Eurozone crisis

SUMMARY

The eurozone sovereign and banking crisis evolved in three phases. Following the onset of the subprime tremors in July 2007, the risk premia (spreads) on bonds issued by eurozone sovereigns rose from historically low levels; but they rose largely in tandem across the eurozone membership along with global banking stresses. The rescue of the US investment bank, Bear Stearns, in March 2008, oddly enough, marked the start of a distinctively European banking crisis accompanied by increased differentiation of countries within the eurozone. With the greater expectation of public support for distressed banks, the spreads that a sovereign paid tended to rise following evidence of stress in its domestic financial sector. This was especially so in countries with lower growth prospects and higher debt burdens. But there was as yet no feedback from banks to sovereigns. Finally, as the limits of fiscal support for domestic banks became clearer, and coinciding with the nationalization of Anglo Irish in January 2009 but gathering steam with evidence of the Greek sovereign's distress in May 2010, sovereign weaknesses also came to be quickly transmitted to a more pessimistic assessment of the financial sector's prospects, creating the potential of mutual destabilization.

— Ashoka Mody and Damiano Sandri

The eurozone crisis: how banks and sovereigns came to be joined at the hip

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1. INTRODUCTION

In early July 2007, when the subprime crisis was just placing the world on notice, the spread (risk premium) on the 10-year maturity Irish sovereign bond was still negative. In other words, the Irish sovereign paid a lower interest rate than did the German sovereign. Even in March 2008, when Bear Stearns was rescued – the point at which, in our view, the European banking-sovereign crisis took a decisive turn – the Irish spread was only 30 basis points.[1] Thereafter, spreads rose at a more rapid pace, with some ups and downs, but through the Lehman bankruptcy

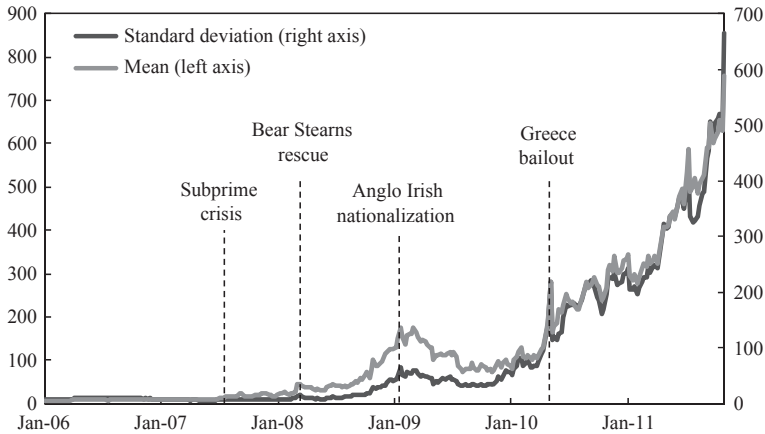[1] 100 basis points equal one percentage point.

Figure 1. Increase and dispersion of eurozone sovereign spreads (basis points)

to the nationalization of Anglo Irish in January 2009. They had risen then to 300 basis points. That increase in a short period of 9 months seemed dramatic, but in retrospect appears quaint. As of this writing, in mid-December 2011, Irish spreads are about 600 basis points, having scaled over a 1,000 basis points before retreating.

This basic sequence played out, with varying intensities, across the eurozone. For several tranquil years – from the introduction of the euro in January 1999 to the start of the subprime crisis in mid-July 2007 – spreads on bonds of eurozone sovereigns had moved in a narrow range with only modest differentiation across countries (Figure 1).[2] The homogeneity was questionable then and became untenable as the eurozone crisis unfolded. In this paper, we tell the tale of that crisis as it unfolded in three phases.

In the first phase, global financial stress was transmitted to Europe. Spreads of European sovereigns rose along with metrics of the health of global banks. This phase lasted from July 2007 through to the rescue of Bear Stearns in March 2008. At that point, spreads had risen modestly, but the differentiation across countries was still low.

From Bear Stearns onwards, a distinctive European dimension of the banking crisis emerged, a phase that included the Lehman bankruptcy and lasted through to January 2009. In this phase, a sovereign's spread responded increasingly to the weakness of its own financial sector. It was as if news of financial sector distress caused a recalibration of public debt ratios via the likely additional claims on the

[2] At the launch of the euro on 1 January 1999, eleven members of the European Union were admitted to the eurozone. These included Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. Greece was admitted on 1 January 2001. Cyprus (January 2008), Malta (January 2008), Slovenia (January 2007), Slovakia (January 2009), and Estonia (January 2011) are now also part of the eurozone.

public purse and the adverse impact on GDP. The role of global developments did not disappear, with the Lehman bankruptcy raising, for example, risk premia everywhere. However, the substantial increase in spreads was now accompanied by a significant differentiation across countries.

The start of the final phase coincides with the nationalization of Anglo Irish in January 2009 and the dynamics initiated then continue through to the present writing. Anglo Irish was a small Irish bank but, in retrospect, its nationalization proved to be a European marker. After Anglo Irish, the crisis evolved into its full-blown phase characterized by highly intertwined financial and sovereign shocks, and this relationship was further strengthened after the Greece bailout. Not only did financial sector stress raise sovereign spreads as before, but in this last phase sovereign weakness also transmitted to the financial sector. Although spreads declined initially after the nationalization of Anglo Irish, the subsequent march upwards was spectacular, as was the country differentiation.

This narrative in three phases is informed by our analysis of the determinants of weekly *changes* in the sovereign bond spreads of 10 eurozone countries over the period January 2006 to November 2011. Estimates based on monthly changes are also presented to assess the timing of the effects and the robustness of the results. The countries included in the analysis are Austria, Belgium, Netherlands, Finland, France, Greece, Ireland, Italy, Portugal and Spain. Germany is excluded since the yield on the benchmark 'German Bund' is treated as the 'risk-free' rate or the numeraire over which each country's spreads are computed.[3] Also excluded are Luxembourg (which has limited traded public debt) and those countries that have entered the eurozone only recently, such as Cyprus, Malta, Slovakia, Slovenia and Estonia, given their shorter histories in the eurozone. For a high-frequency measure of financial sector prospects, we use the ratio of the financial sector equity index over the overall equity index. When this index goes down, the market is assessing that the financial sector is more vulnerable than the rest of the economy.[4]

The key developments start around the rescue of Bear Stearns. Spreads at the time were still trivially low. Bear Stearns, as Reinhart (2011) has most forcefully argued, created a presumption that policymakers would provide sufficient financial support to banks to enable the bailout of the banks' creditors. If there was an intended policy message in the Lehman bankruptcy in September 2008, the message was rapidly reversed as the US authorities quickly thereafter bailed out several other large financial institutions. The presumption that European authorities would

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[3] The spreads are based on yields reported in the secondary market trades of government bonds. Spreads on credit default swaps (CDS) offer another perspective on the market's perception of default risk. Because CDS spreads are, in effect, an insurance premium on a notional outstanding amount, they exist also for Germany – and these have also risen (and, in this sense, the notion the German Bund is 'risk free' is not necessarily precise). For the purpose of this paper, CDS spreads are not suitable since the series are shorter and the markets are thinner than for the conventional government bonds.

[4] It is also possible to use the CDS spreads of banks to measure the market's perception of their vulnerability. As with sovereign CDS spreads, the series are short and the markets thin.
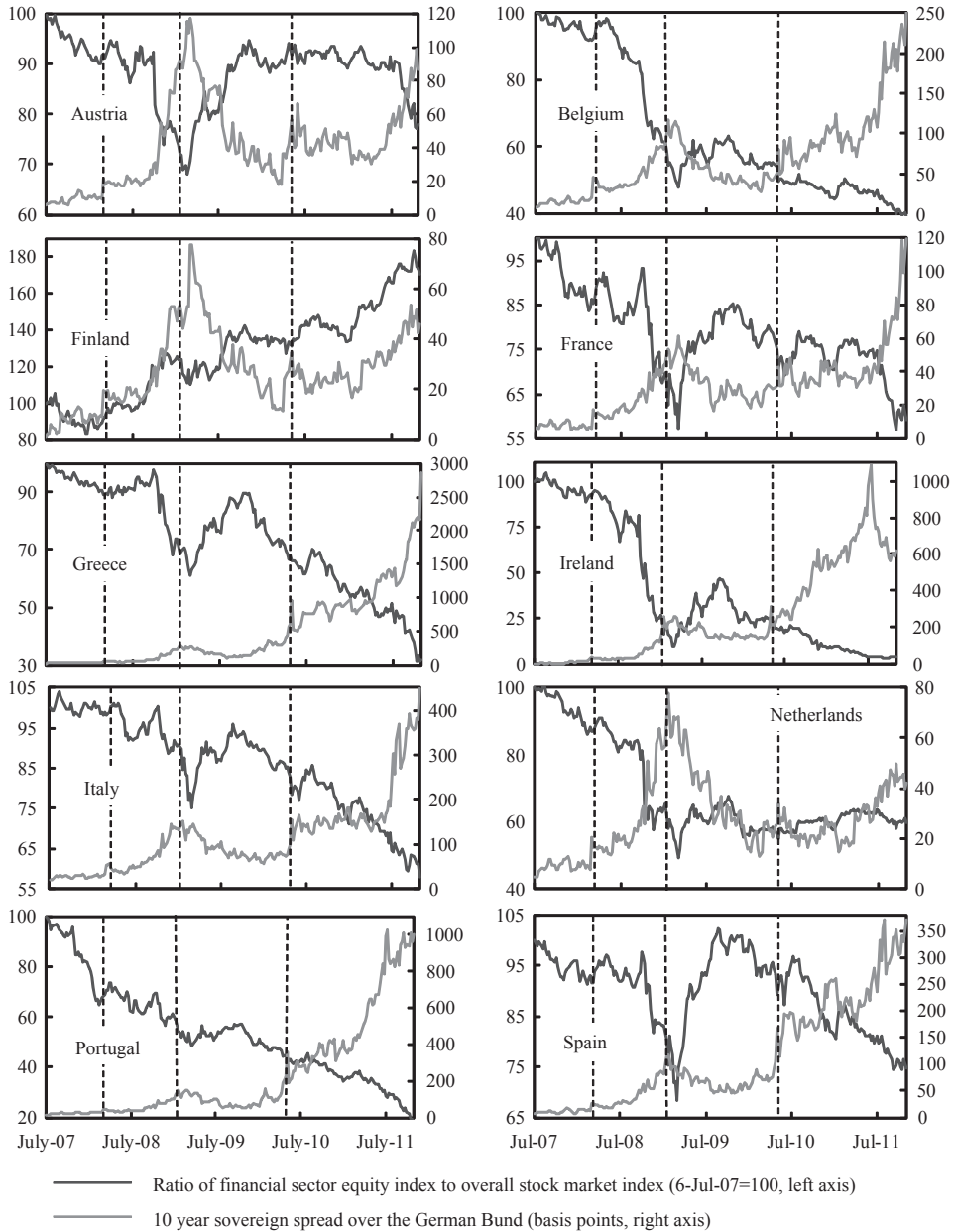
also do the same is noticeable in Figure 1, where Lehman (despite its cataclysmic impact on global financial markets) is not a visible milestone in the run up of euro-zone sovereign spreads from Bear Sterns to Anglo Irish. Each sovereign's spreads during this period evolved largely in response to the stress experienced by its domestic financial sector (Figure 2). As the ratio of financial equity prices to aggregate equity prices fell, sovereign spreads rose.

The econometric analysis shows that post-Bear Stearns, a drop in the financial sector pressure index was followed over two or three weeks by a rise in sovereign spreads. This implies that as information about financial sector weakness emerged, the market filtered its implications for sovereign debt and output growth and reflected that assessment in sovereign spreads. The rapid rise in spreads reflected not only a new estimate of future public liabilities but also the increased uncertainty of what those liabilities may be – with the uncertainty priced into the sovereign risk premia.

Growth prospects also played a key role during this period. Growth projections were massively revised down during the course of 2008. While some part of this downward revision was the result of the emerging Great Recession, it also involved realignment from unsustainable growth towards the countries' actual growth potential. The eurozone countries that had experienced a large appreciation of their effective real exchange rate had become competitively weak, and the pre-crisis buoyancy in some of them was not sustainable. The econometric results show, indeed, that countries with weaker competitiveness were prone to greater sovereign stress resulting from financial sector weakness. Thus, during this key phase, financial shocks translated into higher spreads especially for countries with lower growth prospects and higher debt burden.

The significance of the Anglo Irish nationalization as the other turning point is, at first, less evident. This was a small bank in a small eurozone country. But the event came in the wake of the Lehman bankruptcy in September 2008 with banks worldwide in an elevated state of vulnerability and a widespread sense of interconnections in bank balance sheets, as seen in the heightened comovement of banks' credit default spreads (Eichengreen *et al.*, 2009). The possibility that other banks may need to be nationalized, and the consequent public debt obligations, was very much on peoples' minds.[5] The large fiscal cost of the Anglo Irish nationalization, around 20% of Irish GDP, contributed importantly to the rapid build-up of Irish public debt and hence to the serious concerns about the sustainability of Irish

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[5] Reporting the nationalization of Anglo Irish on 16 January 2009, the British newspaper, the *Independent*, noted that the event had generated 'talk of further state control of U.K. and U.S. banks'. It went on to say: 'Bank shares fell heavily in the U.S. and Europe yesterday on fears that more big lenders would have to ask for state help. Speculation mounted that Bank of America and Citigroup could be fully nationalised. In the U.K., where the Government now owns part or all of five banks, concerns increased that Royal Bank of Scotland could be fully nationalised after a dire profit warning from Deutsche Bank. Germany's biggest lender admitted to a disastrous fourth quarter in the wake of the Lehman Brothers bankruptcy that spelt bad news for U.K. banks such as RBS and Barclays' (http://www.independent.co.uk/news/business/news/anglo-irish-bank-nationalised-1380495.html).

Ratio of financial sector equity index to overall stock market index (6-Jul-07=100, left axis)

10 year sovereign spread over the German Bund (basis points, right axis)

Vertical lines: rescue of Bear Stearns (Mar-08), nationalization of Anglo Irish (Jan-09), Greece bailout (May-10)

Figure 2. Prospects of the financial sector and sovereign spreads

public finances. Suddenly, the ability of sovereigns to prop up the financial sector was in doubt. In this sense, Anglo Irish crystallized the public finance implications of global banking tensions.

Thereafter, we find in the data that not only did the weakness of the financial sector raise sovereign spreads, but shocks to a sovereign's fiscal strength

compromised the scope of financial sector support. Banks and the sovereign, at this point, were joined at the hip.

Specifically, we find a change in the autocorrelation structure of sovereign spreads and banks' equity valuations. While in the pre-Anglo period a reduction in the stock market index for the financial sector preceded by a few weeks an increase in sovereign spreads, the correlation turned contemporaneous after the Anglo Irish nationalization. Reassessments of fiscal sustainability, reflected in a change in sovereign spreads, became important independent drivers of the crisis, and were immediately reflected into banks' equity valuations, presumably because banks held substantial portfolios of sovereign bonds and because the inability of the sovereign to support the financial sector led to a downgrade of growth prospects. The contemporaneous correlation between sovereign spreads and banks' equity valuations further strengthened in May 2010 when the Greek government's financial situation became undeniably critical and limits of fiscal support for domestic banks became even more evident.

It is worth juxtaposing our analysis with the celebrated findings of Reinhart and Rogoff (2009, 2011). First, they report that banking crashes are followed by fiscal crises. Because they deal with annual data, their estimate of the gap between the two is somewhat coarse. We can time the gap more precisely. If the start of the European banking crises coincides with the rescue of Bear Stearns in March 2008, as we suggest, and the ability of the sovereign to shield the financial sector was neutralized in January 2009, then the fiscal crisis followed the banking crisis by nine months. Second, Reinhart and Rogoff find that sovereign debt ratios (and the likelihood of a sovereign default) typically rise substantially after a banking crisis. Importantly, they point out that the rise in sovereign debt is not primarily due to the liability incurred for rescuing the financial system. Rather, slower growth after a financial crisis leads to a rapid rise in the public debt ratios. Our analysis suggests a more nuanced interpretation: a country that is predisposed to grow slowly will experience a more virulent interaction between financial sector shocks and public debt. This low growth potential – often camouflaged by the pre-crisis boom – is made manifest by the crisis rather than being mainly an outcome. Finally, Reinhart and Rogoff do not find a feedback loop from rising public debt to banking crises, from which they infer that it is primarily the surge in private debt that causes banking crises. While private debt may instigate the initial incidence of a banking crisis, our results show that the perpetuation of these twin public debt and banking crises is due to their mutual reinforcement.

Looking ahead, therefore, the banking sector vulnerabilities uncovered by the crisis, weaker growth prospects, and higher debt ratios (and higher spreads) could persist because they have the potential to reinforce each other. In this sense, the paper documents a transition from a benign equilibrium to a new, more stressed equilibrium. Indications of stress were present in the pre-crisis years, albeit in muted form. But markets chose to largely ignore them. That is no longer the case, creating new challenges for policymakers.

The rest of the paper is organized as follows. We begin in Section 2 by discussing the theoretical links between the domestic financial sector and sovereign

spreads. Section 3 describes the data and the econometric approach. In Section 4, we consider the period before the nationalization of Anglo Irish and establish the case that the domestic financial sector matters in explaining changes in sovereign bond spreads; this link holds even when various global influences are accounted for. Section 5 documents the co-evolution of bank and public sector fragilities after Anglo Irish. In Section 6, we examine the differences between country groups with large and more moderate losses in competitiveness, highlighting the non-linearities due to financial shocks, high debt ratios and weak growth potential. In conclusion, Section 7 cautions that the downward reassessment of short-term global growth prospects, an unstable financial sector, and rising public debt can continue in the absence of decisive intervention in the financial sector.

2. FINANCIAL CRISIS AND SOVEREIGN DEFAULT

In this section we discuss the theoretical links between the conditions of the financial sector and sovereign spreads. These considerations will guide us in selecting the econometric specifications and interpreting the results. Leaving aside liquidity considerations, sovereign spreads essentially reflect the risk of default which tends to increase with the ratio of public debt to GDP. As shown in the simple model presented in Box 1, losses in the banking sector can lead to higher sovereign spreads because they have the potential to both reduce GDP and increase the level of public debt. The growth outcome from the weakening of banks' balance sheets arises from a contraction in credit supply that, by curbing investment, reduces GDP. Furthermore, in order to support lending and limit the GDP contraction, government often have to absorb part of the banks' losses with a consequent increase in the level of public liabilities.

Box 1. The impact of financial shocks on sovereign spreads

Consider a simple two-period model that helps clarify how financial shocks affect sovereign spreads. In period 1, the government issues a certain stock of bonds, B_1, pledging a rate of return, r. The government's ability to honour that commitment in period 2 depends on the ratio of debt repayment over GDP, $b_2 = B_1(1 + r)/Y_2$. As a simple stylization, we assume that the government defaults if b_2 exceeds an exogenous threshold $\bar{b}$. GDP is determined by $Y_2 = A_1(1 + g)K_1\varepsilon_2$, where A_1 is the level of productivity which grows between time 1 and 2 at the economy's potential growth rate g, K_1, is capital investment at time 1, and ε_2 is a mean-one log-normally distributed shock with standard deviation σ. The role of the financial sector in this context is to determine capital investment K_1. Banks leverage their own equity endowment E_1 with external funds to finance investment, so that $K_1 = \lambda E_1$, where λ is the leverage factor.

Risk-neutral investors require a premium over the exogenous risk-free rate, i, for compensation against the risk of default. Thus, the sovereign spread, $r - i$, has to be such that the expected return on government bonds is equal the risk-free rate $(1 - D)(1 + r) + D \mu (1 + r) = (1 + i)$, where D is the default probability and μ is the recovery rate in case of default. Therefore, financial shocks that reduce the capitalization of the banking sector, E_1, can generate an increase in spreads through a combination of lower GDP and higher public debt. First, equity losses impair banks' ability to finance investment, leading to a contraction in GDP. Second, in order to support credit supply, governments often incur liabilities to recapitalize the financial sector.
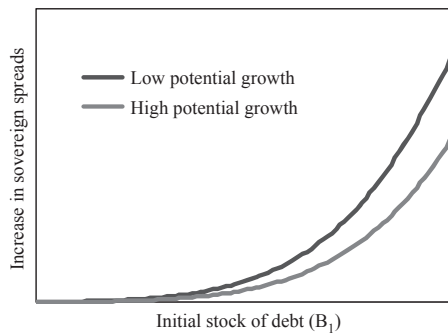

Figure 3. Impact of equity losses in the financial sector on sovereign spreads

The model also reveals that the impact of financial losses on government spreads can differ across countries. Under plausible parameter values, the default risk is exponentially increasing in the debt-to-GDP ratio. This implies that a further increase in debt and contraction in GDP caused by a financial shock has a stronger impact on the sovereign spreads of countries with higher initial debt levels. Similarly, the impact is also expected to be more severe for countries with lower growth potential that even in the absence of financial problems would face possible fiscal challenges. These model implications are depicted in Figure 3 which shows that a given equity loss in the financial sector leads to a particularly severe increase in the sovereign spreads of high-debt and low-growth countries. We will see that the econometric analysis provides support for these theoretical implications.

To inform the policy discussion, it is important to emphasize that, even though the recapitalization of the financial sector involves fiscal costs, it does not necessarily lead to a further increase in sovereign spreads. This is because the injection of capital in a distressed financial sector has the potential to support lending and prevent a more severe collapse in GDP. To the extent that the lending multiplier of public capital injections is sufficiently high, recapitalizations can actually contain the increase in the

expected debt-to-GDP ratio and in sovereign spreads. Looking back at Figure 1, note the modest decline in spreads following the rescue of Bear Stearns, and the more extended decrease following the nationalization of Anglo Irish. In both cases, the availability of a government safety net provided short-term reassurance to markets that banks – and, hence, economic growth – would be protected. Of course, the recapitalization is not a substitute for winding down an unviable financial institution. In retrospect, the government support for Anglo Irish proved more than the state could handle as the hole in the bank's balance sheet was relentlessly revealed to be deeper. That said, bank recapitalization, when undertaken judiciously, can be an important policy tool for breaking the vicious circle of sovereign and banks' vulnerability.

The model in Box 1 also shows that the impact of financial shocks on sovereign spreads depends on countries' characteristics. The increase in spreads is expected to be much more pronounced for economies facing low growth prospects. While a negative financial shock in a healthy growing country only mildly increases the default probability, it has a much larger impact on a slower growing or contracting economy. The country's fiscal position is another important factor that differentiates the response in spreads to financial shocks. The same capital loss in the financial sector triggers a much larger increase in sovereign spreads for countries with a large stock of debt. More interestingly, there are negative synergies between low growth and high debt: the magnifying effect of high public debt on spreads is expected to be especially strong if the growth potential is low. In other words, the model predicts that financial crises in high-debt countries will create more upward pressure on sovereign spreads the lower is the growth potential. This is a hypothesis that we test in our econometric analysis. Note also that the association between financial crises and slow subsequent growth is often interpreted as a causal effect from financial crises on growth. Our analysis suggests that weak growth prospects can also breed crises.

We have thus far outlined how shocks to the financial sector may impact on sovereign spreads. However, fiscal problems may themselves have repercussions on banks through several channels.[6] Most simply, banks hold government securities, and the mark-down on these assets when spreads rise results in reduced capital. Morever, higher spreads may require fiscal consolidation that depresses GDP and banks' profitability. A worrysome consideration is that the presence of these feedback effects between the financial and public sector has the potential to create vicious loops in which financial and sovereign fragilities reinforce each other. Our empirical analysis indicates that the eurozone crisis did enter such a distressed equilibrium after the nationalization of Anglo Irish.

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[6] Recent papers modelling the impact of sovereign risk on the banking system are Bolton and Jeanne (2011) and Gennaioli *et al.* (2011).

3. THE DATA AND ECONOMETRIC APPROACH

The sovereign spread for country i at time t, S_{it}, is measured as the difference between the secondary-market yield on the country's 10-year bond and the yield on the German 10-year benchmark government bond (the German 'Bund'). Since the yield on the Bund is regarded as a 'risk-free' rate, the spread is the premium paid for the risk of default. Figure 2 plots the sovereign spread for each country against a measure of the prospects of the financial sector. This measure, F_{it}, is the ratio of the equity index of the country's financial sector divided by the overall equity index. Thus, a fall in F_{it} indicates that the financial sector is expected to underperform the rest of the economy. With some exceptions, a striking inverse relationship exists between S_{it} and F_{it}. In other words, as markets revised down their view of a country's domestic financial sector, sovereign spreads rose – and vice versa. This relationship has held in the short-term movements and over the long haul.

To explain sovereign risk premia and their association to the conditions in the financial sector, we analyse their correlation structure at weekly frequencies. Consider the following relationship which is first specified in *levels* to motivate the discussion:

$$S_{it} = \alpha + \sum_{s=1}^{p} \beta_{i,t-s} S_{i,t-s} + \sum_{s=0}^{m} \lambda_{i,t-s} F_{i,t-s} + \sum_{s=0}^{n} \phi_{i,t-s} Z_{i,t-s} + \varepsilon_{it}$$

Possible persistence in the spreads is captured by their lagged values. As discussed above in Section 2, a weaker financial sector (a lower F_{it}) is hypothesized to raise spreads as public debt dynamics worsen due either to lower growth prospects or because large bailout costs are anticipated. The Z_t regressors include other factors likely to affect risk perceptions. For example, flight to quality is proxied by the yields on US government bonds. Flight to quality is a nebulous concept but could be understood as risk aversion or a re-evaluation of global risk, including the path of GDP and public debt. Slower, more uncertain growth and even rising public debt projections have been associated with lower US treasury yields, including after the S&P downgrade of US debt. We also use credit default swaps (CDS) on US banks to capture global financial conditions.

A number of econometric issues are associated with estimating this relationship. First, as is clear from Figure 2, both S_{it} and F_{it} trend. As such, the equation is estimated in first differences: in other words, the estimation explains the *change* in spreads. Second, although weekly observations for the full time period allow for country-by-country estimations, there is an important evolution over time in the relationship between spreads and financial stress. Investigating this evolution even with weekly data is not possible on a country-by-country basis since the sample size becomes too small. To maintain comparability of results across phases, it therefore helps to stay throughout within a common panel framework. Third, within that
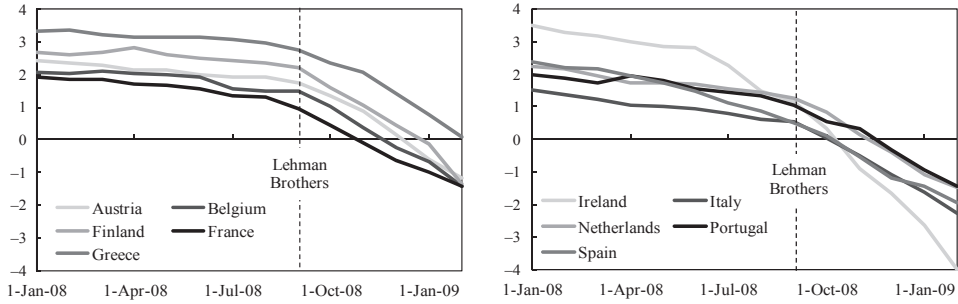
Figure 4. Downward revision of Consensus Forecast for 2009 real GDP growth

panel framework, because the time series dimension of the data is relatively long even for the smaller samples, the endogeneity concern on account of the lagged dependent variable does not arise. Hence, dynamic panel data techniques are not required. Instead, the panel estimation technique used allows for heteroscedasticity, that is, for the variance of the error terms to vary by country. It also allows for first-order autocorrelation in errors and for contemporaneous correlation of error terms across countries and, hence, for unobserved global shocks felt by all countries.[7]

Fourth, the US government bond yields and CDS spreads of banks do not capture all the global impulses. As Figure 4 shows, the fall of Lehman in September 2008 involved a global downward revision of growth prospects and had an inevitable effect on sovereign risk premia in Europe. To allow for such shift, we include a dummy variable D_t for the period between Lehman and Anglo Irish. The inclusion of this dummy variable implies that the estimation explains a country's deviation in the change in spreads from the period average change for all countries in the sample. Finally, in all but the set of regressions where we examine the effect of public debt ratios (which do not change much over time), country dummies δ_i are included to allow for the influence of unobserved country factors. With those considerations to guide the analysis, the specification to be estimated is:

$$\Delta S_{it} = \sum_{s=1}^{p} \beta_{i,t-s} \Delta S_{i,t-s} + \sum_{s=0}^{m} \lambda_{i,t-s} \Delta F_{i,t-s} + \sum_{s=0}^{n} \phi_{i,t-s} \Delta Z_{i,t-s} + \varepsilon_{it} + \delta_i + D_t$$

The goal is to identify the factors that led to the rise and dispersion of sovereign spreads. Through these regressions, we can identify the principal correlates of the short-term variations in sovereign spreads. There remains the thorny question of whether these correlates are 'determinants' of spreads in a causal sense. We discuss

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[7] As Beck and Katz (1995) suggest, we allow for a common autocorrelation coefficient for all countries. They caution that this is best since it guards against the risk of mismeasurement of the autocorrelation coefficient for individual countries, and we follow that recommendation. In practice, the results do not change qualitatively if the autocorrelation coefficients are country specific.

below the extent to which the lag structure revealed by our high-frequency data can be used to draw inferences about causality.

4. FROM EUROZONE TRANQUILITY TO CRISIS

The basic structure of the regressions is as follows: lags of the dependent variable are used to assess the degree of persistence in the change in spreads; changes in the domestic financial sector pressure index (and its lags) ascertains the relationship of key interest, that between financial sector stress and sovereign spreads; and global variables, including the post-Lehman dummy variable, control for generalized influences on spreads. The regressions examine the lags in the relationships not just for their intrinsic interest but also for what they may tell us about the sequencing of developments and hence (potentially) about causality.

In the tranquil phase up until the start of the subprime crisis, the changes in sovereign spreads were essentially random. The variables used in this analysis certainly do not explain those changes, and the R-squared of the regression is also small (column 1, Table 1). This conclusion is consistent with earlier studies, which have examined other possibilities (see summaries of the previous literature in Codogno *et al.*, 2003, and Pagano and von Thadden, 2004). In their 2004 paper, Pagano and von Thadden concluded that explaining the time variation in spreads had been 'challenging', and that remained the case through to the start of the subprime crisis. The differences in spreads across countries did reflect the variation in debt levels or credit ratings, but the differentiation was negligible by current standards. These considerations do not necessarily imply that eurozone sovereign bonds were mispriced. But clearly sovereign spreads had converged to a much a greater degree than economic prospects had.

Starting with the onset of the subprime crisis in mid-July of 2007 and going through to the rescue of Bear Stearns in mid-March 2008, the variation in sovereign spreads was no longer white noise (column 2, Table 1). In this phase, the change in spreads was related to 'global factors', mainly reflecting global financial risk.[8] Empirically, such risk is found to be best proxied by the change in the spreads on credit default swaps (CDS) of US banks, which are highly correlated with CDS spreads of banks elsewhere, as noted in Eichengreen *et al.* (2009). Thus, the subprime crisis shook the eurozone out of its tranquility, as sovereigns paid a premium for global financial risk.

Though Bear Stearns was a US bank, its rescue marks the start of a distinct eurozone financial crisis. Three trends are noticeable in the econometric analysis. First, the influence of the identifiable global factors declined. Thus, columns 3–4 of Table 1 show that the correlation between the change in CDS spreads of US banks and the change in eurozone sovereign spreads became insignificant at conventional

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[8] The importance of global factors for the movements of sovereign spreads during the early phase of the crisis is also documented in Sgherri and Zoli (2009), and Caceres *et al.* (2010).

Table 1. Phases of the crisis prior to the nationalization of Anglo Irish

VARIABLES	(1) Pre Subprime ΔS	(2) Subprime to Bear Stearns ΔS	(3) From Bear Stearns to Anglo Irish ΔS	(4) From Bear Stearns to Anglo Irish ΔS
LΔ.S	−0.07	−0.04	−0.12	−0.19**
	(0.06)	(0.15)	(0.10)	(0.09)
L2Δ.S	0.04	0.09	−0.28***	−0.32***
	(0.06)	(0.14)	(0.10)	(0.09)
Δ.F	0.00	0.13	−0.02	0.02
	(0.02)	(0.09)	(0.08)	(0.08)
LΔ.F	−0.01	0.17*	−0.15*	−0.11
	(0.02)	(0.09)	(0.09)	(0.08)
L2Δ.F	0.02	0.13	−0.32***	−0.27***
	(0.02)	(0.09)	(0.08)	(0.08)
L3Δ.F	0.01	−0.05	−0.26***	−0.20***
	(0.02)	(0.09)	(0.08)	(0.08)
D.US_yields	−0.62	−2.51	−7.56**	−4.81
	(0.73)	(3.29)	(3.78)	(3.71)
D.CDS_US_banks	0.06	0 09***	−0.02*	−0.01
	(0.04)	(0.02)	(0.01)	(0.01)
LD.CDS_US_banks	0.03	0.07***	−0.01	0.01
	(0.04)	(0.02)	(0.01)	(0.01)
L2D.CDS_US_banks	0.05	−0.01	0.00	0.01
	(0.05)	(0.02)	(0.01)	(0.01)
Lehman to Anglo Irish				3.80***
				(1.43)
Constant	0.10	−0.31	0.94	−0.09
	(0.06)	(0.42)	(0.78)	(0.86)
Observations	760	340	440	440
R-squared	0.03	0.44	0.19	0.25
p-value for sum of lagged ΔF=0	0.52	0.15	0.00	0.00

Notes: Panel-corrected standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Δ is the difference operator; L, L2 and L3 are the first, second and third lags respectively.

levels. Second, external factors did play a role in the post-Bear Stearns phase: but mainly through the general upward pressure on risk premia after the Lehman bankruptcy, proxied by the dummy for that period.

Third, the big change in the post-Bear Stearns phase was the important role of domestic factors, represented by the market's assessment of financial sector prospects. Note, however, that the coefficient on the contemporary effect is insignificant. Rather, the lagged effects (from the previous three weeks) are statistically significant. In other words, following an observed weakness in financial sector prospects,

sovereign spreads rose with a delay of a few weeks.[9] Adding the post-Lehman dummy, does, as expected, reduce the strength of the relationship between financial sector stress and the rise in sovereign spreads. However, the time pattern of that relationship is unchanged and the statistical relationship remains clear and strong. Thus, sovereign spreads began responding to perceived equity loss in their domestic banks. This period is also characterized by increased differentiation in spreads across countries. This can be explained by differences in the size of domestic financial shocks, as well as by the interactions between financial shocks and countries' characteristics as analysed in Section 6.

Bear Stearns, therefore, marked an important turning point in the crisis as seen through the lens of eurozone sovereign spreads. The debate on whether or not Bear Stearns should have been bailed out has hinged on the risk of moral hazard – critics have warned that bank managers will become even more irresponsible while proponents of the rescue have been focused on the stability of the financial system. Even as that debate plays out, the data show that there was an immediate impact. The implicit assumption that systemically important banks would typically be bailed out was converted into an explicit and close tie between banks and the dynamics of public finance.[10] Interestingly, the Bear Stearns rescue initially generated optimism that the financial sector had become safer and, as Figure 1 shows, sovereign spreads fell. However, that optimism lasted briefly. Two months later, by mid-May, 2008, the financial sector was being perceived as increasingly weaker and sovereign spreads were, once again, on the rise.

5. POST-ANGLO IRISH: A NEW DYNAMIC

Following the nationalization of Anglo Irish in January 2009, sovereign spreads started to decline after a virtually uninterrupted increase in the previous 18 months (Figure 1). While this fall was thereafter reversed for a prolonged and, in some countries, dramatic rise, the econometric analysis reveals, more importantly, a qualitative evolution of the crisis after the Anglo nationalization. Financial stress no longer preceded the rise in sovereign spreads; rather the two moved contemporaneously.

There are three differences of interest between the Bear Stearns to Anglo and the post-Anglo periods (Table 2).[11] First, from Bear Stearns to Anglo, the coefficients on the first and second lags of the dependent variable are negative and

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[9] These results are confirmed also for individual countries. The financial indexes and sovereign spreads are not significantly correlated in any country before Bear Stearns, while between Bear Stearns and Anglo Irish lagged changes in the financial indexes predict spreads in all but two countries (these are Finland, where, as discussed below, we would expect the relationship to be weak, and Portugal, where the financial sector was not seen to be a concern during that period). We have also verified that the results are robust to outliers by running median regressions and trimming the tails of the data distribution.

[10] Consistently with this claim, Ejsing and Lemke (2011) document a reduction in the CDS of eurozone banks during this period mirrored by the increase in credit spreads on the sovereigns.

[11] To facilitate the comparison between the pre- and post-Anglo Irish periods, we repeat in column 1 of Table 2 the results of column 4 in Table 1.

Table 2. The post Anglo Irish phase

VARIABLES	(1)	(2)	(3)	(4)	VARIABLES	(5)	(6)
	From Bear Stearns to Anglo Irish	Post Anglo Irish	Post Anglo Irish			From Bear Stearns to Anglo Irish	Post Anglo Irish
			From Anglo to Greece bailout	Post Greece bailout			
	ΔS	ΔS	ΔS	ΔS		ΔF	ΔF
LΔS	-0.19** (0.09)	-0.08 (0.07)	0.21* (0.08)	0.04 (0.10)	LΔF	-0.13 (0.09)	0.01 (0.05)
L2ΔS	-0.32*** (0.09)	0.02 (0.07)	-0.02 (0.09)	-0.03 (0.09)	L2ΔF	-0.03 (0.10)	0.00 (0.05)
ΔF	0.02 (0.08)	-1.88*** (0.42)	-0.91*** (0.21)	-2.43*** (0.89)	ΔS	0.01 (0.04)	-0.01*** (0.00)
LΔF	-0.11 (0.08)	-0.52 (0.41)	-0.04 (0.21)	-0.99 (0.88)	LΔS	0.03 (0.04)	0.00 (0.00)
L2ΔF	-0.27*** (0.08)	0.41 (0.41)	0.22 (0.21)	0.57 (0.85)	L2ΔS	-0.02 (0.04)	0.00 (0.00)
L3ΔF	-0.20*** (0.08)	-0.46 (0.42)	-0.1 (0.22)	-1.40* (0.82)	L3ΔS	0.01 (0.04)	-0.00* (0.00)
D.US_yields	-4.81 (3.71)	-35.04*** (10.68)	-19.92*** (6.01)	-31.41* (18.89)	D.US_yields	0.7 (1.91)	0.75 (0.84)
D.CDS_US_banks	-0.01 (0.01)	0.10 (0.07)	0.09*** (0.03)	0.36* (0.21)	D.CDS_US_banks	0.00 (0.01)	-0.03*** (0.01)
LD.CDS_US_banks	0.01 (0.01)	-0.06 (0.07)	0.02 (0.03)	-0.81*** (0.18)	LD.CDS_US_banks	0.01* (0.01)	0.00 (0.01)
L2D.CDS_US_banks	0.01 (0.01)	-0.03 (0.07)	-0.05 (0.03)	0.29 (0.19)	L2D.CDS_US_banks	0.00 (0.01)	0.00 (0.01)
Lehman to Anglo	3.80*** (1.43)				Lehman to Anglo	-1.13 (0.79)	
Constant	-0.09 (0.86)	0.12 (0.90)	0.8 (0.82)	-3.23 (2.19)	Constant	-1.31 (1.33)	0.03 (0.41)
Observations	440	1470	680	790	Observations	440	1470
R-squared	0.25	0.09	0.24	0.15	R-squared	0.11	0.14
p-value for sum of lagged ΔF = 0	0.00	0.43	0.83	0.22	p-value for sum of lagged ΔS = 0	0.84	0.17

Notes: Panel-corrected standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Δ is the difference operator; L, L2 and L3 are the first, second and third lags respectively.

highly significant: the rise in spreads tended to overshoot and then pulled back somewhat over the next few weeks. In the post-Anglo phase this is much less the case. One interpretation is that there was much greater learning going on in the first phase. The market was absorbing information on financial sector losses and relating that to their eventual implication for public debt. This was all new to the market and it is not surprising that there was a tendency to overshoot early in the crisis.

Second, post-Anglo, we also find a more substantial role for a generalized re-evaluation of eurozone risk. Thus, higher risk perceptions of the eurozone, reflected in higher sovereign spreads, were associated with lower US Treasury yields. While countries within the eurozone were being differentiated, the eurozone was itself being perceived as a greater risk.

Finally, and more importantly, the correlation structure between sovereign spreads and the financial sector index changed markedly after the rescue of Anglo Irish. A weakening of the financial sector was now contemporaneously associated with higher spreads, while the lagged coefficients of the financial index turned statistically insignificant.[12] How do we interpret these findings? While recognizing that lagged correlations cannot prove causality, we believe the econometric results suggest a plausible and interesting progression of the crisis.

Prior to the nationalization of Anglo Irish, the absence of a contemporaneous correlation and the presence of lagged effects suggest that the crisis was primarily driven by financial sector shocks, which were gradually transmitted to the sovereign. These lags are consistent with the theme noted above: markets were still learning about the nature and the size of the crisis and, in particular, its implication for public debt and growth. The objection to such an inference is that reverse causality may nevertheless have operated. For instance, anticipating weakness in public finances, the market could have perceived a diminished government ability to support banks and hence marked down their equity prices. But such a possibility appears unrealistic: if markets were indeed persuaded that government finances were under greater strain, it is not clear why financial stocks would be marked down before sovereign spreads rose. At the very least, there would be a contemporaneous relationship.

In the spirit of Granger causality tests, we explore this idea further by reversing the regression, with the financial sector equity index as the dependent variable and the lags of the sovereign spreads as explanatory variables. This analysis confirms that sovereign spreads did not predict a change in the financial sector prospects in the Bear Stearns-Anglo phase (column 5, Table 2).[13] Together, then, the evidence

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[12] The change in the correlation structure can be detected also at the level of individual countries. While no country displays a negative contemporaneous correlation between the financial indexes and sovereign spreads prior to Anglo Irish, all of them do afterwards.

[13] This is the case also for individual countries, with the exception of a weak significance of the second lag in Ireland and the third lag in Spain compensated however by the opposite-sign first lag.

suggests that in this phase the news of financial sector developments filtered into a reassessment of the government's fiscal commitments and, hence, into sovereign bond spreads.

After Anglo Irish, the correlation between spreads and the financial index becomes contemporaneous, suggesting a new stage of the crisis. After having driven the increase in spreads from Bear Stearns to Anglo Irish, in this phase, the financial sector was also hurt when greater stress on the sovereign was revealed. The contemporaneous correlation between the financial sector and the sovereign is also clearly evident when the regression is reversed (column 6, Table 2). It is possible, of course, that growth and other shocks impacted both the financial sector and the sovereign and these were reflected in the contemporaneous correlation. But this possibility also existed before Anglo. Rather, after supporting banks in the previous months, the by now weakened public finances had themselves an adverse impact on the financial sector. The government's ability to support banks had been compromised, and banks' holdings of public bonds became a more serious strain on them. Also higher sovereign spreads meant higher borrowing costs for domestic banks, leading to higher rates charged for investment and, hence, lower investment rates and growth. At the same time, new revelations of banks' weakness raised sovereign spreads. Thus stresses in one domain were quickly transmitted to the other. This feedback loop goes some way towards explaining the rapid rise in spreads in some countries and hence the emergence of a very high degree of country differentiation.

In columns 3 and 4 of Table 2, we further partition the period after the nationalization of Anglo Irish, before and after the decision in May 2010 by the IMF and eurozone countries to provide Greece with financial support. A highly significant contemporaneous correlation is detected even in the period after the Anglo nationalization but before the Greece bailout. Importantly, however, as we would expect, the contemporaneous correlation between sovereign spreads and the financial sector index became much stronger after the Greece bailout proved the risks to sovereign stability. This confirms that sovereign concerns became an important driver of the crisis after the nationalization of Anglo Irish and intensified in the months thereafter.

To provide further perspective on the timing of developments – but also as a test of the robustness of the findings – Table 3 reports on the *monthly* rather than weekly changes in spreads. While the results do not pick up some of the high frequency movements, they reassuringly capture the main narrative. Before the subprime crisis, the movement in spreads had no evident explanation. From the start of the subprime crisis to Bear Stearns, global risk was factored into the risk premia paid by eurozone sovereigns. In these monthly regressions, we find that the influence of US banks' CDS spreads is statistically weaker than in the weekly regressions; that influence is absorbed by the US government yield. It is as if the impact from the CDS spreads reversed relatively quickly, and is, therefore, not evident over the longer, monthly horizon. Importantly, in the next phase, the domestic financial sector vulnerabilities,

Table 3. Phases as seen through monthly changes in spreads

	(1)	(2)	(3)	(4)	(5)	(6)
					Post Anglo Irish	
	Pre Subprime	Subprime to Bear Stearns	From Bear Stearns to Anglo Irish	Post Anglo Irish	From Anglo to Greece bailout	Post Greece bailout
VARIABLES	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S
LΔ.S	−0.04	−0.19	0.18	0.45***	0.52**	0.27
	(0.14)	(0.22)	(0.18)	(0.15)	(0.21)	(0.21)
L2Δ.S	0.11	−0.17	0.29	0.28*	0.02	0.32
	(0.14)	(0.22)	(0.23)	(0.15)	(0.23)	(0.21)
Δ.F	−0.04	0.01	−0.2	−1.75***	−0.79**	−3.94**
	(0.04)	(0.13)	(0.16)	(0.67)	(0.37)	(1.77)
LΔ.F	0.07*	−0.1	−0.35**	0.08	0.33	−0.2
	(0.04)	(0.09)	(0.16)	(0.72)	(0.37)	(1.90)
D.US_yields	−0.53	−10.40**	−3.77	−13.90	−23.76**	−22.76
	(1.21)	(4.80)	(5.81)	(14.54)	(11.36)	(27.20)
D.CDS_US_banks	0	−0.01	0.01	−0.06	0.09	−0.64
	(0.07)	(0.04)	(0.02)	(0.14)	(0.08)	(0.49)
LD.CDS_US_banks	−0.06	−0.03	0.02	−0.03	−0.13*	0.35
	(0.08)	(0.03)	(0.02)	(0.12)	(0.07)	(0.34)
Lehman to Anglo Irish			9.18**			
			(4.01)			
Constant	0.26	−0.8	−2.5	0.37	1.89	−14.90*
	(0.30)	(1.41)	(2.35)	(2.43)	(2.82)	(8.34)
Observations	150	80	110	340	160	180
R-squared	0.06	0.46	0.61	0.37	0.43	0.34

Notes: Panel-corrected standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Δ is the difference operator; L, L2 and L3 are the first, second and third lags respectively.

which had no role before Bear Stearns, led the changes in sovereign bond spreads and, thereby, acted to differentiate the evolution of spreads. The Lehman effect is also detected at monthly frequencies as a generalized aversion to risks. Finally, the relationship between financial sector and sovereign vulnerability becomes contemporaneous after Anglo Irish and strengthens after the Greece bailout.

6. COUNTRY DIFFERENCES

Are the countries across the eurozone affected uniformly by the factors identified above? Or, are there interesting and helpful distinctions across groups of countries? Our simple model in Box 1 suggests that the impact of financial shocks on sovereign spreads should be differentiated by the growth prospect and fiscal position of each country. In particular, countries with lower growth potential should be more sensitive to financial sector vulnerabilities; moreover, conditional on growth poten-
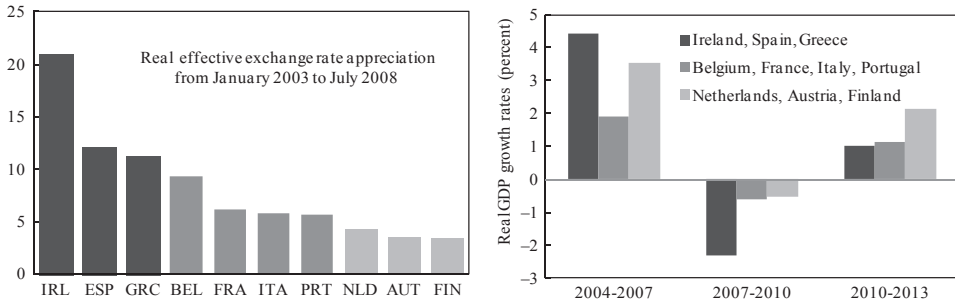
Figure 5. From high appreciation to low growth prospects

tial, a higher public debt-to-GDP ratio should have a bigger impact on spreads. In this section we empirically test the relevance of these model implications.

6.1. Following Bear Stearns: spotlight on countries' loss of competitiveness

In order to assess the growth potential of eurozone countries on the onset of the financial crisis, we focus on a measure of their competitiveness. Figure 5 is the starting point: its left panel shows the appreciation of the real effective exchange rate from January 2003, near the bottom of the previous cycle to July 2008, near the peak. Ireland had the largest appreciation, followed by Spain and Greece. At the other end, the Netherlands, Austria and Finland experienced the most modest appreciations. The appreciation of the exchange rate over the previous cycle is likely to have an important bearing on how the economy will behave during the next cycle and hence on the short-term and medium-term growth outlook.[14] This conjecture is supported in the right panel of Figure 5. After very high growth prior to the crisis fuelled by credit expansion, the countries with the largest appreciation experienced the most severe GDP contraction and have the lowest growth prospects. As discussed in Section 2, it is exactly in these countries where the impact of financial shocks on sovereign spreads should have been the strongest. At the other end, Austria, the Netherlands and Finland had the least appreciation, the smallest decline in GDP growth during the crisis, and the highest medium-term projected growth. The middle group of countries was already growing slowly before the crisis, their decline in GDP growth during the crisis falls in the middle of these eurozone countries, as do their medium-term growth prospects. Thus, we use these country groupings to test if growth prospects did make a material difference to the interaction between financial stress and sovereign spreads.

Notice, first, that following the onset of the subprime crisis but before the Bear Stearns rescue, the patterns are quite similar across countries (columns 1–3,

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[14] Instead of this admittedly crude measure, an alternative would be to assess the deviation from 'equilibrium exchange rates'. However, there are also well-known difficulties in such an assessment.

Table 4. Country differentiation by loss of competitiveness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Subprime to Bear Stearns			Bear Stearns to Anglo Irish			Post Anglo Irish		
	IRL, ESP, GRC	BEL, FRA, ITA, PRT	NLD, AUT, FIN	IRL, ESP, GRC	BEL, FRA, ITA, PRT	NLD, AUT, FIN	IRL, ESP, GRC	BEL, FRA, ITA, PRT	NLD, AUT, FIN
VARIABLES	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S	Δ.S
LΔ.S	-0.01	-0.1	-0.19	-0.07	-0.32***	-0.15	-0.1	-0.23***	-0.12**
	(0.14)	(0.17)	(0.17)	(0.10)	(0.11)	(0.10)	(0.08)	(0.07)	(0.06)
L2Δ.S	0.13	0.16	-0.08	-0.33***	-0.37***	-0.34***	0.05	-0.12*	-0.10*
	(0.14)	(0.16)	(0.16)	(0.11)	(0.11)	(0.10)	(0.08)	(0.07)	(0.06)
Δ.F	0.02	0.17	0.14	-0.05	0.18	0.07	-3.92***	-2.20***	-0.50***
	(0.16)	(0.14)	(0.09)	(0.12)	(0.16)	(0.07)	(1.22)	(0.47)	(0.09)
LΔ.F	0.34**	0.22	0.04	-0.25**	0.02	0.06	-1.09	-1.09**	-0.09
	(0.16)	(0.14)	(0.09)	(0.12)	(0.16)	(0.07)	(1.24)	(0.47)	(0.09)
L2Δ.F	0.08	0.15	0.14	-0.28**	-0.43***	-0.17**	0.96	0.4	0
	(0.16)	(0.14)	(0.10)	(0.12)	(0.16)	(0.07)	(1.17)	(0.41)	(0.09)
L3Δ.F	-0.26	0.18	-0.06	-0.27**	-0.04	-0.16**	-0.71	-0.48	-0.14
	(0.16)	(0.14)	(0.10)	(0.12)	(0.16)	(0.07)	(1.16)	(0.40)	(0.09)
D.US_yields	-3.10	-3.29	-1.50	-8.07	-5.88	-3.44	-66.02***	-31.63***	-8.12***
	(3.48)	(3.63)	(2.81)	(4.93)	(4.06)	(2.68)	(24.35)	(8.51)	(2.13)
D. CD S_US_banks	0.09***	0.11***	0.06***	-0.02	-0.01	-0.01	0.15	0.03	0.07***
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.17)	(0.06)	(0.01)
LD.CDS_US_banks	0.06***	0.11***	0.06***	0	0	0	-0.13	-0.05	0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.16)	(0.06)	(0.02)
Lehman to Anglo-Irish				4.74**	3.20**	2.55**			
				(1.90)	(1.46)	(1.03)			
Constant	-0.56	-0.43	-0.15	2.56	1.85	0.9	1.66	0.27	0.13
	(0.39)	(0.57)	(0.38)	(1.64)	(1.34)	(0.72)	(1.64)	(0.71)	(0.44)
Observations	102	136	102	132	176	132	441	588	441
R-squared	0.43	0.52	0.47	0.29	0.27	0.31	0.12	0.18	0.35
p-value for sum of lagged ΔF = 0	0.57	0.04	0.52	0.00	0.10	0.04	0.69	0.12	0.13

Notes: Panel-corrected standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Δ is the difference operator; L, L2 and L3 are the first, second and third lags respectively.

Table 4). As we reported for the full sample of countries, global factors are influen-
tial for each of the groups and the domestic financial sector plays a limited role.
Moreover, the coefficients on the global factors are close in size. This supports the
claim made above that the eurozone sovereign bond markets had come within the
ambit of the international financial tensions early on in the crisis, but there was no
sense of a eurozone crisis or a tendency towards a differentiation of spreads before
Bear Stearns.

Once Bear Stearns was rescued, markets placed a special spotlight on domestic
financial vulnerabilities. Consistent with our discussion in Section 2, in countries
with the largest loss in competitiveness and lowest medium-term growth prospects,
a weaker financial sector translated into the greatest increase in sovereign spreads.
As a reminder, lower growth prospects tend to increase the public debt-to-GDP
ratio and make a country more liable to go above the debt threshold following neg-
ative surprises. The results, moreover, show that the relationship between financial
vulnerability and sovereign spreads moderates smoothly as we move across country
groups from the greatest to the lowest pre-crisis real exchange rate appreciation.
To be clear, this relationship remains statistically significant for all country groups
– even the countries with the best prospects experienced in a significant manner an
increase in spreads when their financial sectors were under stress. However, both
the 'short-term' impact – reflected in the sum of the coefficients on the F-index –
and the 'long-term' impact (that accounts for the overshooting reflected in the
lagged terms of the sovereign spreads) decline in potency as the competitive and
growth position improves.

In the post-Anglo Irish phase, the results are both technically reassuring and eco-
nomically supportive of the hypotheses sketched in Section 2. The tendency for
spreads to overshoot goes down, as if the 'learning' phase were over. The correla-
tion between sovereign spreads and the financial sector index becomes contempor-
aneous for all countries. Our overall results were thus not driven by a select group
of countries, but this new phase was experienced throughout the eurozone. What
differed was the strength with which it was experienced, being strongest for coun-
tries with the weakest competitive and growth prospects. Also, after Anglo Irish,
global factors become again significant. As in the previous regressions that did not
differentiate between countries, the evolution of US yields absorbs the statistical
significance of CDS spreads prior to Bear Stearns. But again, the coefficient on
the US yields declines in absolute value from the weakest to the strongest growth
prospects, implying that the flight to quality was most sizeable and significant for
the countries with the weakest growth prospects.

6.2. The role of public debt

The impact of financial stress on sovereign spreads should also be shaped by the
government's fiscal position. As discussed in Section 2, the negative shocks to the
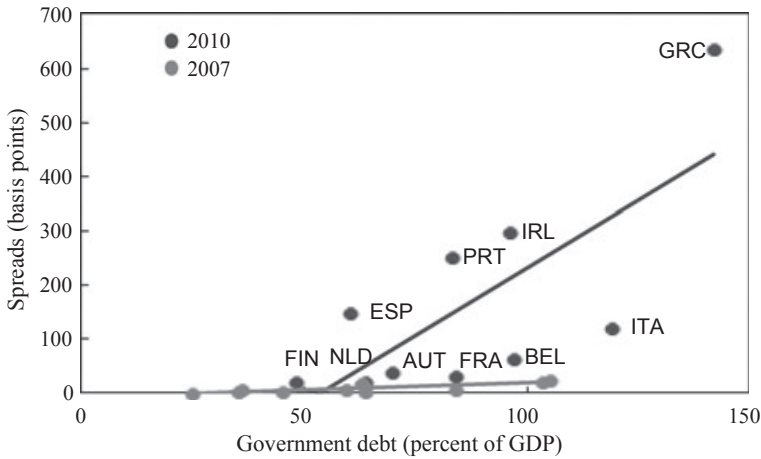
Figure 6. During the crisis, stronger repricing of sovereign risk for high-debt countries

financial sectors should translate into a much larger increase in sovereign spreads for countries with high levels of public debt. Consistent with this proposition, is the change in the relation between spreads and government debt during the course of the financial crisis from 2007 to 2010 (Figure 6). The re-pricing of sovereign risk during the financial crisis has indeed been much larger for countries with high public debt to GDP ratios, as also emphasized in von Hagen *et al.* (2011). Our analysis goes a step further. An implication of the model presented in Box 1 is that financial shocks should have a larger impact on spreads in countries with higher public debt; moreover, this adverse relationship is further amplified in countries with lower growth potential. Do the econometrics support these hypotheses?

Using again the real exchange rate appreciation as a proxy for weaker growth prospects, the question being posed in the next econometric exercise is whether countries *within* particular competitiveness-loss categories are differentiated by their debt ratios. More specifically, the question posed to the data is whether the impact of financial shocks on sovereign spreads is increasing in the country's *level* of public debt as a percentage of GDP. Moreover, according to Figure 3, the magnifying effect of public debt should be stronger in countries that experienced high appreciation and whose growth prospects are therefore weaker. Empirically, this means augmenting the specification used thus far with terms that interact the domestic financial index with the public debt-to-GDP ratios. As such, country dummies are not included in these regressions.

The results confirm the implications of our simple model. Columns 1 to 3 in Table 5 consider the period between Bear Stearns and Anglo Irish. To facilitate the interpretation of the results and their comparability with the post-Anglo phase, we include in the regression only the first lag of the change in the domestic financial index and its interaction with the debt level. The coefficient on the interaction

Table 5. The role of public debt

VARIABLES	(1) From Bear Stearns to Anglo Irish IRL, ESP, GRC Δ.S	(2) BEL, FRA, ITA, PRT Δ.S	(3) NLD, AUT, FIN Δ.S	VARIABLES	(4) After Anglo Irish IRL, ESP, GRC Δ.S	(5) BEL, FRA, ITA, PRT Δ.S	(6) NLD, AUT, FIN Δ.S
LΔ.S	-0.05 (0.10)	-0.28*** (0.11)	-0.16 (0.10)	LΔ.S	-0.22*** (0.08)	-0.24*** (0.09)	-0.03 (0.06)
L2Δ.S	-0.25** (0.10)	-0.32*** (0.11)	-0.38*** (0.11)	L2Δ.S	0.02 (0.08)	-0.02 (0.08)	-0.12** (0.06)
LΔ.F	1.29*** (0.27)	1.64** (0.76)	-0.02 (0.85)	Δ.F	4.53* (2.42)	1.85 (1.40)	-0.65 (0.95)
LΔ.F *Debt/GDP	-2.89*** (0.59)	-2.16** (1.10)	0.13 (1.39)	Δ.F*Debt/GDP	-9.15*** (3.50)	-2.92** (1.34)	0.14 (1.41)
Debt/GDP	2.34 (1.59)	2.24 (1.90)	3.00* (1.80)	Debt/GDP	7.53 (7.40)	-2.95 (3.62)	0.52 (1.83)
D.US_yields	-7.51 (4.73)	-5.06 (4.28)	-3.14 (2.89)	D.US_yields	-28.62 (21.47)	-22.80*** (7.83)	-10.09*** (2.37)
D.CDS_US_banks	-0.02 (0.01)	0.00 (0.01)	-0.01 (0.01)	D.CDS_US_banks	0.18 (0.13)	0.11** (0.05)	0.08*** (0.01)
LD.CDS_US_banks	0.00 (0.01)	0.01 (0.01)	0.00 (0.01)	LD.CDS_US_banks	0.07 (0.13)	0.08 (0.05)	0.03** (0.02)
Lehman to Anglo-Irish	5.12*** (1.79)	3.31** (1.50)	3.09*** (1.12)				
Constant	-0.88 (1.14)	-1.37 (1.43)	-1.26 (0.98)	Cons tant	-2.34 (4.57)	3.9 (4.09)	-0.43 (1.01)
Observations	132	176	132	Observations	309	412	309
R-squared	0.39	0.24	0.24	R-squared	0.17	0.16	0.39

Notes: Panel-corrected standard errors in parentheses. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
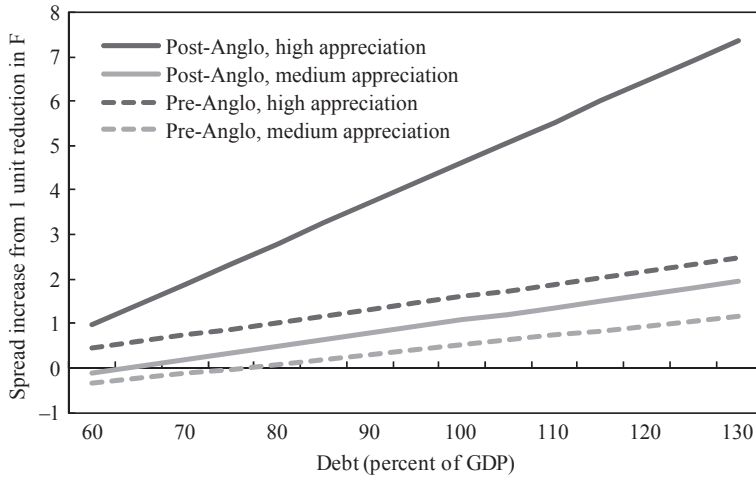Δ is the difference operator; L and L2 are the first and second lags respectively.

Figure 7. The impact of a reduction in the F index on spreads is larger in low-growth and high-debt countries

term is negative and highly statistically significant, thus confirming that a higher stock of public debt magnifies the impact of financial shocks on spreads. Furthermore, the relevance of the interaction between debt and financial shocks on countries' risk premia declines monotonically according to the extent of the real exchange rate appreciation. This is clearly visible in Figure 7 that uses the regression estimates to plot the impact of a unitary reduction in the financial index on spreads as a function of the stock of debt. The dark grey and light grey dashed lines refer respectively to the countries with high (Ireland, Greece, and Spain) and medium appreciation (Belgium, France, Italy and Portugal) in the period before Anglo Irish. The impact on spreads is larger for countries with high debt and lower growth prospects, exactly as predicted by the model in Figure 3.

The presence of negative synergies between financial shocks, low growth and high debt is detected even more strongly in the post-Anglo phase. In columns 4 to 6, debt is interacted with the contemporaneous change in domestic financial conditions and the estimation results confirm its relevance in the transmission of financial shocks to sovereign spreads, particularly in high-appreciation countries. The continuous lines in Figure 7 are based on the regression estimates in this post-Anglo period. The impact of financial shocks on spreads is now even larger, especially for the countries that experienced the highest appreciation. These results are strongly supportive of the idea that after Anglo the crisis evolved in a more much sensitive stage where non-linearities and negative synergies dangerously amplify the effects of shocks.

As with any taxonomy of countries, the groupings discussed here do not do justice to the further more graded and nuanced variations. Nevertheless, the results do reveal an important pattern: where external competitiveness had been lost and,

hence, growth potential had been compromised, domestic weaknesses took on a more worrying role. As such, although the crisis was global, domestic vulnerabilities came to matter. Within the large and moderate competitiveness loss groups, countries were differentiated both by the developments in their domestic financial sectors and by the interaction with their public debt ratios. These regressions help, for example, to differentiate Ireland and Greece, two countries with the largest increases in sovereign spreads. In Ireland, the proximate correlate of the increase in spreads has been the weakening of the financial sector. In Greece, where the markets have been less pessimistic about the financial sector, spreads in the post-Bear Stearns phase have been driven to a greater extent by a re-evaluation of the prospects for servicing high levels of public debt and the amplifying effects on financial stress. Similarly, the Italian rise in spreads is better accounted for when the differentiation by debt ratios is incorporated into the analysis. In countries with the least loss of competitiveness, financial vulnerability has had a statistically significant effect but the economic effects are smaller; and the markets have not focused on their public debt dynamics.

7. CONCLUSIONS

We use the rise and dispersion of sovereign spreads to tell the story of the emergence and escalation of financial tensions within the eurozone. After the introduction of the euro in January 1999, the risk premia on the bonds of eurozone sovereigns became compressed at a low level and in a narrow range across the member countries (Ehrmann *et al.*, 2011). The short-term movements of spreads were essentially random and markets judged the probability of default by any eurozone sovereign to be negligible. That changed with the start of the subprime crisis in July 2007. But at first, the eurozone crisis took shape essentially as an offshoot of the global crisis. A more significant change occurred in March 2008 with the rescue of Bear Stearns, an event that marks the beginning of a distinctive eurozone crisis. The greater presumption that sovereigns would ride to the rescue of their domestic banking sector, linked the projection of a eurozone member's sovereign debt to its domestic financial vulnerabilities: sovereign spreads now rose in response to the perceived weakness of domestic banks. Moreover, weaker growth prospects linked to financial sector weakness also raised the projected trajectory of public debt ratios. Finally, when the fiscal space to deal with financial sector vulnerabilities narrowed, as appears to have occurred around the nationalization of Anglo Irish, the fates of financial sectors and sovereigns became intertwined.

The crisis also exposed countries' pre-existing weaknesses. Financial shocks had a more severe impact on the sovereign spreads of countries with low growth prospects. Also, sovereign spreads increased more where public debt-to-GDP ratios were higher – and this effect became more pronounced after the rescue of Anglo Irish by when growth and public debt projections had worsened.
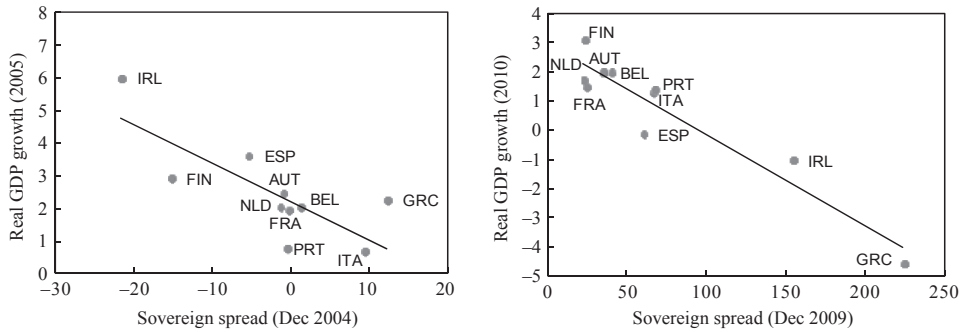
Figure 8. Higher sovereign spreads anticipate lower growth

Thus, the sovereign and the banking sectors became caught in the possibility of mutual destabilization. Of course, these feedback loops could also act in a positive direction as they did for brief periods. The immediate aftermath of the Anglo Irish nationalization brought a short period of relief. Financial prospects seemed to improve and so did those of the sovereign. However, with the untenable nature of the Anglo Irish rescue becoming evident and the Greek fiscal distress in May 2010, a rapid and virtually relentless increase in sovereign and banking vulnerabilities ensued.

The scope for policy intervention has also evolved with the crisis. Until the nationalization of Anglo Irish, the nature of crisis was rather straightforward, primarily driven by financial shocks. Policies targeted to supporting the financial sector had therefore a clear potential to alleviate the crisis. Such policies carried the risk of perpetuating the incentives of bankers to behave irresponsibly in the future, and were especially prone to errors in judgement on the scale of help needed. The size and scope of the guarantees provided by the government to ensure liquidity for banks has indeed proved controversial. And an orderly winding down of Anglo Irish, rather than its nationalization, would certainly in retrospect have been the superior course of action. But most countries had, at the time, enough fiscal space to finance these interventions, and the reductions in spreads after the rescue of Bear Stearns and even after the nationalization of Anglo, tended to support such activism.

Along with the dynamics of the crisis, the available policy options changed markedly during 2009. The contemporaneous association between spreads and domestic fiscal stress since then suggests that the crisis remains in a full-blown phase, with sovereign spreads, the health of the financial sector, and growth prospects in a potentially mutually destabilizing regime.[15] The financial sector is no longer the clear driver of the crisis. Rather, the crisis also reflects fiscal and competitiveness vulnerabilities. As fiscal problems result in higher sovereign spreads, banks face increased borrowing costs and capital losses on their holdings of public debt, con-

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[15] A similar argument is presented in Acharya *et al.* (2011).

tributing to lower growth. Figure 8 shows indeed that higher sovereign spreads are strongly correlated with future lower growth. With the fiscal room for intervention in banks much more limited, the eurozone economies are in a stressed regime from which there is no quick return.

As such, policy options are now much more constrained. Investors are questioning the fiscal sustainability of several countries and this is creating additional pressure on those banks that are directly exposed to sovereign bonds. Clearly the ability of such countries to support their financial sectors is compromised. A more precise policy approach is needed. It is important to keep in mind that the pay-offs from strengthening banks' balance sheets can still be large and, therefore, fiscal support is merited. But a more resolute strategy for winding down banks is also needed.

Where banking models have failed or proven fragile, a credible approach to phasing down such banking operations is needed. At the start of the crisis, bank resolution powers were relatively limited in most European economies. A lesson learned from the crisis is the need for such powers, which now are more widespread. In this regard, time is of the essence, as the crisis has once again demonstrated that delays can be extremely costly. Prompt action may still have the potential to turn around the ongoing vicious cycle between sovereign downgrades and banks' losses.

Discussion

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The Eurozone crisis re-taught us that sovereign debt crises are not exclusive to developing economies. It is also not a coincidence that the this sovereign debt crisis was triggered by a financial crisis. But how exactly were these two intertwined?

This paper provides a compelling answer to that question by looking at the relationship between financial stress and sovereign yield spreads in the euro area. In effect, the authors find that in relatively good times sovereign spreads are divorced from financial stress, but once the crisis became serious enough, and market participants realized that bailing out financial sectors would bankrupt countries, sovereign spreads and financial stress began to move in lockstep. This is a timely and well thought paper that makes a nice point.

The major difficulty in providing an empirical answer to the question of whether there is a link from stress in financial markets to sovereign spreads is in measuring stress in financial markets. This paper uses the relative share price of the financial sector, interpreting declines in this variable as capturing stress in financial markets, as in Fornari and Stracca (2012). This is a good measure.

The trickier part here is to establish causality, which requires finding exogenous variation in variables. The paper does this effectively by arguing that financial stress Granger causes sovereign spreads. This is not exactly satisfactory but the real value added of the paper is in showing how the correlation between financial stress and sovereign spreads changed over time, not in arguing a causal relationship between these variables. Having said that, the story the paper tells about financial stress causing market participants to expect a costly bail-out and budgetary problems, leading to higher spreads is reasonable and is consistent with the empirical results, even though alternative stories may also be consistent with the same evidence.

The paper presents two kinds of causality arguments. The first is the causal relationship between financial stress and sovereign spreads, where the causality goes from stress to spreads. This is a reasonable story and is consistent with the econometric evidence provided, although it remains the case that the causality may not be sufficiently uniquely identified in the regressions. It would be hard to argue that sovereign risk or perceptions of future budgetary difficulties do not cause financial stress today.

But this causal story is not the main strength of the paper. It is important to see that the paper's main contribution is showing that the nature of the correlation between financial stress and sovereign spreads changed over the course of the crisis. While early in the crisis period financial spreads were volatile, they were divorced from sovereign spreads. Later, these became highly correlated. The paper convincingly documents this time variance in the correlation.

It then offers the second causal story and argues that it was the Anglo-Irish bailout that made market participants perceive a link between financial stress and sovereign risk and change their pricing behavior. This also is a reasonable story but it is more likely that the news about the Greek debt debacle were the turning point, rather than the Anglo-Irish bailout. These two events are close enough to each other in time that one cannot precisely pinpoint the date of the increased correlation to overlap with one but not the other.

While statistically Anglo-Irish bailout and Greek debt blowup cannot be precisely differentiated as the turning point, market commentary is helpful in doing so. The story requires a change in the market participants' perception of the state of the world and that is a major event. But Anglo-Irish bailout was not such a major event when it was first announced, it did not occupy the front pages of newspapers for weeks.

The key ingredient for any significant action in sovereign spreads is a belief that a euro area member country may go bankrupt and fail to honor its debt. The initial cost estimate for the Anglo-Irish bailout was not of a sufficient magnitude (and Irish finances were in excellent shape before the crisis) to make Ireland as a whole seem bankrupt. It was with Greece that this idea took hold and market participants began to think of euro area member countries as having non-negligible credit risk. In fact, it is often said that Greek problems precede Irish problems in

the sovereign debt sense, even though the Irish bank bailout happened before Greece announced the scale of its recent deficits and debt stock. Hence, while statistically the data will not precisely differentiate Anglo-Irish bailout from the succeeding announcements of Greek budgetary problems, market commentary points to Greece as the more likely turning point for the correlation between financial stress and sovereign spreads.

Regardless of the exact date and event that changed the nature of the relationship between financial stress and sovereign spreads, and regardless of the causal relationship between these two variables, the changed correlation clearly shows that the nature of the crisis changed from the early part, when it was a crisis of financial institutions, to the later part, when it was a crisis of financial institutions and the countries that housed them. This paper shows this striking change and tells a compelling story to go with it.

Panel discussion

Mick Devereux pointed out that the model posited a relation between bank equity and capital that is dubious at the best of times. For instance, in the case of Ireland, practically none of the bank lending flowed into manufacturing capital. Devereux also asked whether it would be possible to study differences in causation across individual countries. Justifying this alternative approach, Devereux argues that if one scrutinizes the separate cases of Ireland and Greece it can be seen that the causal relationship runs from the banks to the sovereign for the former and in the opposite direction for the latter.

Nicola Fuchs-Schündeln argued that there may potentially be an additional break in the data. Specifically, she drew attention to the sudden decrease in the mean and standard deviation of sovereign spreads after the Anglo Irish nationalization and contends that the story may be strengthened if the authors insert another line at the point where these two moments are at a minimum. It is only after this mark that the series start rising again. At the same time, she also agreed with the discussant that the Anglo nationalization may not be a significant turning point. Carlo Favero noted that as the regression is in first-differences, the level of the spread remains undetermined.

In response, Damiano Sandri pointed out that the more one breaks the sample, the more one moves towards an analysis of smaller specific phases of the crisis, and thus loses sight of the overall picture. He also noted that the fiscal concerns of Greece only appeared at a fairly late stage of the crisis.

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