Implicit Government Guarantees

in European Financial Institutions

Lei Zhao[1]
ICMA Centre, Henley Business School

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Abstract

I exploit the price differential of CDS contracts written on debts with different seniority to measure the implicit government guarantees enjoyed by European financial institutions over the period 2005-2013. The guarantee increases substantially during the global subprime crisis and peaks at an average of 89 basis points in September 2011. Implicit support is higher for banks than insurance companies. My analysis suggests that Eurozone financial firms benefit more from such guarantees than their non-Eurozone counterparts within the European Union. On one hand, the aggregate guarantee implicitly offered by a government positively "Granger causes" the sovereign's default risk. On the other hand, the analysis reveals two offsetting effects from sovereign default risk on the implicit guarantee. Furthermore, I also find evidence that the phasing in of Basel III rules does not appear to have reduced the guarantees available to major financial institutions in Europe.

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[1] Contact email: l.zhao@icmacentre.ac.uk.

1. Introduction

The moral hazard problem caused by the implicit public subsidies extended to too-big-to-fail (TBTF) institutions has long been known to pose a serious threat to the stability of the financial system. Implicit government guarantees (IGG) stem from the expectation that the government will lend support to troubled financial firms that are deemed to be of systemic importance. As pointed out by Demirguc-Kunt and Huizinga (2013), in practice, a bank bail-out is often not limited to insured deposits alone. This is because wide ranging bailout packages designed to avert large defaults are not only politically convenient but may also be economically justifiable if they can prevent severe market dislocations. Using an event study, Veronesi and Zingales (2010) estimate the economic benefit of the Paulson bailout plan in 2008 at a range between $86bn and $109bn.[2] The implication is that it might not be desirable to end government bailouts and thus not possible to eliminate IGG completely. However, to reduce the resulting moral hazard and the cost of such implicit support, several measures have been suggested. Examples are, among others, (1) limits on leverage and higher capital requirements (Basel III), (2) compulsory "living wills" for financial institutions (French et al., 2010), and (3) a broader adoption of bail-in arrangements through hybrid securities that can be converted into equity in case of distress (Evanoff and Wall, 2002 and Evanoff et al., 2011).

This paper contributes to the existing literature in several ways. First, to the best of my knowledge, I am the first to investigate how information in different segments of the credit default swap (CDS) market can be used to value IGG for individual financial firms as well as at an aggregate level. Second, differently from previous research that focuses on the bond market, the paper examines the existence of a too-big-to-fail effect using information from the CDS market. Blanco et al. (2005) find that CDSs are a more accurate measure of credit

[2] What is known as the Paulson's plan is the joint intervention of the US Treasury and the Federal Deposit Insurance Corporation announced on October 13, 2008, which injected $125 bn into the ten largest US commercial banks with the intention of stabilizing the financial system.

risk than bond yields. Furthermore, the CDS market tends to be more liquid than the bond market, especially when credit conditions deteriorate (Acharya and Johson, 2007 and Stulz, 2010). Third, I investigate whether the extent of the implicit guarantees depends on the type of financial institutions, and specifically look at differences between banks and insurance companies. Fourth, the paper studies the impact of new financial regulations on such guarantees. Fifth, I look at the potential difference between Eurozone and non-Eurozone financial firms with respect to IGG. Further, using Granger causality tests, I investigate the possible feedback effect between implicit guarantees and sovereign default risk. Finally, the paper expands the sample period of previous studies to cover both the subprime crisis of 2007-2009 and the European sovereign debt crisis of 2010-2012.

My analysis shows that the aggregate IGG in the European financial system increases substantially in the aftermath of the subprime crisis. The average discount on default insurance peaks at 89 basis points during the sovereign debt crisis, which corresponds to an annual subsidy of about €175 billion. Over the 2005-2013 period, the largest financial institutions in Europe have an implicit public subsidy of around 18 basis points per year on average, which increases dramatically from only about 1 basis point before the crisis to 25 basis points during the crisis. Individually, although IGG varies across firm and over time, a few financial institutions consistently attract a large proportion of the total implicit guarantees given by governments.

Investigating the difference between US banks and insurance companies, Acharya et al. (2013) find that US insurance companies are not perceived to be supported implicitly by the government, which challenges the evidence of the US government involvement with the rescue of AIG during the crisis. In contrast, I do find substantial implicit guarantees in European insurance companies. On the other hand, in line with Acharya et al. (2013) I find that banks enjoy higher IGG than insurance companies, especially during the financial crisis. This may reveal the fact that banks are perceived to be more systemically important and thus more likely to be bailed out by the government during difficult times. I also provide evidence of too-big-to-fail effect for European financial firms. After controlling for default risk, interconnectedness and prevailing market risk aversion, larger financial institutions tend to have higher IGG. Moreover, the IGG of larger institutions is more sensitive to their default risk. In other words, they benefit more from government implicit support when default risk increases, compared with smaller firms. Interestingly, Basel III, as a major international regulatory response to the recent financial crisis, does not seem to reduce IGG. Within the European Union, Eurozone financial firms are found to enjoy more IGG compared with non-Eurozone ones, all else being equal, which may raise issues of unfair competition.

Finally, the paper examines the feedback relationship between IGG and sovereign default risk. I find that higher IGG leads to higher sovereign default risk due to the substantial impact that bailouts can have on public finances. Regarding the impact on IGG from sovereign risk, my analysis suggests two offsetting effects. On one hand, when the credit condition of a country deteriorates, it is more difficult for the government to provide support for distressed financial institutions and hence the perceived IGG falls. On the other hand, sovereign credit risk increases IGG since higher sovereign risk results in higher default risk in the banking system due to the fact that financial firms hold sovereign debt in their balance sheet.

The rest of the paper is organized as follows. In Section 2 I review the literature. The methodology and a description of the data are reported in Sections 3 and 4 respectively. The empirical results are discussed in Section 5 and conclusions are summarised in Section 6.

2. Related Literature

An active CDS market has flourished around both senior and subordinated bank debt. The different spreads between these two CDSs have the potential to indicate the magnitude of implicit guarantees. My working assumption is that guarantees are extended to senior debt but not junior debt.[3] [4] This difference between the two contracts should be reflected in the different extent of market discipline exerted by the two types of debt holders and has been documented in the literature.

Although there is little research directly focussing on subordinated CDS, significant attention has long been paid to subordinated debt. Since the mid-1980s, academics and regulators have suggested the use of subordinated debt as a tool for enhancing market discipline on banks. Calomiris (1999) proposes that banks should maintain a minimal proportion of subordinated debt so that its credit premium, undistorted by government insurance, could provide market discipline. The idea was favoured within the Federal Reserve System prior to the 1991 enactment of the Federal Deposit Insurance Corporation Improvement Act (FDICIA). Senior debt is also not explicitly insured by the government. However, the expectation is that senior creditors would be bailed out if a bank fails (namely they enjoy implicit guarantees, see Demirguc-Kunt and Huizinga, 2013 and Beyhaghi et al., 2013, among others). Although it is possible that subordinated debt is perceived sharing the implicit protection from the bank safety net as well, Kwast et al. (1999) point out the specialty of subordinated debt: "Among bank liabilities, [subordinated debt and debentures] (SND) are uninsured and among the first (after equity) to lose value in the event of bank failure. SND holders likely view a bailout in the event of bank failure as highly improbable."

[3] A recent example is the nationalisation of SNS, the fourth largest bank in the Netherlands, where only subordinated debt was seized by the government in exchange for a bailout package.

[4] This, however, could be relaxed as mentioned in Black et al. (2013), who explain that the magnitude of implied IGG can be extracted from the price differential of the two CDS contracts as long as CDS spread on subordinated debt is less sensitive to IGG.

However, early studies did not find much evidence in this direction (Fraser and McCormack, 1978, Avery et al., 1988 and Gorton and Santomero, 1990).[5] In contrast, a later research of Flannery and Sorescu (1996) finds that although subordinated debt received implicit government support in the first half of 1980s, such support became weaker or disappeared afterwards due to the enactment of the FDICIA in 1991. Sironi (2003), using European banking industry data, confirms the idea that for private sector banks, subordinated debt investors are sensitive to bank risk and behave as if they were not covered by implicit government support in case of default.

More recently, with an analysis of the incidence of losses for different stakeholders in selected cases of bank distress, Schich and Kim (2012) claim that "holders of unsecured bank debt other than subordinated bonds have typically been exempted from the loss-sharing". This is consistent with the findings of Moody's (Moody's investors Service, 2009) that historically investors in banks' senior debt, rather than subordinated debt, have been bailed out by governments in Europe. This divergent treatment of debt holders with different seniority may forge the disparity between senior and subordinated CDS with respect to perceived IGG. Using an international sample of banks, Demirguc-Kunt and Huizinga (2013) find evidence of an implicit guarantee for large banks (the so called "too-big-to-fail" effect) in the senior CDS market. In addition, Nguyen (2013) demonstrates that subordinated debt is the best choice for providing increased market discipline due to its junior status, while other uninsured debt (including senior unsecured debt) does not appear to be as effective. Furthermore, based on comprehensive data on the Canadian banking sector, Beyhaghi et al.

[5] The conclusion that yields of subordinated debt were insensitive to banks' riskiness in the early 1980s may not at all indicate the presence of implicit guarantees, which blinded investors' eyes. Goyal (2005) argues that it is also possible that investors include more covenants in debt contracts as an alternative channel to implement market disciplines. By taking into consideration not only yield spread but also restrictive covenants the author finds that subordinated debt holders can effectively monitor banks' risk-taking incentives.

(2013) also support the too-big-to-fail argument in the senior unsecured debt sector and argue that market discipline exists for subordinated debt but not for senior debt.

The conclusion that the price of subordinated debt may not reflect implicit public subsidies is not uncontroversial. Although Flannery and Sorescu (1996) argue that the yield of subordinated debt is sensitive to bank risk measures, they also find that it is negatively related to bank size. This may indicate a too-big-to-fail effect. Alternatively, it could simply reflect the greater ability of large banks to diversify their assets or the higher liquidity of their debt. Balasubramnian and Cyree (2011) find that yield spread on subordinated debt is no longer sensitive to bank risks and, as a result, is not exempt from implicit support after the Long-Term Capital Management bailout.[6]

Previous studies that have tried to quantify implicit public guarantees have typically focussed on either U.S. financials or a sample of worldwide banks. An analysis of the European market, which is the aim of this paper, should afford a valuable extension to the literature. Also, none of the previous contributions in this area investigates the subordinated and senior segments of the CDS market. Ueda and di Mauro (2013) analyse the information from credit ratings and estimate the expected subsidy from governments worldwide as of end 2007 and end 2009. Kelly et al. (2011) provide a measure of collective government guarantees for the financial sector by comparing the price of a basket of out-of-the-money put options for individual banks and put options on the financial sector index. Their method can only be applied to measure implicit guarantees at an aggregate (sector) level. However, financial firms should be treated differently if they indeed enjoy different implicit support, which makes it important to measure individual implicit guarantees. In addition, quantifying implicit guarantees individually also enriches my analyses by allowing cross-sectional

[6] Their findings, however, could be doubted, since they only study a short list of the largest banks from 1984 for a very limited period of time, as pointed out by Acharya et al. (2013).

differences in financial institutions. Jobst and Gray (2013) price IGG for financial firms by utilizing both equity and senior CDS market information based on the notion that equities benefit less from implicit protection than senior debt. With the similar idea that the government guarantees have different impact on the pricing of default risk in credit and stock markets, implicit guarantees are also investigated in Tsesmelidakis and Merton (2012), assuming such guarantees are worthless during the "uncontaminated" pre-crisis period. A recent work of Acharya et al. (2013) estimates an annual subsidy of 24 basis points on average from 1990 to 2011 from a bond sample of US banks. Like most other studies that examine the spread-to-risk relationship in financial firms, their approach can only be applied at an aggregate level. Further, in order to provide an accurate measure enough control variables for firm characteristics and risk, bond maturities and liquidity and general market conditions are required. In contrast, I circumvent these problems by calculating the value of implicit support for individual financial institutions directly from market expectation.

3. Methodology

In this section, I first illustrate how information embedded in the two segments of the CDS market, that is senior and subordinated CDS, can be used to derive market implied IGG. I next demonstrate the methods of computing two important elements of my measures: probability of default (PD) and asset return correlation, following which measures of various IGG are designed.

3.1 Rationale of calculating IGG from the two types of CDS contracts

As described in Section 2, the presence of an implicit guarantee enjoyed by senior creditors results in a lower senior CDS spread than in the absence of such a guarantee. Assuming subordinated debt does not have the guarantee, this discount can be calculated using information from the two segments of CDS market. More specifically, I demonstrate below that the implicit guarantee discount is reflected in the different PDs derived from senior and subordinated CDS spreads for the same company.

The CDS spread is influenced by the risk-neutral PD and the loss given default (LGD). I assume fixed but different LGD for the two classes of debt and check the robustness of my findings against alternative LGD levels. I find that results are qualitatively the same when the distance between senior and subordinated LGDs remains within a certain range. Empirically, a fixed LGD in the analysis of financial institutions is justifiable as the financial sector is characterised by a low number of actual default events. Thus, it is difficult to derive accurate time varying LGD from historical data (Norden and Weber, 2012). Furthermore, recovery risk is sometimes viewed as reasonably diversifiable and relatively unrelated to the business cycle (Duffie, 1999). As explained in Longstaff and Schwartz (1995), the risk of LGD is also unsystematic since it represents the outcome of the bargaining process in a default reorganization.[7] As a result, although I assume fixed LGD, the framework could easily be adapted to stochastic LGD. As LGD affects the CDS spread linearly, a constant LGD could be replaced by the expected value of a stochastic one.

With constant LGDs and a counterfactual assumption of absence of guarantees for senior debt, risk-neutral PDs implied from a firm's senior and subordinated CDSs should be identical.[8] The risk-neutral PD can theoretically be decomposed into physical PD and a risk premium. In practice, default occurs for all debt contracts at the same time due to cross-default provisions, acceleration of principal provisions and other contract constraints. Then, it is reasonable to assume the same physical PD for senior and subordinated debts. Would the

[7] However Altman et al. (2005) argue that average realized LGD tends to be positively correlated with aggregate default rates.

[8] The assumption of identical risk-neutral PD is also made implicitly by Norden and Weber (2012) in calculating time-varying PD and LGD simultaneously with senior and subordinated CDS spreads. This is also consistent with the pricing model in Longstaff and Schwartz (1995) who assume the same risk neutral PD for a firm's debts with different seniority.

risk premium then also be the same? As suggested by Fisher (1959), the risk premium required on a corporate bond depends on the actual (physical) PD and the "marketability" of the bond. Accordingly, the risk premium incorporated in risk neutral PD mainly consists of a default risk premium and a liquidity ("marketability of the CDS") premium. I argue that both are equal for the same firm's subordinated and senior CDS. As explained in Amato (2005), the default risk premium is required to compensate for systematic risk (cyclical variation in physical PD) and jump-at-default risk (the actual default and its impact on an investor's wealth due to her inability to perfectly diversify credit portfolios). Since physical PD is identical for the two CDS contracts, both systematic risk and jump-at-default risk should be the same for the two types of CDS contracts written on the same company. As a result, the default risk premium does not give rise to a difference between PDs extracted from senior and subordinated CDSs. On the other hand, the liquidity premium could be different. However, as pointed out by Longstaff et al. (2005) and Berndt et al. (2008), the nature of CDS contract makes CDS prices far less sensitive to liquidity effects. In addition, Norden and Weber (2012) show that although, on average, subordinated CDSs have lower relative bid-ask spread before the crisis, the difference becomes negligible during the crisis. Since their study examines the period of 2001-2008, which only covers the very beginning of the recent financial crises, I have extended their analysis up to June 2013. My results are largely consistent with the conclusion that senior and subordinated CDSs are almost equally liquid during the financial crises.[9] In conclusion, the difference between risk-neutral PDs computed from senior and subordinated CDS spreads, if there is any, should result from IGG.

[9] Subordinated CDS are only marginally more liquid, which makes my results even more robust. This is because the liquidity differential diminishes the gap between the subordinated and senior CDS spread and hence the implied implicit guarantee I estimate.

3.2 Risk-neutral PD

Following Duffie (1999) and Huang et al. (2009), the one-year risk-neutral PD is derived separately from both senior and subordinated 5-year CDS spreads, assuming constant but different LGD for the two types of debt:[10]

$$PD_{i,t}^{j} = \frac{a_t s_{i,t}^{j}}{a_t LGD_j + b_t s_{i,t}^{j}} \tag{1}$$

Where $a_t = \int_t^T e^{-r_t \tau} d\tau$ and $b_t = \int_t^T \tau e^{-r_t \tau} d\tau$

r_t is the "risk free" rate and I use the 5-year swap rate in Euros to measure it, as in Black et al. (2013). $PD_{i,t}^{j}$ is the probability of default for firm i at time t, derived from the senior or subordinated CDS spread. j is CDS type indicator (e.g. senior (SEN) or subordinated (SUB)). LGD_j is the loss given default and $s_{i,t}^{j}$ is CDS spread for firm i at time t. I set LGD_{SEN}=0.6. This is consistent with the ex-ante measures in Black et al. (2013), which exhibit a small variation (between 0.57 and 0.64) during the period 2005 to 2012. It is also in line with the median LGD backed out from the CDS spread by Norden and Weber (2012), which is 0.56 for the pre-crisis period and 0.61 for the crisis period. LGD_{SUB} is set to be 0.7. The estimate is based on Moody's average recovery rates on subordinate corporate bonds for the period 1982 to 2012, which range between 0.29 and 0.37 (Moody's Investors Service, 2012).[11,12]

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[10] When extracting PD_t from a CDS price on a particular day t I do so under the assumption that the risk free rate r_t and PD_t are constant for the duration of the CDS contract, namely between t and T. However, PD_t and r_t are allowed to vary from one day to the next.

[11] Also see Altman (1992) and Franks and Torous (1994) for consistent average LGD for senior debt and subordinated debt.

[12] Although I assign specific values to senior debt LGD and subordinated debt LGD, it is the difference between them that really matters. The average difference between the two LGDs during 1982 to 2012 period is around 0.1 according to Moody's, which is consistent with my assumption. However the findings are statistically robust if this difference increases up to 0.3, although obviously the average magnitude of delta PD (the difference between the two PDs extracted from the two CDS contracts) decreases from 0.71% to 0.18% during the whole sample and from 0.96% to 0.25% during the crises (June 2007 to June 2013).

3.3 Time-varying asset return correlations

The government would step in and bailout a troubled financial institution only if the financial system as a whole is in distress. As a result, in order to price IGG fairly and accurately, the dependence structure of asset returns across firms in the financial sector needs to be taken into consideration to determine a financial crisis. In the paper, this is done by simulating correlated default scenarios for all firms in the sample. As proposed by Hull and White (2004) and Huang et al. (2009), asset return correlation is proxied with equity return correlation.[13] To estimate daily equity return correlation, I employ the Factor DCC model proposed by Engle (2007), which is designed to forecast correlations in high dimensional problems. See Appendix A for details about the model.

For each day in the sample period, a variance-covariance matrix and the corresponding correlation matrix (Σ_t) can be estimated using Equation (A.1). The correlation matrix then will be employed in Monte Carlo simulations to generate interconnected financial firm asset dynamics. Together with the assumption of asset return normality, correlated defaults of financial firms can be simulated based on the PDs backed out from CDS spreads using equation (1).

3.4 Measures of various IGG

As discussed in Section 2, I assume that the risk neutral PD computed from subordinated CDS is free from an implicit guarantee discount while the discount is present in the PD derived from senior CDS. Consequently, to measure the subsidy from the public to senior debt holders, let us first define (1) $L_{i,t+1}^{Subsidized,k}$ as the subsidized percentage loss for senior debt holders of financial firm i in scenario k in Monte Carlo simulations at time t+1 (in three

[13] The equivalence between equity return correlation and asset return correlation is exact when the leverage ratio is constant. So it is only a reasonable assumption for a shot horizon, such as less than one quarter (see Huang et al., 2009 for details). As a result, I choose three months to calculate IGG in the next sub-section.

months) and (2) $L_{i,t+1}^{Real,k}$ as the corresponding unsubsidized percentage loss for senior debt holders in the same scenario k, namely:

$$L_{i,t+1}^{Subsidized,k} = LGD_{SEN} * 1_{default,PD_{i,t}^{SEN}}^{k}, \quad L_{i,t+1}^{Real,k} = LGD_{SEN} * 1_{default,PD_{i,t}^{SUB}}^{k}$$

where $1_{default,PD_{i,t}^{SEN}}^{k}$ is an indicator function, which is equal to 1 if firm i defaults in scenario k at time t+1, based on PD calculated from senior CDS spread at time t, and 0 otherwise. Similarly, $1_{default,PD_{i,t}^{SUB}}^{k}$ is based on PD calculated from subordinated CDS spread. IGG is only relevant if the financial system as a whole is in distress. Otherwise the government could simply step back and let healthy firms takeover the troubled ones. As a result, the indicator IGG for an individual firm is defined as:[14]

$$IGG_{i,t} = E[\left(L_{i,t+1}^{Real,k} - L_{i,t+1}^{Subsidized,k}\right) * 1_{distress}^{k}] \qquad (2)$$

Where $1_{distress}^{k}$ is an indicator function equal to 1 if the financial system is in distress at time t+1 in scenario k, and 0 otherwise. In this paper, financial system distress is defined as a crisis event when the proportion of the liabilities of default firms to the total liabilities of all firms in the sample exceeds a certain threshold (e.g. 10%), or, when the number of default firms exceeds a certain proportion of the number of all firms (e.g. 10%).

Aggregate IGG is simply the weighted average of individual IGG, using total uninsured liabilities as weights:[15]

$$IGG_{agg,t} = \sum_{1}^{N} w_{i,t} IGG_{i,t} \qquad (3)$$

[14] The expectation is in three months and should be multiplied by the risk free discount factor to get the fair present price of IGG. Given that the risk free rate during the crises was very low and for simplicity I assume that three month risk free rate is zero and therefore the discount factor is 1.

[15] A simple average is also calculated as a robustness test and the results are qualitatively unchanged.

Where $w_{i,t} = \frac{L_{i,t}}{\sum_1^N L_{i,t}}$ and $L_{i,t}$ is total uninsured liabilities of firm i at time t. N is the number of firms in the sample.

It is also of interest to examine a distressed version of individual IGG, which is the IGG conditional on the financial system being in distress. This measure provides additional information since it is conditional on the scenarios when IGG (subsidy) is actually realized. In other words, distressed IGG is the amount of subsidy transferred from the public sector to financial firms when tail events happen. Let d-IGG denote distressed IGG, then:

$$d\text{-}IGG_{i,t} = E\left[\left(\mathrm{L}_{i,t+1}^{Real,k} - \mathrm{L}_{i,t+1}^{Subsidized,k}\right) \middle| 1_{distress}^{k} = 1\right] \tag{4}$$

The two types of individual IGG described above can be easily calculated by deriving default scenarios with Monte Carlo simulations. Given $PD_{i,t}^{SEN}$ and $PD_{i,t}^{SUB}$ and assuming normality, we can first compute two default thresholds for each firm i at time t, $N^{-1}\left(PD_{i,t}^{SEN}\right)$ and $N^{-1}\left(PD_{i,t}^{SUB}\right)$, where $N^{-1}()$ is the inverse function of the cumulative standard normal distribution. Second, for each time t, the correlation matrix Σ_{t} derived with equity returns is used to generate 100,000 scenarios of asset returns for all firms in the sample. By comparing these returns with the default thresholds, one can determine correlated defaults of financial firms to calculate the implicit guarantee measures in (2), (3) and (4).

4. Data

I start with the largest 100 European financial firms in Bloomberg (in terms of total assets as of the end of December 2012). The sample covers all Euro area countries which joined the Eurozone before 2002. I add three more countries with large systemically important financial firms: Switzerland, Sweden and the United Kingdom.[16] I then apply similar filters as in Black et al. (2013) for each firm: 1) a minimum number of 24 valid observations of monthly CDS spread for both subordinated and senior debts since January 2005; 2) publicly available daily equity returns since January 2005. These criteria reduce the sample size to 46 financial firms, including 11 insurance companies and 35 banks.[17] I collect from Bloomberg monthly CDS spreads denominated in Euro for financial firms, daily individual equity returns and European stock index returns from January 2005 to June 2013. Balance sheet data is collected less frequently, every three months or half year, whichever is available in Bloomberg.

5. Empirical findings

In this Section I first look at the liquidity of senior and subordinated CDS contracts. Next, I calculate PDs separately from senior and subordinated CDS spreads using equation (1). I then estimate time-varying equity return covariance and different IGG measures. Regression analysis follows to corroborate my previous findings and directly investigate the determinants of implicit guarantees. More concretely, I look at the too-big-to-fail effect, regional effects and the impact of Basel III regulation on the perceived public support for the finance sector. Lastly, possible feedback relationship between countrywide IGG and sovereign default risk is investigated using Granger causality tests.

5.1 Market liquidity for the two CDS segments

I calculate the aggregate market liquidity of senior and subordinate CDSs as cross-sectional medians of relative bid-ask spreads. Figure 1.A shows that monthly aggregate bid-ask spreads for both types of CDSs decrease after the burst of the subprime crisis and remain

[16] Countries included in the sample: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

[17] The 46 financial firms in my sample include all the largest 27 firms as of end 2012 and the total assets of these 46 firms are about 85% of asset value of the largest 100 firms.

relatively low afterwards. This indicates that the higher credit risk in the banking system during the crises makes them more attractive and liquid. Largely consistent with Norden and Weber (2012), before the recent crises aggregate market liquidity for subordinated CDS is much higher than senior CDS. However, since the crisis periods, the relative bid-ask spreads in the two CDS segments have been almost identical, with the spread for subordinated CDS slightly lower on average (senior: 6.96% vs. subordinated: 6.39%). Instead of just focusing on the median as in Norden and Weber (2012), I also look at the weighted average and other quartiles (the upper and lower quartiles) of the spread distribution across firms to portray a more complete picture. Liability-weighted average is investigated to take into account the possible “size effect” that larger firms’ CDS may be more liquid than that of smaller ones. Figure 1.B through Figure 1.D displays the same pattern as in Figure 1.A, which further confirms the previous conclusions. As mentioned in Section 3, the similarity in liquidity of both CDS segments suggests that their spread differential is mostly driven by implicit government guarantee effects.

5.2 PD and equity return covariance

Figure 2 illustrates the time series of average PDs across firms derived from subordinated CDS spread (real PD), senior CDS spread (subsidized PD) and also the difference between them (delta PD). Before the 2007-2009 subprime crisis, the PDs and their difference remain almost zero. After the burst of the crisis, although subsidized PD grows substantially along with real PD as financial conditions of banks and insurance companies deteriorate, it increases to a much less extent. This is reflected in the sharp raise of their deviation (delta PD), which represents the market perception of implicit guarantees in the system.

Equity return covariance can be decomposed into three components as demonstrated in Appendix A. Figure 3 shows, as one may expect, that the average covariance peaks right after the Lehman Brothers failure (September 2008). It is also clear from the Figure that, on average, pairwise covariance between the sample firms mainly comes from their co-movement with the market index (static effect). Idiosyncratic correlation contributes to the increase of covariance during the crises. However, it seems, from the negative correlation between firms' idiosyncratic risk and market shocks (changing β effect), that financial institutions manage their risk and adjust their asset portfolio or business structure to reduce their co-movement with the market during the crises.

5.3 The magnitude and evolution of IGG

The IGG derived from the mispriced senior CDS of financial institutions can be interpreted as a funding cost advantage (subsidy), as it lowers the expected default loss of senior debt holders. From Figure 4, we can see that the overall subsidy (light green area in the Figure) remains almost zero before 2008 and reaches just over 40 basis points around the Lehman Brothers failure before it peaks at 89 basis points during the sovereign debt crisis. The level increases with several critical events, such as the Bear Stearns bailout (March 2008), the Lehman Brothers failure (September 2008) and European sovereign debt hot spots (2011 to 2012). I also compute the Euro value of the subsidy for the sample financial institutions at an aggregate level by multiplying the overall implicit guarantees (IGG_{agg}) from equation (3) by total uninsured liabilities.[18,19] During the sample period (January 2005 to June 2013), the largest financial firms (46 institutions in the sample) enjoyed an implicit subsidy of €34 billion per year on average. This annualized subsidy was merely €1.83 billion before the

[18] I exclude deposits since they are covered by an explicit deposit insurance scheme. I should also deduct subordinated debt since I assume it is not subsidized by implicit government support. However I am not able to do so due to lack of data. As a result, the Euro value of IGG is only a rough estimate, although in general subordinated debt represents only a small fraction of total liabilities of financial firms. For example, Beyhaghi et al. (2013) point out that for Canadian banking sector subordinated debt is at most 2% of banks' total liabilities as of 2010.

[19] Using total uninsured liabilities from balance sheet to calculate the Euro value of IGG, I assume that debt is refinanced under current (new) conditions rather than conditions prevailing when it was issued and I do not account for different debt maturities and covenants as this information is not available.

crises and became as large as €47.92 over the following period, with its highest value above €175 billion in September 2011.

My sample consists of both banks and insurance companies, which enables us to make comparisons between these two sectors. The solid and dashed lines in Figure 4 show that in general the two sectors both enjoy IGG and move in the same direction. However banks get higher IGG compared with insurance companies, especially during the deeply distressed periods, when IGG is most prominent. This could be simply due to the higher default risk of banks, or because banks are perceived to be more important and, as a result, are more likely to be saved during the crises. I investigate this question further in the next sub-section.

It is also of great interest for both academics and regulators to examine which financial firms benefit the most from the implicit guarantees and how much is the value of their subsidy. The summary statistics for individual firm's IGG are reported in Table 1. We observe, from the Table, significant dispersion across firms and also an obvious time-varying feature of IGG. Table 2 presents the top 15 firms in terms of implied IGG as of June 2013 and their rankings in previous years. In general, the rankings are time-varying. It may reflect the evolution of individual firms' default risk and their relative importance to the financial stability. The fluctuation of their home country's sovereign credit strength may also play a role in the changes of individual institutions' IGG rankings. On the other hand, 8 institutions remain consistently among the top 15, including Societe Generale, BNP Paribas, Barclays and Commerzbank. Further, Figure 5 shows that IGG has not been shared evenly among financial firms and the top 10 constantly accounts for more than 60% of the aggregate Euro value subsidy to the sector. Consequently, the policy implication is that, to deal with implicit guarantee issues, regulators could focus on a (maybe dynamic) list of a few most important firms. In line with the proposal of Morris and Shin (2008) and Acharya et al. (2011) to manage systemically important financial institutions (SIFIs), I believe that a transparent and straightforward Pigovian tax would be more efficient and effective than extensive government supervision that attempts to curb implicit public support. The estimates of individual IGG could serve as a starting point to generate the list of important financial firms over time and to price their Pigovian tax accordingly.

Individual firm's IGG is an important indicator, which can be used by regulators to provide financial firms with incentives to reduce excess risk-taking. However, distressed IGG as defined in Section 3 is also useful as a complement to IGG since it measures the subsidy given to senior debt holders when a crisis strikes. Table 3 gives both IGG and d-IGG for top 15 firms at the end of 2007 and 2011. It is evident that IGG increases markedly from 2007 to 2011 and d-IGG also increases but to a much lower extent. As conditional expectation, d-IGG, which could be treated from the perspective of stress tests, is far larger and more stable than IGG. It is worth noting that although in 2007 IGG was almost zero, its distressed counterpart (d-IGG) was fairly large, which should be monitored closely by regulators.

5.4 TBTF effect and Basel III impact

To examine the determinants of implicit public support, I estimate the following regression:

$$\begin{aligned} IGG_{i,t} = \alpha &+ \beta_1 Risk_{i,t-1} + \beta_2 Interconnectedness_{i,t-1} + \beta_3 MRA_t + \beta_4 TBTF_{i,t-1}(TSITF_{i,t-1}) \\ &+ \beta_5 Bankdummy + \beta_6 Baseldummy + \beta_7 TBTF_{i,t-1}(TSITF_{i,t-1}) * Risk_{i,t-1} \\ &+ \beta_8 TBTF_{i,t-1} * Baseldummy + \varepsilon_{i,t} \qquad (5) \end{aligned}$$

In equation (5), the subscripts i and t denotes the financial institution and the time (month) respectively. I use default risk (Risk), interconnectedness and market risk aversion (MRA) as control variables. Risk is summarized in the PD derived from subordinated CDS spreads (PD^{SUB}). Interconnectedness is measured as the average pairwise correlation between one institution and the others in the sample. With regard to the proxy of MRA, in line with previous literature, I use the VIX, which is the implied volatility on the S&P 500 (see, for example, Coudert and Gex, 2008 and Remolona et al., 2008).[20] To represent TBTF, I use two measures. One is simply log total assets of a firm (Size) and the other is whether a firm is one of the top ten firms in terms of total assets in a given month (Top10). Recent literature suggests that size is the most significant driver of a financial firm's systemic importance (see, for example, De Jonghe, 2010, Hovakimian et al., 2012 and Varotto and Zhao, 2014). However, it is not the only determinant since complexity of operations and diversification in terms of a firm's business lines and income may also be contributing factors. To capture these other characteristics, I employ a comprehensive measure of systemic importance (SRISK%) proposed by Acharya, Engle and Richardson (2012). This will enable us to examine the too-systemically-important-to-fail (TSITF) effect, as a complement to TBTF effect. In addition to TBTF (TSITF), bank dummy and Basel dummy are also of interests. I use a bank dummy variable (Bank) to explore the possible difference between banks and insurance companies in terms of perceived IGG. Basel dummy is a dummy variable (Basel III) equal to 1 after the announcement of Basel III (Nov. 2010) and 0 otherwise. Summary statistics of the regression variables and their pairwise correlations are reported in Appendix B.

I am aware that the dependent variable (IGG) comes from a first-stage estimation, which may introduce measurement error and, as a result, heteroscedasticity. Since I do not obtain detailed information about the possible measurement error, I use White period standard errors to account for heteroscedasticity (as in Weiß et al., 2014), as well as possible autocorrelation within firms in the regression's residuals (see Petersen, 2009).[21] Table 4 displays the results

[20] Since I study European financial firms, VSTOXX, the implied volatility on the Eurostoxx 50 Index, could be more relevant. However, unreported results show that replacing VIX with VSTOXX does not change my findings due to the high correlation between the two index, which is as high as 0.95 during the sample period.

[21] Unreported results of robustness tests using various standard errors confirm that White period standard errors are the most conservative.

of the regressions. Single regressions in column 1 and 2 suggest immediately the presence of the TBTF effect. Adding control variables in column 3 and 4 does not change the positive sign or significance of both Size and Top10 variables, indicating that larger firms have higher IGG, all else being equal. All control variables have significant coefficients with expected signs, namely IGG increases with default risk, interconnectedness and market risk aversion. I add another dummy variable Bottom10 in column 5 to represent the smallest 10 firms in the sample. The result confirms our expectation with a negative coefficient. In column 6, to further investigate the TBTF effect, we are interested in the interaction term Top10*PD^{SUB}. A higher default risk (PD^{SUB}) does not necessarily mean higher IGG, unless the institution is systemically important to some extent. As a result, one would expect that for a more systemically important firm, such as a top 10 firm, its IGG should be more sensitive to its default risk. Put it another way, the coefficient on the interaction term should be significant and enhance the coefficient on the default risk variable PD^{SUB}. This is precisely what we find in column 6.

In column 3 through 6, the Bank dummy variable has a positive and significant coefficient, which further confirms the finding in Figure 4, i.e. that banks are perceived to enjoy more IGG than insurance companies. Since I control for default risk, this is not simply due to banks being more risky. It could be caused by the unique intermediary functions of banks, which are, or believed to be, more important to financial stability and economic growth than the role performed by insurance companies.

If we look at the coefficients of the dummy variable Basel III in Table 4 (columns 3 to 6), interestingly, it seems that not only has the announcement of Basel III failed to decrease the perceived IGG, but on the contrary, it has made the implicit subsidy even more prominent. This looks puzzling at a first glance. However, if the market regards the more stringent regulatory framework of Basel III as further justification for future bailouts, the positive and significant coefficient of the Basel III variable is not that surprising. Besides, all "one-size-fits-all" micro-prudential approaches imposed by regulators may enhance systemic linkages among financial institutions, as illustrated with a static model in Zhou (2013). The newly added leverage limits and the more stringent capital requirement of Basel III may result in more correlated financial system and thus lead to higher IGG. Since Basel III applies to banks alone, I also do a regression on the sub-sample of only banks. The results are shown in column 7, which are consistent with those of the whole sample. The coefficient of an additional variable interacting Top10 with Basel III reveals that after the announcement of Basel III, very large banks are believed to benefit even more from the implicit subsidy. This means that the TBTF effect has effectively been enhanced. It is possible that this enhancing effect is due to other missing time-specific factors which influence IGG. However it seems that, at least, the phasing in of Basel III has not solved the problem of implicit guarantees.

As a complement to the TBTF effect, the TSITF effect is also examined. I replace Size and Top10 variables with SRISK% as a measure of systemic importance. SRISK% is based on the conditional expected capital shortfall framework and is believed to be a reliable measure of systemic risk (see Acharya et al., 2012).[22] Table 4 contains the results and shows a significant and positive correlation between SRISK% and IGG in column 8 through 10. This indicates that financial institutions with higher systemic importance enjoy more implicit government support. As in the previous analysis, I use an interaction term to capture the differential effect default risk has on IGG for financial institutions with different systemic importance. The positive coefficient of the interaction term in column 10 suggests that more systemically important firms gain more implicit government support when default risk

[22] I thank Tun Wei for his excellent assistance of collecting SRISK% data from The Volatility Laboratory (V-Lab) at http://vlab.stern.nyu.edu .

increases. Not surprisingly, when controlling for the main contributors to systemic risk, namely size, default risk and interconnectedness, the coefficient of SRISK% loses its significance in column 11.

5.5 Robustness Tests

I conduct a number of robustness tests to further check the conclusions I draw regarding the TBTF effect and the impact of Basel III. First, in the main regressions I include time-varying variables like VIX and the Basel dummy that capture common factors across firms. However, it is still possible that I may miss other important time-specific explanatory variables that matter. As a result, I replace VIX and the Basel dummy with monthly fixed effects. The intention is to capture potential observable and unobservable factors that jointly determine the magnitude of individual IGG. The results are shown in Table 5 Panel A. My previous conclusions are unchanged as indicated in column 1 through 3. Similarly, I also include firm fixed effects instead of a bank dummy to capture firm-specific factors that may be important but missing in the main regressions. My results are robust to adding both monthly and firm fixed effects, as shown in column 4 to 6.

Second, I examine if the results are driven by size, namely whether they are biased by extremely large financial firms. In order to do so, I drop the top five financial firms in terms of average total assets over the sample period and redo the regressions. The results are reported in Table 5 Panel B. Consistent with the previous findings, larger financial institutions are associated with higher IGG and Basel III has enhanced the market perception of implicit guarantees.

Finally, in Figure 4 I show that the level and variation of IGG before the subprime crisis are very small relative to the later crisis periods. I therefore focus only on the two crises, namely the subprime crisis from M6 2007 to M12 2009 and the European sovereign debt crisis from M1 2010 to M6 2013. The results of the two sub-samples largely confirm the previous findings, as can be seen in Panel C of Table 5. However, the TBTF effect seems to be much more prominent during the sovereign debt crisis compared with the subprime crisis. Although the coefficient of Size is equally statistically significant in the subprime crisis sample (column 1), it is much less economically significant than that for the sovereign debt crisis sample shown in column 4 (i.e. it goes from 6.12 to 1.73). Top10 and the interaction term Top10*PD are less significant both economically and statistically for the subprime crisis period, when comparing column 2 and 3 with column 5 and 6. These findings provide evidence that the sovereign debt crisis is a more severe scenario than the subprime one for European countries.

5.6 Is Euro area different?

After the establishment of the Euro area, Euro member states exhibited low and very similar levels of interest rates. This suggests the existence of another form of implicit guarantee that benefits single countries and their sovereign debt (rather than financial institutions) (see Chinn and Frieden, 2012). However, the Euro area may also have implications for IGG enjoyed by financial firms in the area when compared with non-Eurozone firms within the European Union. The failure of a financial institution in one Eurozone country has more potential ramifications for the other Euro-members due to the single currency and stronger economic ties. Summary statistics contained in Table 6 suggest that IGG for Eurozone financial firms seems indeed larger than that for Non-Eurozone ones. This apples to the whole period sample as well as the two sub-period samples.[23] However the difference revealed in the statistics could simply be due to the fact that on average Eurozone financial firms in the sample are larger or/and more risky than the non-Eurozone ones. More

[23] The Non-Eurozone sample includes 14 out of 46 financial firms in the whole sample. I split the sample period into pre-crisis period (up until M5 2007) and crisis period (from M6 2007 to M6 2013).

rigorous analysis is warranted to control for the relevant factors. Therefore I use a dummy variable NonEuro, representing non-Eurozone financial firms, to investigate further if Eurozone financial firms enjoy more IGG compared with their non-Eurozone counterparts, all else being equal. The results of regressions shown in Table 7 lend support to my speculation that Eurozone financial firms benefit more from IGG, reflected in the negative and significant coefficient of the dummy variable NonEuro in column 1. Eurozone firms are also found to have more prominent TBTF effect, judging from the negative coefficient of the interaction term Size*NonEuro in column 2. I expect the triple interaction term, which captures the risk sensitivity of IGG for extremely large non-Eurozone firms compared to Eurozone ones, to be negative and significant. The result in column 3 delivers the expected sign, although it is insignificant.

5.7 Feedback relationship between countrywide IGG and sovereign credit strength

IGG is not only an implicit subsidy for financial institutions, but also represents contingent liabilities to the public sector. As a result, higher IGG contributes to higher sovereign default risk. The European sovereign debt crisis is perhaps a vivid demonstration of how such public support can lead to considerable risk transfer to the government. On the other hand, the ability of the authorities to support the financial system may be impaired when sovereign credit condition weakens. This would lead to lower IGG. To investigate such feedback effect between IGG and sovereign credit strength, I do Granger causality tests. A country's sovereign default risk is measured with its 5-year senior sovereign CDS spread denominated in USD (SovereignCDS), which are collected monthly from Bloomberg. To proxy the corresponding implicit subsidy, I use countrywide IGG (c-IGG), computed as the weighted average of the individual IGG for all the financial institutions in a given country that are represented in the sample. As a first step, I test the stationarity of c-IGG and SovereignCDS using Levin, Lin and Chu (2002) common unit root tests (LLC). The results shown in Table 8 reject the null hypothesis of non-stationarity for both c-IGG and SovereignCDS at the 1% significance level. The outcomes of non-causality tests appear in Table 9 Panel A. As we would expect, the null hypothesis of "c-IGG does not Granger cause SovereignCDS" can be rejected at around 5% significance level. However, it seems that the feedback is unidirectional and the analysis does not support the idea that sovereign default risk also Granger causes c-IGG. This is surprising and I investigate it further.

As sovereign credit risk increases, the market value of sovereign debt, heavily held by local financial institutions (see Acharya et al., 2011, Blundell-Wignall, 2012 and Ang and Longstaff, 2013), decreases. The lower asset value of financial firms due to the depreciation of sovereign bonds they hold increases the default risk in the financial system and pushes up the necessity of government bailouts. This mechanism is referred to as "collateral damage" in Acharya et al. (2011) and also represented in the "diabolic loop" between banking and sovereign risk in Brunnermeier et al. (2011). In short, on one hand higher sovereign default risk reduces IGG due to the fact that the government is less capable of subsidizing financial firms when its own credit condition weakens (attenuating effect hereafter). On the other hand, higher sovereign credit risk leads to higher default risk in the financial system, which in turn results in higher IGG (enhancing effect hereafter). It seems from the results shown in Table 9 Panel A that these two offsetting effects may lead to the failure of rejecting the non-causality hypothesis from sovereign default risk to c-IGG during the sample period.

To separate these two contrasting effects and focus on the attenuating effect alone, I first measure the default risk in a country's financial system (c-PD^{SUB}) as a weighted average of individual default risk (PD^{SUB}) across all sample firms in a country. Then I use the component of SovereignCDS that is orthogonal to c-PD^{SUB} ($SovereignCDS^{\perp}$) to redo the

Granger causality tests. Following Ferguson and Shockley (2003), SovereignCDS$^{\perp}$ is the monthly residual ε_t from the regression:

$$SovereignCDS_t = \alpha + \beta \text{c- PD}_t^{SUB} + \varepsilon_t$$

As shown in Table 8, SovereignCDS$^{\perp}$ also passes the LLC stationarity test and thus Granger causality tests can be performed directly. Clearly in Panel B of Table 9, the coefficient of the orthogonalized SovereignCDS (SovereignCDS$^{\perp}$) becomes negative and significant at 1% level and the expected bidirectional feedback relationship seems to exist at the same significance level. The results are consistent with the intuition, namely IGG decreases as a country's credit risk increases, controlling for the enhancing effect aforementioned.

6. Conclusions

It is difficult and sometimes not desirable to end government intervention when the financial system is in distress. As a result, pricing and internalizing implicit government support is an important area of investigation. In this paper I propose measures of implicit government guarantees based on the information from the CDS market. The paper investigates the evolution of such implicit support in the European financial sector at an aggregate level as well as for individual institutions over the 2005-2013 period. I find that aggregate IGG was at its record high in 2011 in the heat of the European sovereign debt crisis. The estimates of individual IGG may help devise regulations that aim to reduce market distortion induced by such implicit support. Also my finding that only a small number of large financial firms contribute to the majority of total implicit guarantees supports current policy actions directed at containing the size of banks. However the method can only be applied if both senior and subordinated CDSs for the same firm are available. Unfortunately the subordinated CDS market largely exists only for financial firms. This prevents an extension of my analyses to other industries that may enjoy implicit support from the government, such as the automotive industry. Requiring or at least encouraging the development of a subordinated CDS market in the non-financial sector could be a regulatory step forward attempting to deal with the problem of implicit guarantees more generally than has so far been the case.

My findings confirm the presence of too-big-to-fail effect in the European financial system. The substantial implicit guarantees extended to banks and insurance companies encourage them to grow larger (become more systemically important). Financial firms within the Eurozone are found to receive more implicit support than other European firms in the sample period. Through Granger causality tests I also examine the potential feedback relationship between countrywide government support and sovereign credit risk. Interestingly, I find that the announcement of Basel III failed to curb the perception of public support for the financial sector. It seems that the market is not convinced that the proposed regulation of too-big-to-fail institutions will be effective.

If banking regulation could succeed in internalizing implicit guarantees and better aligning risk with return for financial institutions, the moral hazard of socializing losses and privatizing gains would be reduced. A first step in this direction would be a mechanism to measure implicit guarantees, such as the one discussed in the paper, which could lay the foundations for more effective tools to bring systemic risk under control. The implications in terms of market stability, liquidity and economic growth could be far-reaching and profoundly beneficial.

Appendix A. Estimating equity return correlations with the Factor DCC model

I employ the Factor DCC model to estimate equity return correlation. By blending a factor model with the dynamic conditional correlation (DCC) model, the Factor DCC model is shown by Engle (2007) to perform invariably the best, compared with the alternatives.

Let $r_{i,t}$ and $r_{m,t}$ be the daily equity return of financial firm i and the market index at time t respectively and r_t be the vector of $r_{i,t}$ of all financial firms. The model can be specified as follows:

$$r_t = \beta r_{m.t} + D_t \varepsilon_t \ , \ r_{m,t} = \sqrt{h_{m,t}} \varepsilon_{m,t}, \begin{pmatrix} \varepsilon_t \\ \varepsilon_{m,t} \end{pmatrix} \sim \mathrm{N}(0, R_t)$$

D_t is a diagonal matrix with GJR-GARCH (1,1,1) standard deviations on the diagonal and $h_{m,t}$ is GJR-GARCH (1,1,1) variance of the market index. Therefore ε_t is the vector of individual firms' standardized residuals and $\varepsilon_{m,t}$ is the market index standardized residual.

R_t (correlation matrix of the standardized residuals) then is modelled with an asymmetric DCC model. This is done to take into consideration that correlation increases faster when markets are declining. Let the covariance matrix of the standardized residual be Q_t:

$$Q_t = (1 - \alpha - \beta)\bar{R} - \gamma \bar{N} + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \gamma \epsilon_{t-1} \epsilon'_{t-1} + \beta Q_{t-1}$$

Where $\epsilon_t = \min(\varepsilon_t, 0)$, $\bar{R} \equiv \frac{1}{T} \sum_1^T \varepsilon_t \varepsilon'_t$, which is the unconditional covariance matrix of ε. $\bar{N} \equiv \frac{1}{T} \sum_1^T \epsilon_t \epsilon'_t$ is the unconditional covariance matrix of ϵ. α, β and γ are the parameters to be estimated. It follows that R_t=diag$\{Q_t\}^{-1} Q_t$diag$\{Q_t\}^{-1}$.

The Factor DCC model is estimated by quasi-maximum likelihood to deal with possible deviations from the normal distribution assumption. After all parameters are estimated, we can derive the correlation matrix R_t. If we decompose R_t as:

$$R_t = \begin{pmatrix} R_{I,I,t} & R_{I,m,t} \\ R_{m,I,t} & 1 \end{pmatrix}$$

where $R_{I,I,t}$ is the correlation matrix among individual firms' standardized residual ε_t and $R_{I,m,t}$ is the correlation vector between individual firms' standardized residuals ε_t and the market index standardized residual $\varepsilon_{m,t}$.

The covariance matrix of individual firms' returns can be obtained as,

$$V_{t-1}(r_t) = \beta\beta' h_{m,t} + D_t R_{I,I,t} D_t + \sqrt{h_{m,t}}\left(\beta R_{m,I,t} D_t + D_t R_{I,m,t} \beta'\right) \qquad (A.1)$$

It is clear from the above equation that the covariance can be decomposed into three components: a) the static co-movement with the market (the first term in the right-hand side of the equation), b) the correlation among firms' standardised residuals (idiosyncrasies), which captures the time-varying correlations arising from additional factors rather than the market index and is represented in the second term of the equation, and c) the correlation between firms' standardised residuals and market shocks (the last term), which captures time variations in the β coefficient.

Appendix B. Summary statistics of regression variables

The following Tables show summary statistics (panel A) and pairwise correlation (panel B) for the financial firms in the sample. IGG (in basis points) is the measure of implicit government subsidy. TA represents total assets. SRISK% is a comprehensive measure of a financial institution's systemic importance. PD^{SUB} is a measure of default risk. VIX is a proxy for prevailing market risk aversion and Acorr is average correlation as a measure of interconnectedness. SovereignCDS is 5-year sovereign CDS spread.

Panel A: Summary statistics

	IGG (bp)	TA (bn Euro)	SRISK% (%)	PD^{SUB} (%)	VIX (%)	Acorr	SovereignCDS (bp)
Mean	19.62	683.73	2.07	3.39	22.68	0.50	123.71
Median	14.16	484.07	1.35	2.53	19.50	0.50	54.13
Max	216.00	2508.70	10.61	26.96	59.89	0.84	3535.66
Min	0.00	32.09	0.00	0.09	10.42	0.08	1.75
Std. Dev.	19.90	571.43	2.06	3.32	9.81	0.13	323.86
Skewness	2.12	1.08	1.28	2.84	1.58	-0.16	8.72
Kurtosis	10.55	3.25	3.94	15.07	5.62	2.96	89.55
Obs.	3,082	3,082	3,082	3,082	3,082	3,082	3,082

Panel B: Pairwise correlation

	IGG	Log (TA)	SRISK%	PD^{SUB}	VIX	Acorr
IGG	1					
Log (TA)	0.19	1				
SRISK%	0.15	0.81	1			
PD^{SUB}	0.46	-0.20	-0.13	1		
VIX	0.20	0.03	-0.01	0.08	1	
Acorr	0.01	0.35	0.25	-0.41	0.09	1

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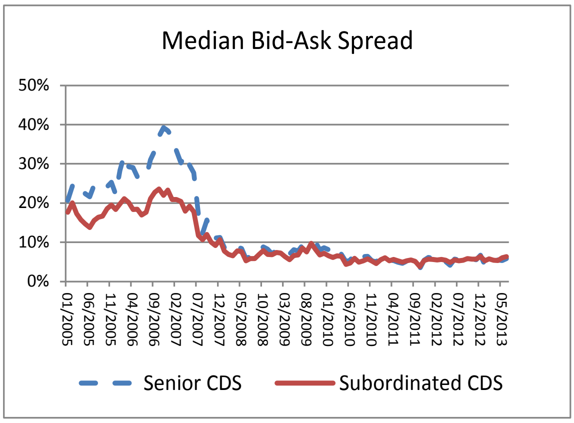

Figure 1.A. Cross-section median of the sample financial institutions' relative bid-ask spread for both senior and subordinated CDS.

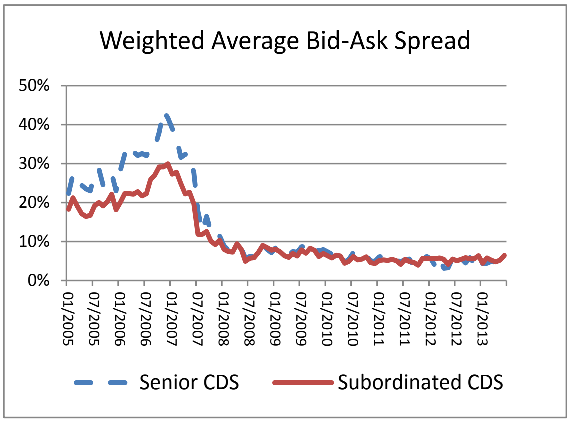

Figure 1.B. Cross-section liability weighted average of the sample financial institutions' relative bid-ask spread for both senior and subordinated CDS.

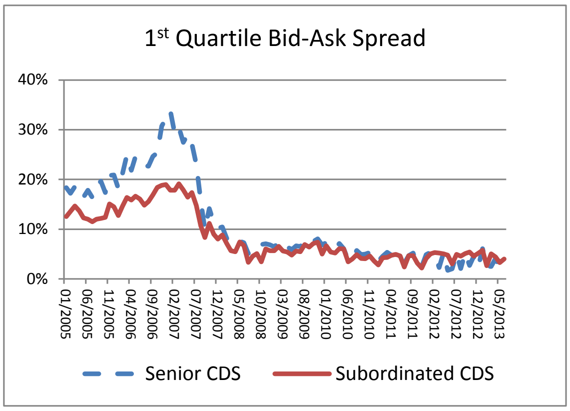

Figure 1.C. Cross-section first quartile of the sample financial institutions' relative bid-ask spread for both senior and subordinated CDS.

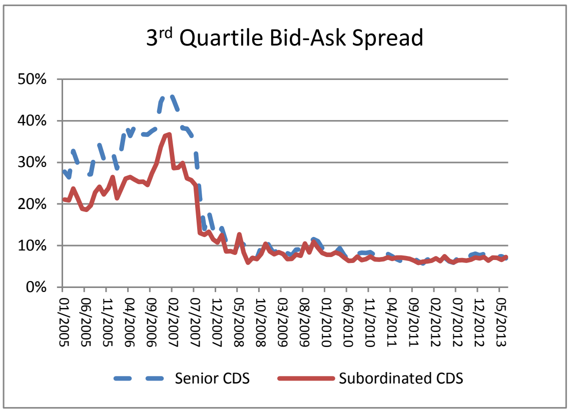

Figure 1.D. Cross-section third quartile of the sample financial institutions' relative bid-ask spread for both senior and subordinated CDS.

Figure 1. Relative bid-ask spread of the two CDS segments. Relative bid-ask spread is calculated as the difference between ask and bid quotes over mid spread for both senior and subordinated CDS.

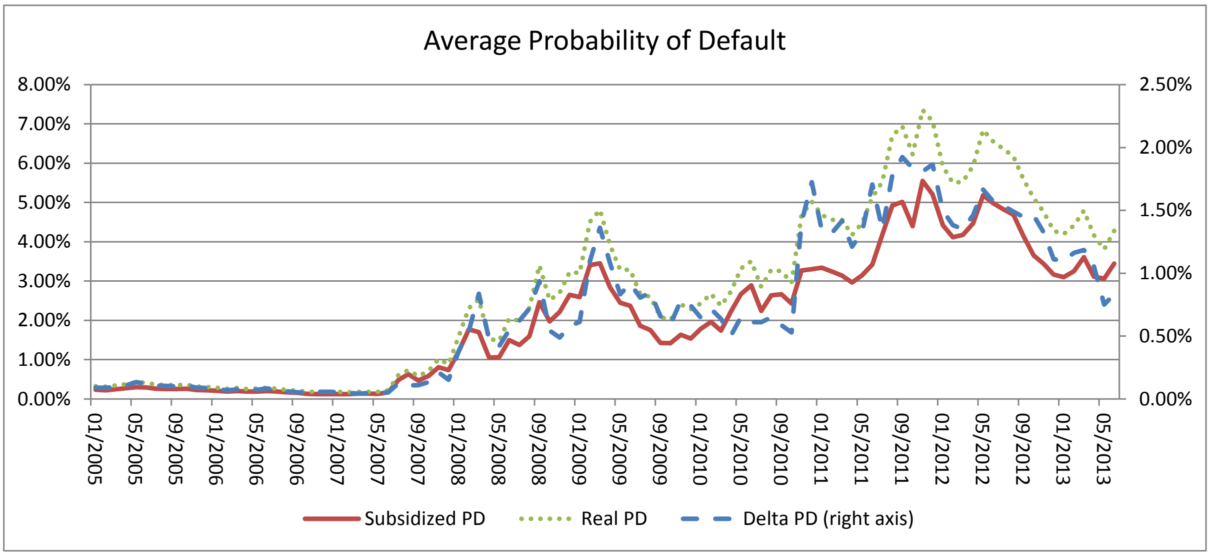

Figure 2. Time-series plot of average probability of default (PD). PDs are calculated as simple averages across financial institutions. Real PD is derived from subordinated CDS spread and Subsidized PD is derived from senior CDS spread. Delta PD is the difference between them.

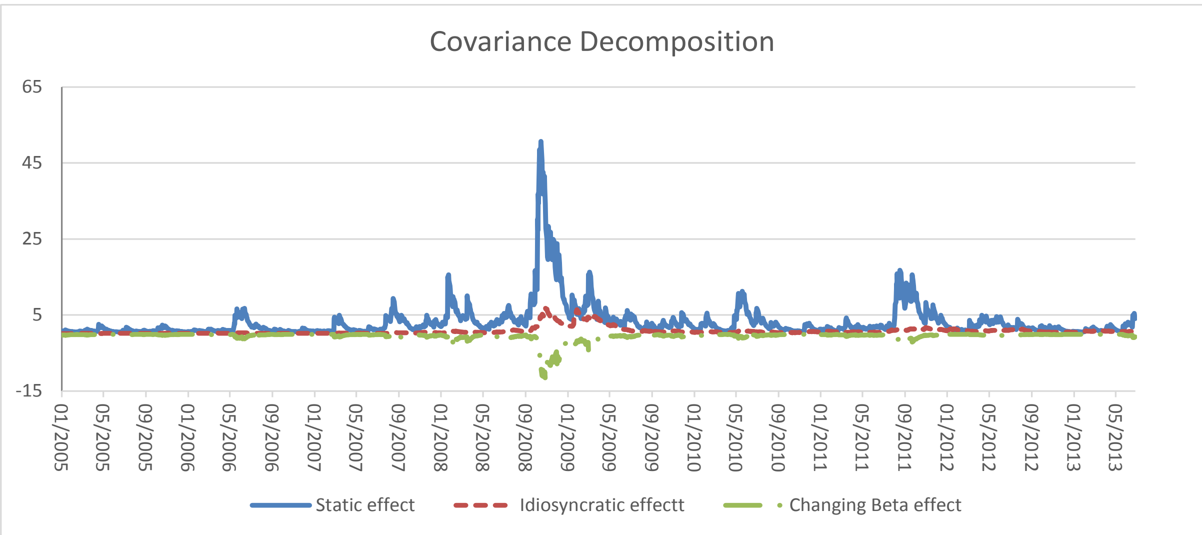

Figure 3. Covariance Decomposition. The covariance consists of three components: static co-movement with the stock index, idiosyncratic correlation and changing β effect. The plot shows the time-series of the daily averages of the three components across firms.

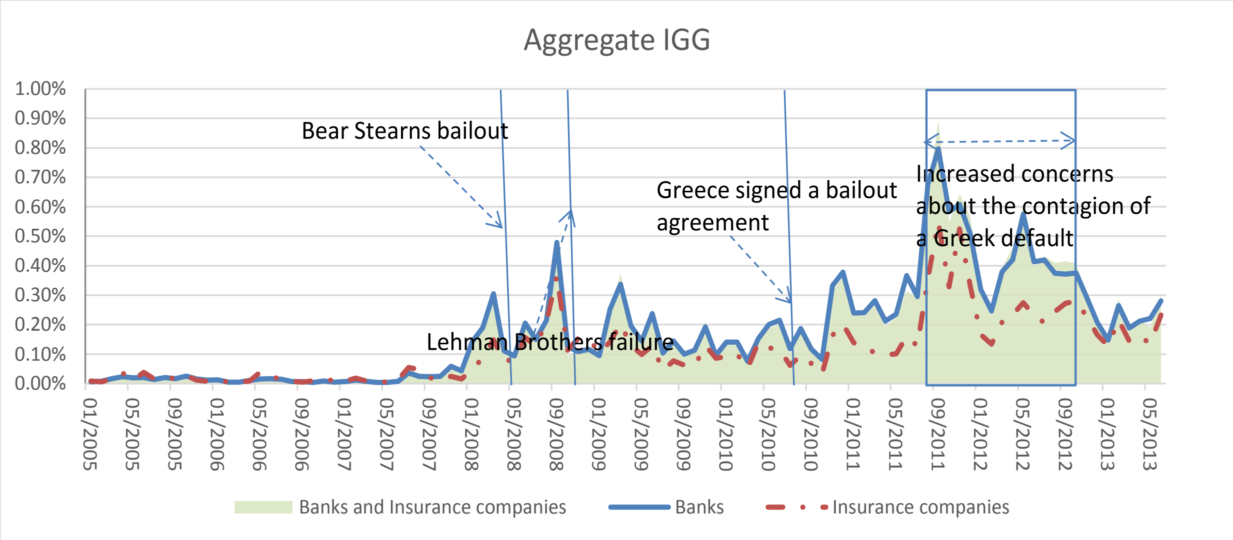

Figure 4. Time-series plot of aggregate implicit government guarantees (Aggregate IGG) for the whole financial sector as well as bank and insurance sub-sectors. Aggregate IGG is calculated as the uninsured liability weighted average of individual firms' IGG within the whole sample and also within sub-samples of banks and insurance companies separately.

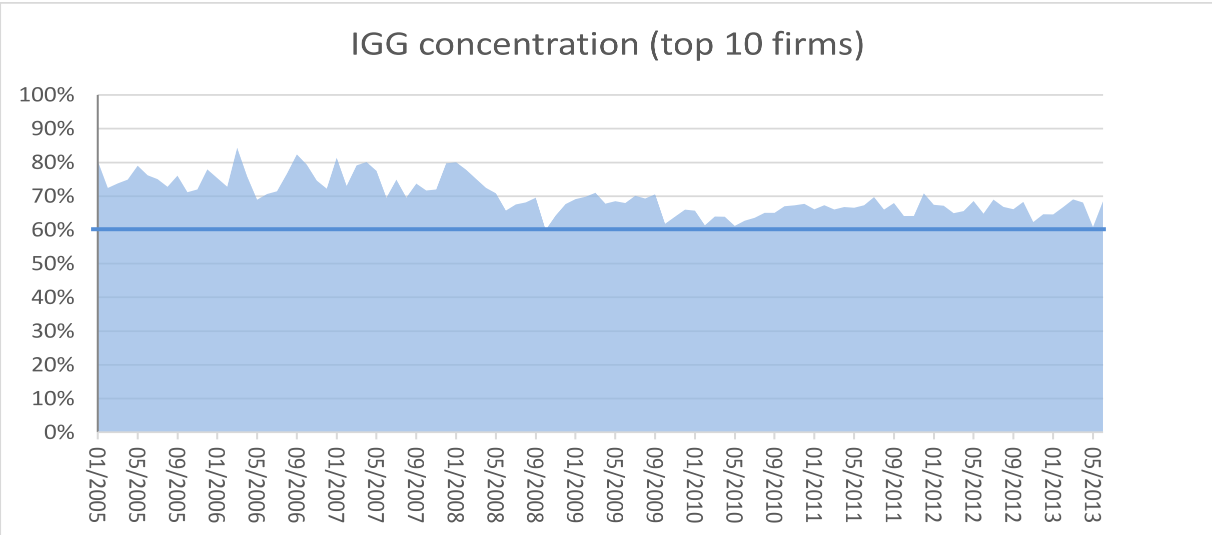

Figure 5. Implicit government guarantees (IGG) concentration. This figure reports the monthly proportion of aggregate IGG in Euro value enjoyed by the top 10 firms (in terms of the magnitude of IGG they enjoy at each point in time).

Table 1. Summary statistics of individual IGG

	Mean	Max	Min	1st Quartile	Median	3rd Quartile	Std. dev.	Observations
Pre-Crisis	1.27	9.84	0.00	0.48	0.96	1.68	0.55	860
Subprime Crisis	13.43	80.16	0.00	5.04	10.32	18.72	6.00	1202
Sovereign Debt Crisis	26.38	216.00	0.00	11.04	20.64	34.56	10.93	1590

This Table reports summary statistics of individual IGG (in basis points) for the pre-crisis period (from M1 2005 to M5 2007) and also for the subprime crisis period (from M6 2007 to M12 2009) and sovereign debt crisis period (from M1 2010 to M6 2013).

Table 2. Implicit government guarantees (IGG) rankings

Financial firms	Jun. 2013	Dec. 2012	Dec. 2011	Dec. 2010
Soc Generale	1	1	5	8
Ccredit Agricole	2	3	3	10
BNP Paribas	3	7	2	6
Banco Sabadell	4	15	--	12
Unipol Gruppo Finanziario	5	24	26	--
Commerzbank	6	2	1	1
Barclays Plc	7	4	6	13
Lloyds Banking	8	5	10	4
ING Groep NV*	9	11	8	19
Standard Chartered	10	26	39	31
Swedbank AB-A	11	--	--	--
Deutsche Bank-RG	12	18	9	20
MUENCHENER RUECKVER*	13	31	24	35
Erste Group Bank AG	14	17	21	22
Natixis	15	14	16	33

This Table reports the rankings of top 15 financial institutions in terms of IGG in basis points in June 2013, the last available month of the sample period. I also report their rankings at year end 2010-2012, which covers the whole European sovereign debt crisis. Firms with an asterisk are insurance companies. -- indicates missing data.

Table 3. Basis points value of implicit government guarantees (IGG)

Dec. 2007			Dec. 2011		
Financial institutions	**IGG**	**d-IGG**	**Financial institutions**	**IGG**	**d-IGG**
Commerzbank	2.10	426.83	Commerzbank	26.04	682.39
Credit Agricole	1.86	378.05	BNP Paribas	23.94	627.36
Banco Santander	1.86	378.05	Credit Agricole	22.62	592.77
Unicredit Spa	1.8	365.85	RBS	21.54	564.47
Standard Chartered	1.68	341.46	Soc Generale	21.54	564.47
Banca Monte dei	1.62	329.27	Barclays Plc	20.16	528.30
Deutsche Bank-RG	1.56	317.07	BBVA	19.86	520.44
BBVA	1.44	292.68	ING Groep NV*	19.86	520.44
Muenchener Rue*	1.26	256.10	Deutsche Bank-RG	17.58	460.69
BNP Paribas	1.26	256.10	Lloyds Banking	17.28	452.83
Soc Generale	1.26	256.10	Intesa Sanpaolo	16.08	421.38
Credit Suiss-Reg	1.08	219.51	Dexia SA	15.06	394.65
Barclays Plc	1.02	207.32	Bank of Ireland	14.52	380.50
UBS AG-Reg	0.96	195.12	Unicredit Spa	14.34	375.79
ING Groep NV*	0.96	195.12	Banco Santander	14.22	372.64

This Table reports the basis points value of both IGG and d-IGG at year end 2007 and 2011, representing separately just before the sub-prime crisis and in the heat of the European sovereign debt crisis. Firms with an asterisk are insurance companies.

Table 4. Too-big-to-fail (TBTF) / Too-systemically important-to-fail (TSITF) effect and Basel III impact

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Constant	-32.67***	15.41***	-59.10***	-24.13***	-22.02***	-21.00***	-47.97***	15.11***	-24.83***	-18.45***	-54.65***
PD^{SUB}_{t-1}			1.49***	1.36***	1.50***	1.29***	1.59***		1.38***	0.77**	1.50***
$Interconnectedness_{t-1}$			0.19***	0.24***	0.21***	0.22***	0.24***		0.22***	0.18***	0.19***
VIX_t			0.57***	0.59***	0.58***	0.54***	0.63***		0.60***	0.50***	0.58***
Bank			4.15***	4.57***	4.59 ***	3.83***			4.28***	2.80**	3.95***
Basel III			19.47***	20.57***	20.04***	18.38***	18.25***		20.78***	16.86***	19.76***
A. TBTF											
$Size_{t-1}$	3.81***		3.04***				2.15**				2.62**
$Top10_{t-1}$		5.72**		5.10***	4.43***						
$Bottom10_{t-1}$					-4.68**						
$Top10_{t-1}*PD^{SUB}_{t-1}$						3.07***					
$Top10_{t-1}$*Basel III							10.57**				
B. TSITF											
$SRISK\%_{t-1}$								0.97**	1.20***		0.30
$SRISK\%_{t-1}*PD^{SUB}_{t-1}$										0.93***	
Adjusted R-squared	0.04	0.02	0.51	0.50	0.51	0.53	0.53	0.01	0.50	0.57	0.50
Observations	3708	3708	3708	3708	3708	3708	2747	3626	3626	3626	3626

Regression results for the model, $IGG_{i,t} = \alpha + \beta_1 Risk_{i,t-1} + \beta_2 Interconnectedness_{i,t-1} + \beta_3 MRA_t + \beta_4 Bank + \beta_5 BaselIII + +\beta_6 TBTF_{i,t-1}(TSITF_{i,t-1})$ $\beta_7 Top10_{i,t-1}(TSITF_{i,t-1}) * Risk_{i,t-1} + \beta_8 Top10_{i,t-1} * BaselIII + \varepsilon_{i,t}$, are reported in the Table. The dependent variable is implicit guarantees in basis points (IGG), a measure I propose to gauge implicit government subsidy for financial institutions. As control variables, PD^{SUB} is a measure of default risk (Risk); Interconnectedness is computed as average correlation; VIX is a proxy for prevailing market risk aversion (MRA). Bank is a dummy variable equal to 1 if a firm is a bank and 0 otherwise and Basel III is also a dummy equal to 1 after the announcement of Basel III. To examine TBTF effect, Size is measured as log of total assets; Top10 is a dummy variable equal to 1 if a financial firm is one of the 10 largest firms in the sample and 0 otherwise; similarly Bottom10 is a dummy variable representing the 10 smallest firms. To investigate TSITF effect, SRISK% proposed by Acharya et al. (2012) is used as a measure of a financial institution's systemic importance. Column (7) is for the sub-sample of banks and the other columns are for the whole sample. *** and ** denotes significance at the 1% and 5% level. t-values have been computed with White period standard errors.

Table 5. Robustness checks

Panel A: Fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-37.15***	-11.79***	-9.79**	-89.65**	6.85	2.22
PD^{SUB}_{t-1}	1.38***	1.36***	1.35***	1.19**	1.11**	1.21**
$Interconnectedness_{t-1}$	0.29***	0.39***	0.35***	0.10	0.11	0.18**
VIX_t						
Bank	4.63***	4.98***	4.19***			
Basel III						
$Size_{t-1}$	2.44***			7.53**		
$Top10_{t-1}$		4.01**			3.90**	
$Bottom10_{t-1}$						
$Top10_{t-1}*PD^{SUB}_{t-1}$			2.69***			3.26***
Monthly fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	Yes	Yes	Yes
Adjusted R-squared	0.66	0.66	0.68	0.73	0.72	0.75
Observations	3708	3708	3708	3708	3708	3708

Panel B: Without top five firms

	(1)	(2)	(3)	(4)
Constant	-58.30***	-23.54***	-21.46***	-21.56***
PD^{SUB}_{t-1}	1.38***	1.25***	1.38***	1.22***
$Interconnectedness_{t-1}$	0.19***	0.24***	0.22***	0.23***
VIX_t	0.55***	0.57***	0.56***	0.55***
Bank	4.47***	4.91***	4.91***	4.38***
Basel III	18.63***	19.73***	19.22***	18.40***
$Size_{t-1}$	3.04***			
$Top10_{t-1}$		5.49***	4.88***	
$Bottom10_{t-1}$			-4.33**	
$Top10_{t-1}*PD^{SUB}_{t-1}$				2.79***
Monthly fixed effects				
Firm fixed effects				
Adjusted R-squared	0.50	0.49	0.50	0.51
Observations	3244	3244	3244	3244

Panel C: Subprime crisis vs. European sovereign debt crisis

	Subprime Crisis			Sovereign Debt Crisis		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	-21.96***	-1.59	-1.06	-125.63***	-53.88***	-49.91***
PD^{SUB}_{t-1}	1.89***	1.91***	1.77***	1.71***	1.39**	1.27***
$Interconnectedness_{t-1}$	0.01	0.03	0.03	0.25***	0.37***	0.32***
VIX_t	0.16***	0.17***	0.16***	1.43***	1.37***	1.38***
Bank	4.53**	4.83***	4.70***	5.41**	6.99***	6.26***
Basel III				23.99***	25.68***	24.19***
$Size_{t-1}$	1.73***			6.12***		
$Top10_{t-1}$		2.40*			9.90***	
$Top10_{t-1}*PD^{SUB}_{t-1}$			1.38*			3.17***
Adjusted R-squared	0.17	0.16	0.16	0.49	0.47	0.50
Observations	1102	1102	1102	1708	1708	1708

Table 5 -continued

Results of robustness checks regarding too-big-to-fail (TBTF) effect and Basel III impact are reported in this Table with the model: $IGG_{i,t} = \alpha + \beta_1 Risk_{i,t-1} + \beta_2 Interconnectedness_{i,t-1} + \beta_3 MRA_t + \beta_4 Bank + \beta_5 BaselIII + \beta_6 TBTF_{i,t-1} + \beta_7 Top10_{i,t-1} * Risk_{i,t-1} + \varepsilon_{i,t}$. In Panel A, fixed effects are included. In Panel B, the largest five firms are excluded from the sample. Panel C separates subprime crisis from sovereign debt crisis. The dependent variable in the regressions is implicit guarantees in basis points (IGG), a measure I propose to gauge implicit government subsidy for financial institutions. As control variables, PD^{SUB} is a measure of default risk (Risk); Interconnectedness is computed as average correlation; VIX is a proxy for prevailing market risk aversion (MRA). Bank is a dummy variable equal to 1 if a firm is a bank and 0 otherwise and Basel III is also a dummy equal to 1 after the announcement of Basel III. To examine TBTF effect, Size is measured as log of total assets; Top10 is a dummy variable equal to 1 if a financial firm is one of the 10 largest firms in the sample for Panel A and C (and one of the 5 largest firms for Panel B, after excluding the largest 5 firms from the original sample) and 0 otherwise; similarly Bottom10 is a dummy variable representing the 10 smallest firms. ***, ** and * denote significance at the 1%, 5% and 10% level. t-values have been computed with White period standard errors.

Table 6. Summary statistics of implicit guarantees for Eurozone and Non-Eurozone financial firms

	Mean	Max	Min	Std. dev.	No. of Observations
			Whole sample period		
Non-Eurozone	15.60	153.12	0.00	8.84	1116
Eurozone	17.16	216.00	0.00	9.90	2659
			Pre-crisis period		
Non-Eurozone	1.00	4.56	0.00	0.40	232
Eurozone	1.36	9.84	0.00	0.59	631
			Crisis period		
Non-Eurozone	19.43	153.12	0.00	9.00	826
Eurozone	22.08	216	0.00	10.14	1867

This table reports summary statistics of implicit guarantees in basis points (IGG) for Eurozone and Non-Eurozone financial firms for the whole sample period (from M1 2005 to M6 2013) and two sub-sample periods: pre-crisis period (from M1 2005 to M5 2007) and crisis period (from M6 2007 to M6 2013).

Table 7. Eurozone effect

	(1)	(2)	(3)
Constant	-62.25***	-62.86***	-20.81***
PD^{SUB}_{t-1}	1.39***	1.39***	1.29***
$Interconnectedness_{t-1}$	0.18***	0.18***	0.21***
VIX_t	0.58***	0.58***	0.54***
Bank	4.37***	4.40***	3.89***
Basel III	19.85***	19.83***	18.31***
$Size_{t-1}$	3.39***	3.44***	
NonEuro	-3.33**		
$Size_{t-1}$*NonEuro		-0.25**	
$Top10_{t-1}*PD^{SUB}_{t-1}$			3.36***
$Top10_{t-1}*PD^{SUB}_{t-1}$*NonEuro			-0.64
Adjusted R-squared	0.51	0.51	0.53
Observations	3708	3708	3708

Regression results for the model, $IGG_{i,t} = \alpha + \beta_1 Risk_{i,t-1} + \beta_2 Interconnectedness_{i,t-1} + \beta_3 MRA_t + \beta_5 Bank + \beta_6 BaselIII + \beta_4 Size_{i,t-1} + \beta_8 NonEuro_i + \beta_8 Size_{i,t-1} * NonEuro_i + \beta_7 Top10_{i,t-1} * Risk_{i,t-1} + \beta_7 Top10_{i,t-1} * Risk_{i,t-1} * NonEuro_i + \varepsilon_{i,t}$, are reported in the Table. The dependent variable is implicit guarantees in basis points (IGG), a measure I propose to gauge implicit government subsidy for financial institutions. As control variables, PD^{SUB} is a measure of default risk (Risk); Interconnectedness is computed as average correlation; VIX is a proxy for prevailing market risk aversion (MRA). Bank is a dummy variable equal to 1 if a firm is a bank and 0 otherwise and Basel III is also a dummy equal to 1 after the announcement of Basel III. Size is measured as log of total assets. Top10 is a dummy variable equal to 1 if a financial firm is one of the 10 largest firms in the sample and 0 otherwise. The variable of interest is NonEuro, which is a dummy equal to 1 for non-Eurozone firms and 0 otherwise. *** and ** denote significance at the 1% and 5% level. t-values have been computed with White period standard errors.

Table 8. Levin, Lin and Chu tests (LLC) for common unit root

	c-IGG	SovereignCDS	$SovereignCDS^{\perp}$
Statistic	-6.20***	-2.38***	-4.12***
P-value	0.0000	0.0086	0.0000

The null hypothesis of LLC tests is non-stationarity and *** denotes the null hypothesis is rejected at 1% significance level. SovereignCDS (5-year senior sovereign CDS spread) represents a country's sovereign credit strength. c-IGG is countrywide IGG, calculated as a weighted average of individual IGG across financial institutions in a country and $SovereignCDS^{\perp}$ is the portion of SovereignCDS that is orthogonal to $c\text{-}PD^{SUB}$, a proxy of countrywide default risk of financial institutions.

Table 9. Feedback effect between countrywide implicit government guarantees (c-IGG) and sovereign credit strength (SovereignCDS)

Panel A

	Granger causality tests
Number of lags	5
	P-value
c-IGG does not Granger cause SovereignCDS	0.0510
SovereignCDS does not Granger cause c-IGG	0.3083
Number of observations	972

Panel B

	Vector autoregressive model (VAR)	
Number of lags	1	
	$c\text{-}IGG_t$	$SovereignCDS^{\perp}_t$
$c\text{-}IGG_{t-1}$	0.761***	0.581***
$SovereignCDS^{\perp}_{t-1}$	-0.003***	1.018***
	Granger causality tests	
		P-value
c-IGG does not Granger cause $SovereignCDS^{\perp}$		0.0000
$SovereignCDS^{\perp}$ does not Granger cause c-IGG		0.0037
Number of observations		1028

Granger causality tests reported in the Table are based on a vector autoregressive model (VAR). SovereignCDS (5-year senior sovereign CDS spread) represents a country's sovereign credit strength. c-IGG is countrywide implicit guarantees, calculated as a weighted average of individual IGG across financial institutions in a country and $SovereignCDS^{\perp}$ is the parts of SovereignCDS that are orthogonal to c-PD^{SUB}, a proxy of countrywide default risk of financial institutions. I use the Bayesian Information Criterion (BIC) as the criterion for selecting the number of lags in the analysis. *** denotes significance at the 1% level.