analysis of daily CDS spreads over the pre- and post-announcement periods was conducted to ascertain changes in the markets' perception of the credit risks of the 10 eurozone sovereigns under consideration. Table 2 reports the results.

Table 2. Principal component decomposition of daily eurozone CDS spreads

	Eigenvalues	Total variation explained (%)		Country loadings (eigenvectors) PC1	PC2
Panel A. Pre-announcement 26.07.2011 – 25.07.2012					
PC1	5.646	56.46	Austria	0.385	-0.025
PC2	1.877	75.22	Belgium	0.320	-0.398
PC3	1.253	87.76	Finland	0.346	0.040
PC4	0.470	92.46	France	0.405	-0.037
PC5	0.334	95.80	Germany	0.368	-0.109
PC6	0.229	98.09	Ireland	0.020	-0.533
PC7	0.072	98.81	Italy	0.368	0.095
PC8	0.057	99.38	Netherlands	0.377	0.162
PC9	0.034	99.72	Portugal	0.097	-0.449
PC10	0.028	100.00	Spain	0.208	0.552
Panel B. Post-announcement 26.07.2012 – 25.07.2013					
PC1	9.148	91.48	Austria	0.328	-0.025
PC2	0.450	95.98	Belgium	0.328	0.039
PC3	0.223	98.21	Finland	0.322	-0.135
PC4	0.070	98.91	France	0.325	0.004
PC5	0.044	99.35	Germany	0.310	-0.344
PC6	0.028	99.63	Ireland	0.327	0.056
PC7	0.014	99.77	Italy	0.320	0.106
PC8	0.011	99.89	Netherlands	0.282	-0.628
PC9	0.007	99.96	Portugal	0.294	0.613
PC10	0.004	100.00	Spain	0.323	0.276

Notes: The table reports eigenvalues λ_j, j=1,…,10 and the proportion of the total variation in the 10 eurozone CDS spreads explained by each principal component given by $\lambda_j/\Sigma\lambda_j$. The last two columns report the eigenvectors or country loadings to construct the first and second principal components (denoted PC1 and PC2, respectively).

The first component in the table can be interpreted as a eurozone credit risk index constructed as a weighted average of CDS spreads, and the second one as an index of the level of divergence across countries (Longstaff et al., 2011; Arghyrou and Kontonikas, 2012). In the pre-announcement period, these two components (denoted PC1 and PC2) explain 75%

[13] Ireland was rescued on 22 November 2010, and Portugal was similarly bailed out on 16 May 2011.

of the total variation in eurozone CDS spreads, and the explanatory power that can be attributed to PC1 is relatively small (56%). However, during the post-announcement period the two components capture 96% of the total variation, and PC1 explains 91%. The contribution of PC2 is 19% pre-announcement and a marginal 4% post-announcement.

The country loadings (the contribution of each country to each principal risk factor) in the construction of the principal components, reported in the last two columns of Table 2, are consistent with this interpretation. The loadings for PC1 are all positive, whereas those of PC2 tend to be positively signed for periphery countries and negatively signed for core countries, meaning that the latter measures the divergence between the credit risks of these two groups of countries Hence, the relatively high explanatory power of PC2 during the pre-announcement crisis period implies that, at the height of the crisis, investors' perception of eurozone credit risk differentiated considerably between countries. Post-announcement, the role of PC1 has notably risen, suggesting that markets began perceiving the eurozone credit risk in a more 'unified' manner after the ECB assumed the role of lender of last resort.

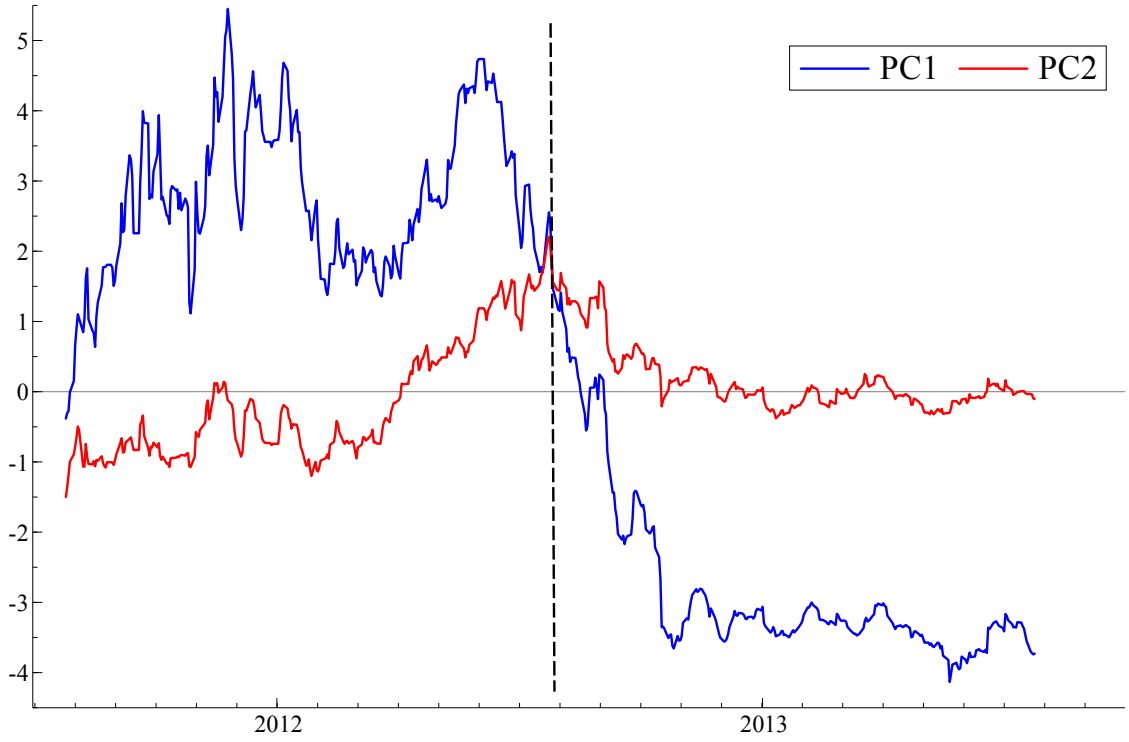
In the pre-announcement period, the contribution of Ireland and Portugal to PC1 (a proxy for a eurozone credit risk index) is small as suggested by respective loadings of 0.097 and 0.020. This result aligns well with the observation that Ireland and Portugal were the only two eurozone countries that experienced an overall decline in CDS spreads over the pre-announcement period (see Table 1). This resulted from the two countries receiving EU/IMF bailout packages at an early stage, which altered investors' risk perceptions and decreased markedly their systemic contribution to the crisis. A similar conclusion is reached by Adrian Alter and Andreas Beyer (2014) using a methodology that quantifies the systemic contribution of each sovereign as the net spillover effect in a total measure of net spillovers.

The loadings of PC2 reveal instead how investors separate eurozone members into two distinct groups of countries. The sign of the loading indicates the group to which the sovereign belongs. The size of the loading indicates how strongly the country belongs to that particular group. Before the announcement, Spain, Italy, the Netherlands and Finland (with a small loading) were in the same group with positive coefficients, and the rest of the countries were in the other set. Additionally, although the loadings of France and Austria were negative, they were very small at -0.037 and -0.025, respectively. This indicates that France and Austria may also have been subject to contagion along with the first group. Spain clearly had the largest positive loading, reflecting investors' risk perceptions. Therefore, during the pre-announcement period, the market clearly discriminated against countries such as Spain and Italy but in favour of Portugal and Ireland, despite the fact that all four of these countries are periphery economies.

After the OMT announcement, the positive loadings of Spain, Italy, Portugal and Ireland indicated that the investors classified them together again, in the same periphery group. Additionally, Belgium and France (although with small loadings) were subsequently classified as 'periphery', which suggests that they might have lost their core status in the eyes of investors. These findings constitute the first building block in constructing an argument that the implicit OMT announcement on 26 July 2012 has induced a more fundamental-based pricing approach in the currency union. The principal components provide preliminary evidence that self-reinforcing panic responses have made their presence felt in the region.

Figure 2 plots the first two principal components of the eurozone CDS spreads obtained from data over the entire two-year period from 26 July 2011 to 25 July 2013. The relative dynamics of PC1 and PC2 suggest a structural break at a point that essentially coincides with the implicit OMT announcement date on 26 July 2012.

Figure 2. First and second principal components of daily eurozone CDS spreads



Note: The vertical dotted line denotes the implicit OMT announcement date on 26 July 2012. The first and second principal components are extracted from the correlation matrix of daily CDS spreads over the two-year period from 26 July 2011 to 25 July 2013 for 10 eurozone countries, of which four are peripheral (Ireland, Italy, Portugal and Spain) and six are core (Austria, Belgium, Finland, France, Germany and the Netherlands).

The two principal components exhibited visibly different dynamics before and after the implicit announcement. PC1 experienced wild swings around a high plateau beforehand but fell sharply and stabilised around a much lower level shortly afterward. This lends itself to the interpretation that the OMT policy has helped decrease market perception of overall eurozone credit risk. PC2 followed a steep upward trend in the first half of 2012, echoing investors' view that eurozone credit risk divergence ('periphery' versus 'core' classification) was intensifying; the OMT announcement marked the beginning of a reversal.

2.3 Spain-specific news

In order to ascertain the presence of panic with self-fulfilling repercussions, the empirical analysis of the dynamics of eurozone credit risks defines 'abnormal' changes in the CDS spreads of a given European country (the dependent variable) as those driven by news from a country encountering difficulties, after controlling for credit risk in the European sovereign market as a whole. As proxy for a Europe-wide sovereign risk factor, labelled as $European_t^{Sov}$, an average of CDS spreads of the eurozone countries in the sample (nine countries after setting aside the country whose CDS spread changes will be used as the dependent variable)[14] and of those of the four stand-alone countries (Denmark, Norway, Sweden and the UK) is calculated.

[14] The country that is used as dependent variable has to be excluded from the European sovereign risk index; hence, the $European_t$ variable has to be reconstructed for each of the 10 eurozone countries.

The implicit OMT announcement date, 26 July 2012, breaks the two-year sample period into two 12-month halves. In fact, although the actual announcement of the OMT programme took place on 6 September 2012, many observers have argued that ECB President Draghi's "whatever it takes" speech marked the bold initiative toward the ECB becoming a lender of last resort in eurozone sovereign debt markets.[15] The analysis of CDS spreads via a principal components decomposition using 26 July as break date (see Figure 2) confirms that investors had by then already begun to anticipate the OMT programme. Nevertheless, a robustness check in the final section of this paper using 6 September as alternative break date does not materially challenge the main findings.

The next task is to choose a periphery eurozone country as the main contagion source over the period under study from 26 July 2011 to 25 July 2013. This country ought to have experienced the zenith of its debt problems during the sample period and ought to have had the highest potential for transmitting the effects of a shock to other eurozone members through cross-market linkages. Greece, Portugal and Ireland are not ideal candidates since, as mentioned earlier, the literature has reached a consensus that countries receiving IMF/EU rescue packages at the early stages of the crisis lost much of their capacity to generate contagion later on (e.g., see Alter and Beyer, 2014). In fact, some studies have shown that Spain and Italy have played a more pivotal role in the transmission of financial shocks after 2009 (González-Hermosillo and Johnson, 2014).

Moreover, the preliminary data analysis reveals that Spanish CDS spreads peaked on 24 July 2012 (that is, two days prior to the implicit OMT announcement; see Figure 1). Meanwhile, as suggested by the magnitude of its loading for PC2 in the analysis reported in the previous section, Spain is the sovereign that was punished the most severely by the markets in the pre-announcement period (see Table 2). All in all, Spain appears to be a reasonably good candidate for testing the eurozone fragility hypothesis.

Accordingly, it becomes necessary to construct a Spain-specific news variable ($News_t$) that will be a key input in the next stage of the analysis to assess whether news pertaining to Spain (unrelated to other sovereigns' fundamentals) act as a 'sunspot' (the notion that such country-specific bad news can trigger fears that are magnified as investors' negative sentiment is concentrated, hence shifting the equilibrium) in European debt markets. To identify the dates of most salient Spain-specific news, one can fit by the method of ordinary least squares (OLS) a regression of daily changes in Spanish CDS spreads on daily changes in a European sovereign risk index

$$\Delta CDS_{Spain,t} - r_{f,t} = \alpha + \beta(\Delta European_t - r_{f,t}) + u_{Spain,t} \quad (1)$$

over the pre- and post-announcement windows. Equation (1) can be seen as an asset pricing model in the spirit of the capital asset pricing model (CAPM) of William Sharpe (1964). $\Delta CDS_{Spain,t}$ represents the daily percentage changes in Spanish CDS spreads, $r_{f,t}$ is the ECB's daily Euro Overnight Index Average interest rate, α is the constant term in the regression and β measures the responsiveness of Spanish CDS spread changes to daily changes in the European CDS index (see below for an explanation of how this index is constructed).

In each period, the days corresponding to the 10 largest (absolute) residuals ($|u|_{Spain,t}$; that is, the difference between an observed value and the value estimated through a function such as equation [1]) are cross-checked against news related to Spanish economic fundamentals from *Reuters*. This residual approach is aimed at reducing the possibility of 'event contamination' on the days of Spain-specific news by market-wide (i.e., eurozone)

[15] See, for instance, Krugman (2011, 2013) and Pisani-Ferry (2013).

shocks that would affect all sovereigns simultaneously. Moreover, among the dates selected according to the size of the residuals, those for which there is no corresponding Spanish news or for which there is news related to bailout decisions by the European authorities or to the ECB's purchases of government debt are excluded.[16] When a date is excluded, the procedure is to search for the next candidate and so forth to yield ultimately 10 dates in both periods with the most-salient Spain-specific news. It is assumed (using the semi-strong form of the efficient markets hypothesis) that a large residual on any day reflects news arriving on that day; that is, the CDS premium quickly incorporates all public information.

Table 3 summarises the Spain-specific news thus identified. Naturally, the news reported in an archive such as that of *Reuters* may not always represent the actual underlying causes of significant market movements. Yet it provides a good approximation of what the average or representative investor might think about the important events of each day and about their potential effects on debt markets (Mink and de Haan, 2013). As a robustness check, a search was also undertaken for news in the *Bloomberg Businessweek* archive; the symbols R (*Reuters*) and B (*Bloomberg*) are used in Table 3 to signify the news source.

It is noteworthy that some of the news releases during the post-announcement period were about the Spanish government's reluctance to apply for a rescue programme; this can be regarded as signals to markets (and EU officials) about the health of the Spanish economy and not about the willingness of the EU/IMF to bail out countries (which would exclude it from consideration here). In any case, the inclusion of such post-announcement news can only be regarded as the conservative approach since it might lead to overestimation of contagion in the post-announcement period, during which one would expect less contagion if the eurozone fragility hypothesis were valid.

Compared with the identification approach employed by Mark Mink and Jakob de Haan (2013) to identify Greece-specific news that is based directly on the observed CDS spread changes, there is reason to believe that a residual-based approach is more suitable to isolate country-specific news. The merit of the latter is that it identifies country-specific event dates as days when the actual change in the sovereign CDS premium deviates substantially from the expected change according to the CAPM equation (1). Thus, it is possible to pin down important news days even when no large CDS spread changes are observed.

The Spanish-news contagion variable is defined as a discrete variable equal to the OLS residual from the CAPM equation (1) on the event dates and zero otherwise,

$$News_{t,Spain} = d_t * \hat{u}_{t,Spain} \quad (2)$$

where d_t is a binary variable equal to 1 on the salient news dates identified and 0 otherwise.

[16] For the purposes of measuring 'sunspot' contagion (unnecessary contagion owing to self-reinforcing panic), it is important to filter out from the Spain-specific news search those items related to bailouts of troubled countries. Such information would lead to an overestimation of the sunspot contagion effects.

Table 3. Spain-specific daily news

Date	News Description	Residual (%)	ΔCDS (%)
Panel A. Pre-announcement 26.07.2011 – 25.07.2012			
10.08.2011	Spain's Banca Civica BCIV.MC said on Wednesday its non-performing loan ratio at the end of the first half was 5.43 percent compared to 4.70 percent at the end of 2010 (R).	5.77	11.34
23.08.2011	An agreement between Spain's ruling Socialists and other political parties over controlling public spending is possible, Spanish Prime Minister Jose Luis Rodriguez Zapatero said on Tuesday (R).	-5.01	0.64
23.09.2011	Spain approved the sale of a stake in state-owned lottery operator Loterias y Apuestas del Estado on Friday, leaving what will be the country's biggest initial public offering on track despite tough markets and political opposition. While revenue from privatisation sales cannot be used to reduce a European country's annual public deficit under EU rules, the proceeds will mean Spain has to issue less debt (R).	-4.33	7.14
14.11.2011	Spain's borrowing costs risk hitting euro-era highs at auction this week, fuelling fears it is getting dragged back into the heart of the eurozone debt crisis as markets await evidence of a new government's commitment to economic reform (R).	6.07	9.07
03.01.2012	Registered unemployment in Spain, where almost half of young people are out of work, rose for a fifth month in December as the euro area's fourth-largest economy contracted. The number of people registering for unemployment benefits rose 1,897 to 4.42 million, the Labor Ministry in Madrid said in an e-mailed statement today (B).	5.85	6.45
04.01.2012	The heavily indebted Spanish region of Valencia delayed a 123 million euro repayment to Deutsche Bank by a week, its deputy chief minister said, but did not call on the country's government to guarantee the funds. Ratings agency Fitch said in December it believed the government would step in to help Valencia if it faced problems (R).	4.81	7.17
02.03.2012	Spain set itself a softer deficit target for 2012 than originally agreed under the eurozone's austerity drive, putting a question mark over the credibility of the European Union's new fiscal pact (R).	4.65	4.86
27.03.2012	Spain's economy is suffering its second recession since 2009, the Bank of Spain said today, a development that obstructs the government's efforts to reorder public finances as it prepares the budget for this year (B).	5.42	- 0.01
18.06.2012	Spanish bond yields hit a new euro-era high above 7 percent on Monday as initial relief after a pro-bailout vote in Greek elections gave way to pessimism about the problems surrounding the bigger Spanish economy (R).	4.29	3.76
09.07.2012	European ministers were set to grant Spain an extra year to reach its deficit targets in exchange for further budget savings but remained far from pinning down details of bank rescues and emergency bond-buying that are of greater concern to markets. Spain faces budget risks despite the looser target (R).	5.59	2.38

(*Cont.*)

Panel B. Post-announcement 26.07.2012 – 25.07.2013			
30.08.2012	Spanish consumer prices surged in August driven by higher fuel costs and a value-added tax hike in September could drive another jump, complicating Spain's efforts to get out of recession and generate the growth needed to reduce its debts (R).	6.87	3.03
17.09.2012	Ten-year Spanish government bond yields extended their rise on Monday, driven by pressure ahead of this week's auctions and lingering doubts over when, or if, Spain will seek financial aid (R).	3.40	1.87
18.09.2012	Spain will consider seeking a bailout if the conditions imposed are acceptable, Deputy Prime Minister Soraya Saenz de Santamaria said as loan defaults at Spanish banks climbed and lending dropped (B).	5.10	5.52
17.10.2012	Spanish government bond yields fell to their lowest since early April on Wednesday after Moody's kept Spain's investment grade rating, removing an immediate threat to the eurozone's fourth largest economy (R).	- 5.11	- 16.81
18.10.2012	Spain's banks face more loan losses as the pace of an economic slump risks turning a worst-case scenario dismissed in stress tests into reality, according to data published by the Bank of Spain on its website today (R).	4.09	2.63
22.10.2012	Spanish bonds fell for a second day on speculation Prime Minister Mariano Rajoy's regional election victory gives him more room to delay seeking a bailout that would allow Europe's central bank to buy the nation's debt (B).	6.28	3.70
23.10.2012	The Bank of Spain said on Tuesday that Spain was at risk of missing its 2012 budget deficit target of 6.3 percent of GDP, including regions and social security, as a prolonged recession slashes revenues (R).	3.98	5.68
04.02.2013	Ten-year Spanish government bond yields rose on Monday as the country's opposition party called for the resignation of Prime Minister Mariano Rajoy over a corruption scandal (R).	3.94	6.07
26.02.2013	Spain is no closer to seeking bond-buying help from the European Central Bank than it was before Italy's election, which has triggered renewed market turmoil, Economy Minister Luis de Guindos said on Tuesday (R).	3.76	7.92
22.07.2013	Spain's Prime Minister on Monday said he would soon appear in Parliament to face questions over a corruption scandal that has dented his ruling People's Party's credibility and upset Spaniards as they go through deep cuts in social welfare (R).	3.55	- 2.16

Notes: The news source is *Reuters* (R), or *Bloomberg Businessweek* (B). The capital asset pricing model (CAPM)–based residuals shown in the penultimate column are taken (in absolute value) as a proxy for the salience of the Spain-specific news on the corresponding days listed in the first column. The last column reports the actual change in the Spanish CDS spread of the corresponding day with respect to the previous day. The spreads (and residuals) are expressed in percentage points.

3. Empirical Results

We now test De Grauwe's eurozone fragility hypothesis, which is neatly aligned with the multiple-equilibria discourse, using two approaches as outlined in the next two subsections.

3.1 Event-study analysis

A capital asset pricing model is employed to measure the abnormal responses of the eurozone CDS premiums to idiosyncratic shocks that are defined as Spain-specific news,

$$\Delta CDS_{i,t} - r_{f,t} = \beta(\Delta European_t - r_{f,t}) + \alpha_0 + \alpha_1 News_{Spain,t} + \varepsilon_{i,t} \quad (3)$$

where the regressand (dependent variable) is the daily CDS spread change in excess of risk-free rate for the *i*th eurozone country in the sample, and beta (β) is the European risk factor loading that represents the sensitivity of that country's CDS premium (in excess of the risk-free rate) to the European CDS premium. The extent of the model's mispricing is captured by the term $\alpha_t \equiv \alpha_0 + \alpha_1 News_t$, which amounts in the present context to a time-varying abnormal return; α_1 is the main parameter of interest that captures the spread changes induced by 'contagion' from Spain. The random innovations (errors) are assumed to be independent and identically distributed, $\varepsilon_{i,t} \sim i.i.d.(0, \sigma_i^2)$. The risk-free rate ($r_{f,t}$) takes as a proxy the Euro Overnight Index Average interest rate from *Datastream*. This approach is similar in spirit to that used by Mink and de Haan (2013) to analyse the impact of news about Greece (inferred from changes in its 10-year government bond prices) on bank stock prices.

The model is estimated for each of the eurozone countries in the sample (in effect, nine countries since Spain is adopted as the contagion source) separately over the 12-month pre-announcement period and the 12-month post-announcement period. The Spain-specific $News_t$ variable is constructed from CDS spread data, as explained in the previous section. The results are presented in Table 4 for each country and period.

Table 4 Spain-specific news effects on eurozone sovereign CDS spreads: two-year window analysis

Pre-announcement: 26.07.2011 – 25.07.2012										
	Austria		Belgium		Finland		France		Germany	
	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT
European	**1.137 (0.085)	**0.751 (0.067)	**1.141 (0.069)	**0.938 (0.072)	**0.822 (0.081)	**0.628 (0.092)	**1.107 (0.086)	**0.850 (0.125)	**0.973 (0.085)	**0.616 (0.090)
Financial	-	*0.107 (0.045)	-	0.036 (0.044)	-	**0.110 (0.039)	-	**0.107 (0.038)	-	0.077 (0.048)
Global	-	**1.485 (0.097)	-	**1.239 (0.076)	-	**0.965 (0.077)	-	**1.289 (0.083)	-	**1.312 (0.092)
α_0	0.002 (0.002)	0.001 (0.002)	0.000 (0.002)	-0.001 (0.002)	0.001 (0.002)	0.000 (0.002)	0.002 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
News (α_1)	**0.219 (0.184)**	****0.432 (0.099)**	****0.404 (0.097)**	****0.506 (0.118)**	**-0.086 (0.178)**	**0.210 (0.138)**	**0.207 (0.134)**	***0.281 (0.120)**	**-0.148 (0.165)**	**0.011 (0.101)**
Adj. R^2	0.57	0.68	0.68	0.72	0.45	0.49	0.59	0.64	0.52	0.63
	Ireland		Italy		Netherlands		Portugal			
	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT		
European	**0.612 (0.050)	**0.636 (0.063)	**1.236 (0.054)	**1.190 (0.097)	**0.951 (0.072)	**0.676 (0.080)	**0.681 (0.064)	**0.736 (0.078)		
Financial	-	0.039 (0.026)	-	**0.089 (0.030)	-	0.104 (0.055)	-	-0.043 (0.041)		
Global	-	**0.544 (0.075)	-	**1.098 (0.081)	-	**1.186 (0.090)	-	**0.607 (0.098)		
α_0	-0.002 (0.001)	-0.002 (0.001)	0.003 (0.002)	0.001 (0.002)	0.002 (0.002)	0.002 (0.001)	-0.000 (0.002)	0.000 (0.002)		
News (α_1)	***-0.547 (0.229)**	***-0.544 (0.240)**	****0.566 (0.137)**	****0.562 (0.122)**	**0.086 (0.163)**	**0.225 (0.135)**	***-0.410 (0.175)**	****-0.561 (0.171)**		
Adj. R^2	0.47	0.48	0.72	0.73	0.50	0.57	0.40	0.41		

(*Cont.*)

Post-announcement: 26.07.2012 – 25.07.2013

	Austria		Belgium		Finland		France		Germany	
	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT
European	**0.735	**0.643	**0.870	**0.734	**0.502	**0.449	**0.845	**0.794	**0.726	**0.624
	(0.078)	(0.091)	(0.106)	(0.117)	(0.091)	(0.108)	(0.107)	(0.123)	(0.127)	(0.138)
Financial	-	-0.006	-	-0.033	-	-0.034	-	-0.037	-	-0.015
		(0.046)		(0.039)		(0.050)		(0.037)		(0.042)
Global	-	**0.720	-	**0.895	-	**0.472	-	**0.718	-	**0.730
		(0.095)		(0.079)		(0.086)		(0.092)		(0.146)
α_0	*-0.003	**-0.004	-0.001	**-0.003	-0.002	**-0.003	0.000	-0.002	-0.001	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
News (α_1)	**-0.058**	**-0.070**	**-0.107**	**-0.113**	***-0.236**	**-0.236**	**-0.158**	**-0.137**	**-0.273**	**-0.281**
	(0.117)	**(0.126)**	**(0.281)**	**(0.293)**	**(0.118)**	**(0.135)**	**(0.281)**	**(0.316)**	**(0.380)**	**(0.411)**
Adj. R^2	0.41	0.43	0.49	0.52	0.24	0.25	0.46	0.46	0.26	0.27

	Ireland		Italy		Netherlands		Portugal	
	CAPM	APT	CAPM	APT	CAPM	APT	CAPM	APT
European	**0.700 (0.099)	**0.665 (0.113)	**1.096 (0.088)	**1.089 (0.107)	**0.627 (0.098)	**0.588 (0.117)	**0.846 (0.138)	**0.771 (0.143)
Financial	-	-0.006 (0.045)	-	0.065 (0.048)	-	-0.059 (0.031)	-	**0.171 (0.053)
Global	-	**0.593 (0.105)	-	**0.811 (0.067)	-	**0.538 (0.073)	-	**0.779 (0.108)
α_0	*-0.003	**-0.005	0.002	-0.002	0.000	-0.002	0.000	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
News (α_1)	**0.054**	**0.075**	**-0.115**	**-0.144**	**-0.142**	**-0.105**	**-0.288**	**-0.423**
	(0.177)	**(0.206)**	**(0.683)**	**(0.722)**	**(0.241)**	**(0.265)**	**(0.283)**	**(0.284)**
Adj. R^2	0.47	0.47	0.45	0.44	0.40	0.40	0.33	0.36

Notes: The table reports results of the OLS estimation of the capital asset pricing model (CAPM), equation (3), which controls for European sovereign risk, and the extended arbitrage pricing theory (APT)–type counterpart, which additionally controls for global sovereign risk and European financial risk. Autocorrelation and heteroskedasticity robust Newey-West standard errors are reported in parentheses. ** and * denote significant coefficients at the 1% and 5% level, respectively.

Before the implicit OMT announcement date, the positive estimates of the news coefficient in equation (3) suggest that there was contagion from Spain to other eurozone countries such as Italy, Belgium, Austria, France and the Netherlands; although the phenomenon appears statistically significant only for the first two of these countries. The largest contagion effects are observed for Italy, a finding that is consistent with common perceptions and with formal evidence of co-movements of Spanish and Italian debt spreads (González-Hermosillo and Johnson, 2014). Judging by these results, adverse Spain-specific news influenced market participants in their perception of the creditworthiness of other eurozone countries, i.e. the CDS spreads of those eurozone countries reacted 'abnormally' prior to the announcement. This observation is in line with the principal component analysis performed previously, which indicated (according to the loadings of PC2; see Table 2) that Spain, Italy, the Netherlands, and possibly France and Austria were priced differently from the remaining eurozone countries in the 12-month period prior to the implicit OMT announcement.

The finding of a negative news coefficient for Portugal and Ireland, which is statistically significant, implies that bad news specific to the Spanish economy (a widening Spanish CDS premium) went hand in hand with substantial declines in these countries' CDS premiums. Various explanations can be offered for this result. One interpretation is that bad news from Spain before the OMT might have heightened market expectations of an ECB intervention through the Securities Market Programme (SMP). Given the unclear and arbitrary nature of the SMP, each setback for Spain might have been perceived as raising the likelihood of ECB debt purchases in the secondary markets, which, in turn, would have reduced the CDS spreads of Portugal and Ireland. Another interpretation is that the focus of the crisis (news) was shifting away from bailed-out countries (Portugal and Ireland) to non-bailed-out ones such as Spain and Italy. Hence, market players were absorbing positive information about the countries that applied strict austerity measures (in exchange for the rescue packages) by comparing them to the new 'strugglers', which were resisting the austerity measures and declining the bailout programmes offered to them.

The results displayed in Table 4 based on CDS data are consistent with the evidence of eurozone contagion provided by Mink and de Haan (2013) from bond yield data. In each case, a significant, abnormal deterioration (i.e., in excess of what a CAPM-type model would predict) is detected in the creditworthiness of various eurozone members in response to country-specific bad news from another eurozone country, Spain in this study, Greece in the other. However, whereas Mink and de Haan explain it as 'wake-up calls', whereby markets draw conclusions about sovereigns by observing the changes in the fundamentals of other countries, here this contagion is ascribed mostly to panic.

The conjecture that the pre-announcement spillovers from Spain to various other eurozone countries largely reflected eurozone fragility (linked to the absence of a lender of last resort) follows De Grauwe (2011a,b) and the multiple-equilibria line of reasoning. Accordingly, the term 'sunspot contagion' is used to describe this phenomenon. Before the OMT programme was introduced, the eurozone lacked a device to stop debt runs (short-term liquidity problems), which, through the actions of investors trying to avert losses, morphed into a solvency crisis. Eurozone CDS spreads were therefore highly sensitive to news releases about Spain's fundamentals not because of the inherent nature of the information they conveyed but because, in the absence of a lender of last resort, adverse developments coloured investors' sentiment and channelled their market responses toward a 'bad' equilibrium.

The second part of Table 4 sets out results of the CAPM equation (3) estimated over the post-announcement period. Interestingly, no significantly positive news coefficient is obtained following the implicit OMT announcement for any of the eurozone member countries examined. Thus, there are no significant Spanish news spillovers to other eurozone countries

after 26 July 2012, which confirms the conjecture's validity. This is the crux of the argument: if the response of eurozone CDS spreads to Spain-specific news were in fact fundamentals based (i.e., news about Spain prompting investors to assess the vulnerability of other countries according to fundamentals) as the wake-up call hypothesis states, then one would not expect a lender of last resort announcement to have any mitigating effect on such contagion. The sharp contrast observed in the pre- and post-announcement periods regarding the influence of Spain-specific news on eurozone CDS spreads, as shown in Table 4, instead points toward self-fulfilling panic reactions in the region as an explanation for the transmission of the sovereign debt crisis from one eurozone country to another.

In sum, it seems fair to interpret the evidence as suggesting that the OMT announcement (the willingness of the ECB to act as lender of last resort) has been successful in curbing the panic to which markets have been susceptible since the early 2011 outbreak of eurozone debt problems. Results of the event study show that, when there is no liquidity facility in the debt markets of a region under a common currency (such as the euro), it leaves room for fears that, through market movements that are inadvertently coordinated, become self-fulfilling to produce undesirable outcomes.

3.2 Herding contagion analysis

Evidence on the validity of De Grauwe's fragility hypothesis for the eurozone may be further provided through a herding contagion analysis. The main idea is to ascertain the simultaneous transmission/occurrence of substantial negative shocks among various sets of eurozone and non-eurozone countries. Measuring the clustering of adverse events constitutes "the cleanest approach to measuring the most common definition of contagion – any transmission of extreme negative shocks" (Forbes, 2012, p. 9).

The analysis seeks to demonstrate that the clustering of large negative shocks (the simultaneous rise in sovereign bond yields or CDS premiums that cannot be explained by common risk factors) relates to investors' fear of losses as opposed to a process of discovering unsettling issues relating to fundamentals. Such sudden rise in CDS spreads of a group of countries would then represent a "debt run" against the particular group at a particular time, driven by panic and ultimately countered by the OMT programme.

In order to derive residuals (which, as the departure of the measured results from what is predicted by formula, serve as proxies for unexpected shocks), begin by estimating the CAPM equation over the two-year sample period around the implicit OMT announcement

$$\Delta CDS_{i,t} - r_{f,t} = \alpha + \beta(\Delta European_t - r_{f,t}) + \varepsilon_{i,t} \quad (4)$$

for each country i=1,…,N in the sample (N = 14 sovereigns). Thus, a daily time series of residuals per country $\hat{\varepsilon}_{i,t}, t = 1, \ldots, T$ (the two-year sample enables T = 523 residuals per country) is developed. Upon calculating the empirical distribution of residuals for each country, focus is placed on the left-tail residuals (as proxies for extreme shocks), defined using the 20th- or 10th-percentile criteria for the extreme end of the distribution. Finally, it is possible to identify days over the two-year sample period when a large proportion of countries simultaneously experienced extreme shocks; such episodes of cross-national clustering of shocks (80% of countries or more) comprise the herding contagion index. This technique is similar in spirit to that employed by Beirne and Fratzscher (2013).

Based on the study's previous findings (from the principal components decomposition of CDS spreads in Section 2.1 and the Spain-specific news analysis in Section 3.1), countries are assigned to three groups. The first consists of Spain, Italy, Belgium, France and Austria, as their CDS premiums have been particularly sensitive to adverse shocks in the absence of a

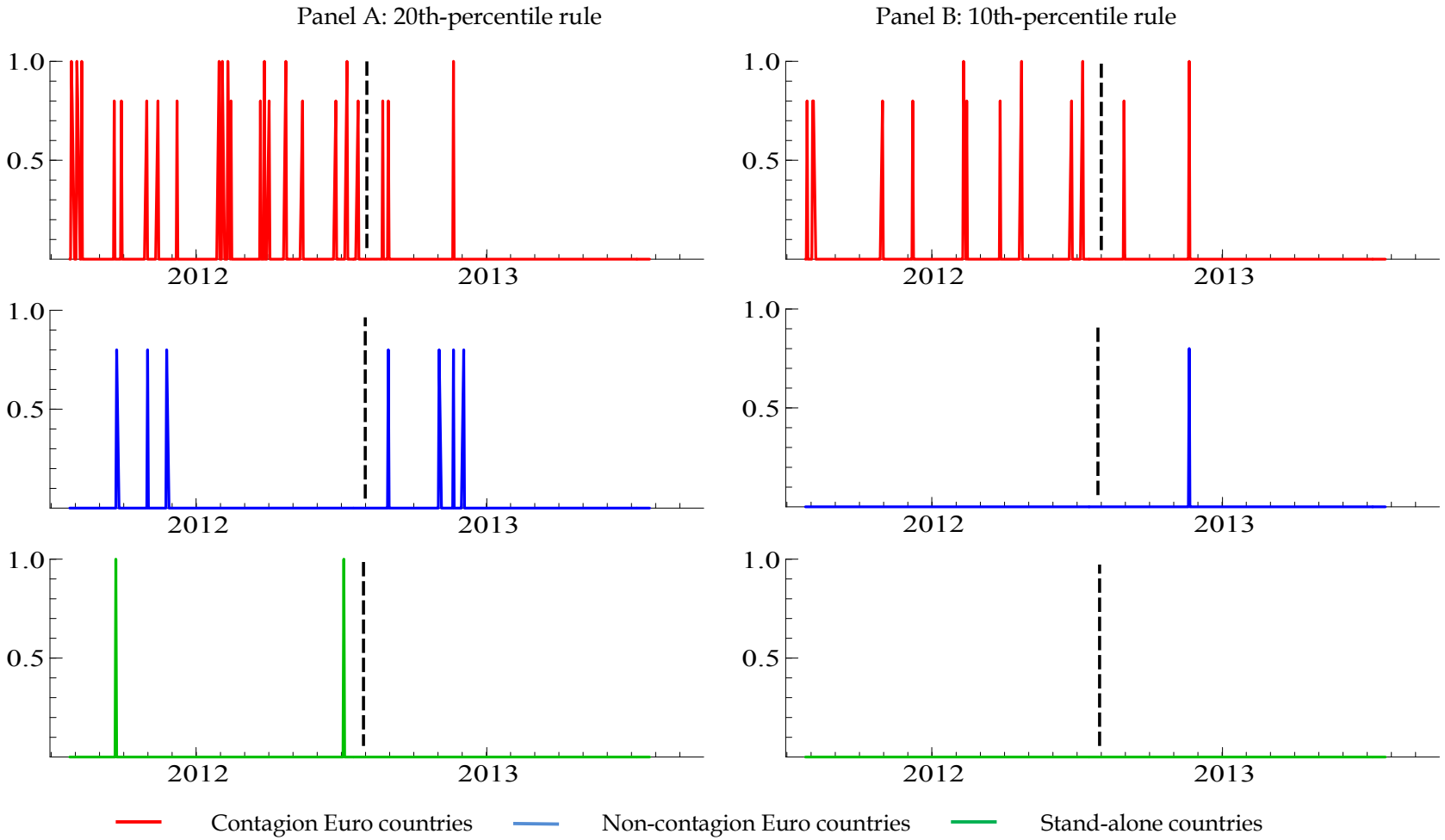
liquidity facility; this is called the 'contagion' set. The second group is made up of Finland, Germany, Ireland, the Netherlands and Portugal; according to the prior results, these were less likely to be affected by adverse shocks during the two-year period under study; call it the 'non-contagion' set. The third group consists of four non-eurozone countries (Denmark, Sweden, Norway and the UK); this is the control set. According to the multiple-equilibria view, as encapsulated in De Grauwe's eurozone fragility hypothesis, the market perception of the creditworthiness of these stand-alone countries is unlikely to be bedevilled by panic precisely because they retain sovereign control over their own currencies. Figure 3 plots the herding contagion indices obtained for the three sets of countries.

Examining first the 'contagion' set, it is clear that cross-national clusters of extreme shocks occur more frequently prior to (on 22 days) than after the implicit OMT announcement. With the 20th-percentile criteria, only three clusters are identified following the OMT announcement. Two of these occur in the days immediately before the explicit ECB announcement of the OMT programme on 6 September 2012; they would not be counted as post-announcement herding contagion events at all had the explicit OMT announcement been adopted as the fulcrum. The third cluster is dated 20 November 2012, and, interestingly, it is seen also in the 'non-contagion' set; hence, it must be associated with a eurozone-wide systematic risk factor that the pricing model presented here does not capture. Analogous results are obtained using the most conservative 10th-percentile criteria to focus on residuals located further along the left-tail.

Now attention turns to the other two sets of countries. Both the 'non-contagion' eurozone set and the non-eurozone set experience few clusters of extreme adverse shocks, and, most important, the frequency of them is essentially similar over the pre- and post-announcement terms. There is no change of pattern after the implicit OMT announcement date in the amount of herding contagion identified for these countries.

Summing up, the analysis in this section points to significant herding contagion in the year before the OMT announcement precisely for the same eurozone countries that were identified earlier as being the most vulnerable to contagion. However, instances of herding contagion became far less frequent after the ECB president pledged to do "whatever it takes" to keep the euro together. The logical interpretation of these findings is that the herding contagion was mainly attributable to panic of a self-fulfilling nature that pushed these countries into a worse equilibrium than their fundamentals would warrant.

Figure 3. Herding contagion indices for three sets of countries, CAPM pricing equation



Note: The vertical dotted line denotes the implicit OMT announcement. The graph plots on each day of the pre- and post-announcement periods the percentage of countries in the corresponding set that experienced large negative shocks according to the capital asset pricing model (CAPM) equation (4) using the 20th-percentile or 10th-percentile criteria. Only days when at least 80% of the countries experienced large shocks are plotted. The contagion set of eurozone countries comprises Spain, Italy, France, Belgium and Austria. The non-contagion set of eurozone countries consists of Portugal, Ireland, Germany, the Netherlands and Finland. The stand-alone set (non-eurozone) of countries is constituted by Denmark, Norway, Sweden and the United Kingdom.

3.3 Additional results

The robustness of the results reported in the previous sections can be assessed by considering a pricing equation that is grounded in the arbitrage pricing theory (APT) of Stephen A. Ross (1976). This approach is enhanced by recent empirical studies that use market indices as proxies for unobserved sources of commonality among sovereigns (Bekaert et al., 2011; Manasse and Zavalloni, 2013). Formally, the adapted APT pricing equation can be written as follows:

$$\Delta CDS_{Spain,t} - r_{f,t} = \alpha + \beta_1(\Delta European_t - r_{f,t}) \quad (5)$$

$$+\beta_2(\Delta Financial_t - r_{f,t}) + \beta_3(\Delta Global_t - r_{f,t}) + u_{Spain,t}$$

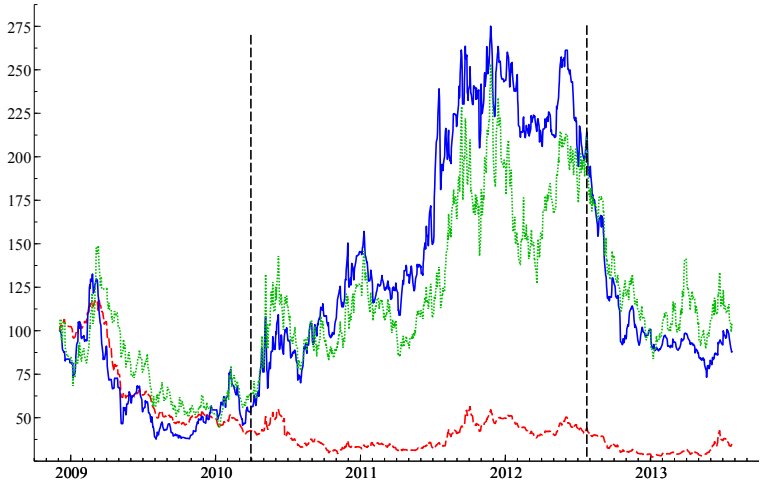
where the loadings or betas $(\beta_1, \beta_2, \beta_3)$ measure the sensitivity of variations in the country's daily spread to the daily changes in three risk factors: one for global sovereigns, another for European sovereigns and a third for financial intermediaries. The regression is estimated over the pre- and post-OMT announcement periods to identify Spain-specific news dates.

As proxy for the global sovereign credit risk factor, labelled $Global_t$,, an equal-weighted combination of the CDS spreads of the same 26 (non-European) sovereigns as used in Francis A. Longstaff, Sanjay Mithaland Eric Neis (2011) has been chosen. Descriptive statistics of the constituent CDS spreads over the two-year period around the OMT announcement are provided in Appendix A. The European credit risk factor $European_t^{Sov}$ is as defined in Section 2.3 above. The proxy for the European financial risk factor ($European_t^{Fin}$) is the Markit iTraxx Senior Financials index, which is composed of the 25 most liquid CDS reference entities for senior debt issued by European financial institutions. All the daily observations are obtained from *Datastream*.

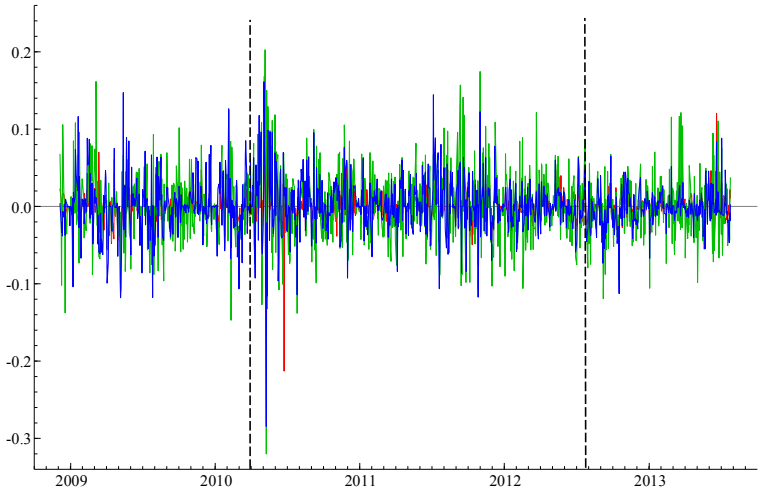
The evolution of the three risk factors is shown in Figure 4 as daily CDS spread levels (Panel A) and changes (Panel B). Panel A reveals strong correlations, particularly between the European sovereign risk index and the European financial intermediary risk index. Those correlations occur through two main channels. One channel reflects the way in which European credit risk is tied in with the greater global financial/economic landscape. A second channel is country-specific and implies that the default risks of financial intermediaries feed into the sovereign country's borrowing costs though the signals sent to investors by the size and frequency of bailout/rescue guarantees. And, the other way round, the increased default risk of a sovereign will feed into the balance sheets of its financial institutions because they hold government debt (Acharya et al., 2011; Arghyrou and Kontonikas, 2012; Alter and Beyer, 2014).

Figure 4. Global sovereign risk, European sovereign risk and European financial risk

Panel A: Global and European CDS spreads (daily levels)



Panel B: Global and European CDS spreads (daily changes)



European sovereign risk Global sovereign risk European financial risk

Note: The first vertical line (31 March 2010) marks the outbreak of the eurozone debt crises, when Greece received its first rescue package. The second line (26 July 2011) denotes the implicit OMT announcement date. The global sovereign risk index is an average of CDS spreads of 26 non-European countries. The European sovereign risk index is an average of the CDS spreads of 10 eurozone countries (Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain) plus four stand-alone countries (Denmark, Norway, Sweden and the United Kingdom). The European financial risk index is the Markit iTraxx Senior Financials index, which is composed of the 25 most liquid CDS reference entities for senior debt issued by European financial institutions. The time span is 5 December 2008 to 25 July 2013. All the indices have been normalised to 100 in 2009.

However, the correlation evident in the stationary daily changes in the CDS indices is much lower, as one would expect, from a low of 0.39 between $\Delta Global_t$ and $\Delta European_t^{Sov}$ to a high of 0.55 between $\Delta Global_t$ and $\Delta European_t^{Fin}$; the correlations between the corresponding CDS index returns in excess of the risk-free rate are similar since the risk-free rate is roughly

constant (e.g., after the announcement, the standard deviation of $\Delta European_t^{Fin}$ is 0.0459 and that of the Euro Overnight Index Average is 0.0008).[17]

Most of the Spain-specific news dates thus identified coincide with those reported earlier in Table 3; the only one change is that 23 September 2011 is replaced by 29 July 2011 (pre-announcement).[18] For the Spain-specific news variable, $News_{t,Spain} = d_t * \hat{u}_{t,Spain}$ (equation [2] from Section 2.3), d_t is 1 at the identified news dates and 0 elsewhere, and $\hat{u}_{t,Spain}$ is the new residual sequence. Although the magnitude of the residuals at the identified dates is different for the APT model and the CAPM model initially employed, the news variables calculated from each are close as borne out by a Pearson correlation of 0.9595 (p-value=0.00). The estimation results for the APT counterpart of equation (4) using three systematic risk factors are recorded under the column labelled APT in Table 4. Before the OMT implicit announcement, the coefficient of the news variable was positive and significant for Italy, Belgium, France and Austria. After the announcement, none of the news coefficients was positive, and they were all insignificant. Likewise, the herding contagion indexes derived from the APT model equation (5) made no meaningful difference to the findings.

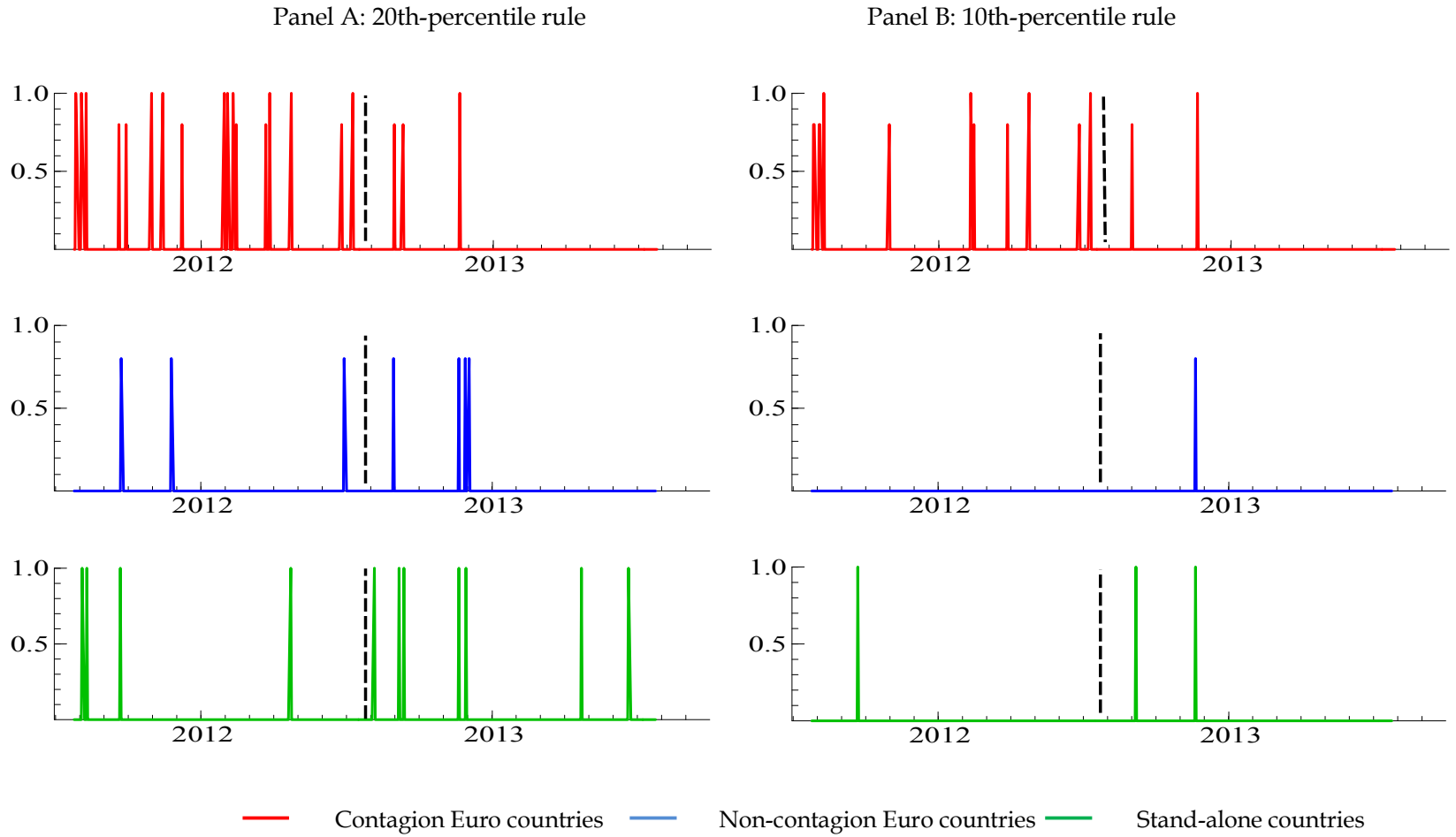
Second, the event-study analysis of Section 3.1 is undertaken again, accounting for the time variation in the risk factor loadings (the beta coefficients). The idea of this robustness check is to gauge the extent to which not allowing for such time variation might bias the news identification. For this purpose, the residuals are obtained by a rolling estimation approach; namely, the residual for day t is obtained as the difference between the actual CDS change on that day and the expected CDS change for that day obtained by using the coefficients of the pricing model, equation (1), estimated over the corresponding window (covering a one-year period of 261 business days) ending on day t-1. The window is then rolled forward one day to obtain the residual for day t+1 and so forth. That helps better capture the surprise component ("unexpected shock") on day t. This rolling exercise made no meaningful difference to the news identification; in fact, about 90% of the dates thus detected matched the dates in Table 3.

It was also reassuring to repeat the herding contagion analysis by re-estimating the CAPM equation (4) and APT equation (5) over rolling windows. The results based on the CAPM model, reported in Figure 5, and those based on the APT model (not displayed here) are virtually undistinguishable from those reported earlier in Figure 4.

[17] The factor orthogonalization approach used by Geert Bekaert and colleagues (2009) and Manasse and Zavalloni (2013) is applied here, adopting the residuals of the OLS regression $European_t^{sov} = a + bGlobal_t + u_t$ as the orthogonalized European sovereign risk factor. This residual construction exercise is repeated 10 times, one for each of the $European_t^{sov}$ indices available for each country (whose CDS spread change was excluded from the European sovereign index construction). The next step is to run the regression $European_t^{fin} = a + bGlobal_t + cEuropean_t^{sov} + u_t$ and take the estimated residuals as the orthogonalized European financial risk factor; again this needs to be repeated 10 times, one for each $European_t^{sov}$, to obtain an orthogonalized $European_t^{fin}$ per country. However, the main findings in the subsequent empirical analysis of the paper would not materially change one were to employ directly the non-orthogonalized factors; detailed results are available from the authors upon request.

[18] The Spain (*Reuters*) news on 29 July 2011 was: "Moody's puts Spain on watchlist on Friday adding to concerns that a Greek rescue package has done little to halt the spread of Europe's debt crisis".

Figure 5. Herding contagion indices for three sets of countries, CAPM rolling estimation



Note: This is the counterpart of Figure 3, based on rolling estimation of the capital asset pricing model (CAPM) equation (4) to identify the shocks. An estimation window of 261 days is rolled forward one day at a time. The vertical dotted line denotes the implicit OMT announcement. The graph plots on each day of the pre- and post-announcement periods the percentage of countries in the corresponding set that experienced large shocks using the 20th-percentile or 10th-percentile criteria. Only days when at least 80% of the countries experienced large negative shocks are plotted. The contagion set of eurozone countries comprises Spain, Italy, France, Belgium and Austria. The non-contagion eurozone set of eurozone consists of Ireland, Germany, the Netherlands and Finland. The stand-alone set (non-eurozone) is constituted by Denmark, Norway, Sweden and the United Kingdom.

An additional robustness check applies a narrower one-year window for the event study, which amounts to a six-month pre-announcement period (26 January to 25 July 2012) and a six-month post-announcement period (27 July 2012 to 25 January 2013). The main purpose of this analysis, summarised in Table 5, is to measure in a more 'sterilised' manner the impact of the OMT announcement: A shorter window serves better to isolate the analysis from changes in the fundamental channels of contagion (e.g., trade or financial links): Despite the essential stability of these fundamental channels, looking at a shorter time interval ensures that they remain constant and cannot be held responsible for driving the changes in the contagion effects across the countries in the sample; thus, any change can be directly associated with the OMT announcement.

One can repeat the same CAPM-based procedure described in Section 3.1 to construct the Spain-specific news variable, $News_{Spain,t}$, with the only difference being that the focus is now on the five most salient events (instead of 10) in each period, owing to the smaller sample.[19]

Table 5. Spain-specific news effects on eurozone sovereign CDS spreads: one-year window analysis

	Pre-announcement: 26.01.2012 – 25.07.2012		Post-announcement: 26.07.2012 – 25.01.2013	
	CAPM	APT	CAPM	APT
Austria	**0.354	**0.299	0.023	-0.023
	(0.124)	(0.109)	(0.133)	(0.134)
Belgium	**0.472	**0.447	0.029	0.063
	(0.106)	(0.112)	(0.375)	(0.376)
Finland	0.521	0.445	-0.121	-0.054
	(0.324)	(0.379)	(0.142)	(0.142)
France	**0.563	*0.526	0.143	0.250
	(0.214)	(0.220)	(0.227)	(0.271)
Germany	0.224	0.140	-0.106	-0.025
	(0.207)	(0.170)	(0.414)	(0.428)
Ireland	*-1.031	-0.939	0.062	0.155
	(0.481)	(0.494)	(0.202)	(0.240)
Italy	**0.536	**0.459	-0.733	-0.820
	(0.130)	(0.076)	(0.905)	(1.010)
Netherlands	**0.630	**0.560	-0.084	0.008
	(0.214)	(0.197)	(0.309)	(0.321)
Portugal	*-0.462	-0.448	-0.044	-0.305
	(0.231)	(0.249)	(0.220)	(0.229)

Notes: The table reports the OLS estimates of the capital asset pricing model (CAPM), equation (3), which controls for European sovereign risk, and the arbitrage pricing theory (APT)–type equation, which additionally controls for global sovereign risk and European financial risk. Autocorrelation and heteroskedasticity robust Newey-West standard errors are reported in parentheses. ** and * denote significant coefficients at the 1% and 5% level, respectively.

[19] The significant news events associated with the dates identified over this smaller period are available upon request.

The results in Table 5 are in line with the main finding that the significant contagion effect of Spain-specific events on the CDS premiums of other eurozone countries during the pre-announcement phase lost its significance after the OMT announcement.

In a final robustness check, instead of adopting ECB President Draghi's 'whatever it takes' speech (26 July 2012, the implicit OMT announcement date), the official OMT announcement (6 September 2012) is chosen instead as the midpoint for the analysis. The results (not laid out here) do not in any significant way challenge the main findings.[20]

4. Policy Implications

The fragility hypothesis, as it concerns the eurozone, asserts that countries that have adopted the euro are prone to sudden reversals in capital flows triggered by investors' lack of confidence that can ultimately trigger the very default they fear; this is what De Grauwe (2011a) calls 'devilish' self-fulfilling dynamics. Could this happen in the United States, the United Kingdom or Japan? Surely not, because these countries can count on their central banks to inject liquidity into the markets in the event of a cash squeeze. Absent the ECB assuming the mantle of lender of last resort, countries using the euro are treated in sovereign debt markets as if they had the status of emerging countries that issue debt in a foreign currency. The OMT programme represents a big step toward completion of the European currency union and avoiding such fragility. This policy stance can ensure a single equilibrium for all eurozone countries.

This study's finding that eurozone debt markets have been subject to panic responses that become self-reinforcing serves to undermine the "you deserve what you get" attitude of hard-core fundamentalists. The evidence provided above that the implicit OMT announcement has curbed such self-fulfilling dynamics (as one, if not the only, channel of contagion) in eurozone debt markets highlights the institutional role played by the ECB in preventing debt runs in the region. Overall, the results support De Grauwe's fragility hypothesis.

Recent developments have stirred contention over ECB President Draghi's 'whatever it takes' bond-buying programme. In response to German Eurosceptics' protests against the legality of the OMT programme, the German Constitutional Court recently (in February 2014) passed the case on to the European Court of Justice; at the time of this writing, the ECJ has still not produced a response. This paper contributes to making an informed judgment on the matter by showing that the OMT announcement has been effective in countering 'unnecessary' contagion in the euro area. The evidence indicates that the new policy stance has helped not only nations considered to be on the periphery (such as Italy and Spain) but also core members (such as Belgium and France) that are struggling to restore their economies to the shape they were in prior to the crisis, even as their southern neighbours face the risk of deflation and stagnation. On that basis, the new ECB policy stance can be seen as beneficial for the interests of the eurozone as a whole.

5. Conclusion

The turmoil in eurozone debt markets that erupted more than five years ago fuelled a heated debate among two old schools of thought. While 'fundamentalists' primarily blamed euro-area countries' deteriorating fundamentals, multiple-equilibria advocates argued that a

[20] All the unreported results pertaining to the robustness checks are available from the authors upon request.

dynamics in which irrational fears feed off each other has been at play in the eurozone. According to the latter view, the European Central Bank ought to accept responsibility as the lender of last resort in government debt markets to counter such dynamics (De Grauwe, 2011b). Representing a major departure in terms of policy stance, the ECB can by doing so prevent eurozone sovereign debt markets from being pushed toward a worse equilibrium than their fundamentals warrant.

ECB President Mario Draghi remarked on 26 July 2012 that the Bank was prepared to do "whatever it takes" to keep the euro together; shortly thereafter, the ECB announced the Outright Monetary Transactions programme. As the financial press summed it up, "The remark triggered a lasting rally in government-bond markets in southern Europe. The ECB did not even have to purchase any government bonds. Mario Draghi's words were enough."[21]

This paper has provided empirical evidence regarding the eurozone fragility hypothesis and, relatedly, on the contagion-mitigating effects of the new ECB policy stance. An event-study analysis revealed significant contagion from idiosyncratic bad news specific to Spain that affected other eurozone countries but only prior to the 'implicit OMT announcement' date of 26 July 2012. Additionally, frequent cross-national clusters of large shocks (so-called herding contagion) showed up among the same set of eurozone countries (including Spain), but the herding contagion became muted following the ECB announcement.

These results suggest that that the new ECB policy embodied in the OMT has curbed the self-fulfilling dynamics and hence the 'unnecessary' contagion in eurozone debt markets. On this basis, a decision against the OMT by the European Court of Justice would not be in the best interests of the region. The empirical evidence presented in this paper calls for the OMT to be formalised into European law.

It is to be hoped that this paper inspires more research to answer further questions as the debate carries on. For example, attempts to ascertain if the ECB's new role as a force of last resort in the eurozone banking system has reduced the amount of systemic risk in European debt markets, as defined in Andrew Ang and Francis A. Longstaff (2013), will benefit all who are concerned about the issue.

[21] In Brian Blackstone, "ECB considers action to stem low inflation", *Wall Street Journal*, European edition, 26 March 2014.

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Appendix A. Descriptive Statistics for daily (non-European) sovereign CDS spreads from 26 July 2011 to 25 July 2013

Country	Average	Standard. Deviation	Min.	Max.	ΔCDS
Brazil	137.64	24.54	99.23	211.18	65.83
Bulgaria	230.90	109.68	90.85	441.64	- 103.66
Chile	94.51	22.57	61.11	163.41	17.47
China	103.04	30.87	55.81	199.57	22.44
Colombia	123.16	28.07	75.16	219.50	16.60
Croatia	387.70	103.42	233.65	581.87	4.22
Hungary	425.21	122.66	241.21	729.89	16.59
Israel	156.40	29.39	105.24	219.50	- 29.65
Japan	93.56	23.29	55.38	152.64	- 22.97
Republic of Korea	108.53	36.65	56.26	234.73	- 17.70
Malaysia	108.14	28.11	66.02	213.73	13.18
Mexico	122.59	26.78	74.17	206.76	8.07
Pakistan	900.04	30.21	816.31	999.75	- 34.74
Panama	120.80	26.83	74.82	211.02	25.16
Peru	129.73	31.51	82.05	219.41	10.07
Philippines	138.98	39.05	80.32	268.35	- 16.53
Poland	165.25	74.72	73.73	337.88	- 74.24
Qatar	101.78	24.11	62.24	148.45	- 19.48
Romania	311.88	93.87	180.57	488.60	- 40.92
Russia	186.78	46.17	116.41	325.65	33.96
Slovakia	177.27	75.67	86.72	306.01	- 24.74
South Africa	150.52	21.27	107.95	233.20	78.33
Thailand	128.56	35.99	81.96	239.06	- 11.81
Turkey	201.05	59.58	109.82	339.22	5.23
Ukraine	720.73	124.41	448.78	974.27	330.98
Venezuela	847.56	155.17	571.42	1249.00	- 85.37

Notes: All the CDS spreads are measured in basis points. ΔCDS denotes the change in the spread from the initial day to the last day of the sample period.

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