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A liquidity risk index as a regulatory tool for systemically important banks? An empirical assessment across two financial crises

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A liquidity risk index as a regulatory tool for systemically important banks? An empirical assessment across two financial crises

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Abstract

We provide an assessment of the IMF suggestion, based on Severo (2012), to use an index of systemic liquidity risk (SLRI) that could help to estimate a Pigouvian tax on large banks for the externality on the international banking system out of their risk exposure. To this end we compute a parsimonious and fully documented SLRI and investigate its statistical significance in explaining level and variability of stock returns for a group of large international banks during the subprime financial and the Eurozone sovereign debt crises. The empirical investigation consistently fails to detect, within and across the two crises, a core group among the systemically important banks listed by the Financial Stability Board and thus supports a sceptical assessment of the proposal.

JEL classification: C58, G01, G12, G13.

Keywords: subprime crisis, Eurozone sovereign crisis, systemic risk, banks' stock returns, macroprudential regulation.

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1. Introduction

The financial crisis ignited in 2007 in the US subprime mortgage market was magnified and internationally transmitted because of an unprecedented liquidity stress especially in the aftermath of the mid-September 2008 Lehman's default. This brought to the forefront the manifold features of liquidity, namely the feedbacks between funding and market liquidity (e.g. Brunnermeier and Pedersen, 2009), and the role played by the scarcity of liquidity in compromising banks' and other financial institutions' solvency (e.g. Brunnermeier, 2009). As a consequence, policy makers were pushed to take these aspects into account as a crucial component of a macroprudential approach to supervision (De Larosière Report, 2009), thus providing impetus to research for appropriate measures of systemic liquidity risk as a first step to devise regulatory requirements.

In this latter connection Severo (2012) estimated a systemic liquidity risk index (SLRI), building on violations of arbitrage relationships in various securities markets, whereby such violations are interpreted as indicators of liquidity stress in global financial markets. In fact, in normal liquidity conditions, arbitrageurs would take advantages through appropriate strategies from misalignments in prices (i.e. price bases). The SLRI received an implicit endorsement by IMF, being the main analytical tool presented and discussed in Chapter 2 of the April 2011 issue of the Global Financial Stability Review (IMF, 2011).

It has to be stressed, however, that other liquidity indexes have been constructed based on a similar methodology, namely a set of violations of arbitrage conditions yielding non-null bases and/or of market microstructure measures on turnover and bid-ask spreads to be summarized using different statistical tools, from simple averages of individual indicators to principal component analysis. An early example, immediately before the 2007 crisis, is Kerry (2008), whose composite indicator of market liquidity has been adopted in the April 2007 Bank of England Financial Stability Report (Bank of England 2007). Kerry's index of liquidity is computed by averaging nine measures, six of which are microstructural (three different bid-ask spreads representing the gilt repo market, the US dollar foreign exchange market and average of individual

stocks in the FTSE100); the remaining three are different return-to-volume measures for the gilt market, the stocks of the FTSE and S&P equity options[1].

The present paper builds on Severo's SLRI for two main reasons. First, besides being to some extent validated by the IMF, the SLRI is instrumental in estimating, within a contingent claims analysis (CCA) pricing scheme, a Pigouvian tax that could be imposed by regulators to large banks for the externality arising from their individual exposure to a systemic liquidity risk. Second, from a macroprudential perspective, detecting a robust association between the SLRI and the evolution of large banks' stock returns would be a promising, though only necessary condition, to pursue the agenda for a more resilient international banking system.

The aim of this paper is to provide a more parsimonious variant of the SLRI with a reduced number of arbitrage violations, and to test its usefulness also over the Eurozone sovereign debt crisis, which could not be considered in Severo's paper but for the initial developments in the Greek case. To this end the paper is structured as follows. In Section 2 we recall the main issues connected with the estimate of the index, while in Section 3 we provide a parsimonious SLRI and illustrate a set of robustness checks on it. In Section 4 we investigate the statistical significance of this SLRI as a regressor explaining level and variability of stock returns for a group of large international banks, over the two subsamples, 2004-2010 and 2010-2012, in the latter case in order to assess the potential of the SLRI as a regulatory tool against the backdrop of the sovereign risk crisis for the Eurozone. Final Section concludes.

2. The estimation of the SLRI

To estimate the SLRI Severo (2012) uses daily bases, namely price differentials with respect to zero arbitrage profit opportunities, across various

[1]Kerry (2008) shows how a simple unweighted average yields an indicator very close to an alternative one using a principal component analysis approach. Two notable features are the normalization for each individual series over an assumed "normal" period, well before the crisis outburst (1999-2004), and a decay factor of 0.94 discount in an exponentially weighted moving average of daily data, in order to privilege more recent information.

geographic locations, and extracts, by means of principal component analysis (PCA), statistical factors that drive most of the variation across these bases over time. The proposed index is represented by the first dominant underlying factor explaining most of the temporal evolution of these bases. Specifically, four different types of arbitrage relationships are considered over the period January 2004 - October 2010 to find out possible bases: i) Covered Interest Parity (CIP); ii) CDS-Bond basis for non-bank corporations; iii) on-the-run versus off-the-run U.S. Treasuries; and iv) (interest rate) swap spread. The series for each basis and of the summarizing indicator are normalized, over the entire sample, at zero mean and unitary standard deviation. As plenty of liquidity allows to exploit arbitrage opportunities, negative and high (in absolute terms) values of the indicator point to systemic liquidity stresses.

Overall the SLRI fluctuates mildly in periods of normal liquidity in global capital markets (i.e. between 2004 and 2007), signals some stresses around the Bear Stearns bail-out (March 2008) and drops sharply (more than 5 standard deviations below its mean) at mid-September 2008, after the Lehman bankruptcy. The pattern is roughly similar to the Bank of England Financial market liquidity index in the June 2009 issue of the Financial Stability Report (Bank of England 2009).

A few remarks are in order on the SLRI. First, Severo (2012) makes use of a very high number of arbitrage relationships (36), including a few which we checked were never violated in practice during the estimation period (swap spread) and others whose violation does not always correspond to the arbitrage rationale (e.g. on-the-run versus off-the-run U.S. Treasuries[2]). Second, the computation of CDS-bond bases implies a highly subjective selection of eleven unidentified non-bank American, European and Japanese corporations. Third, the indicator does not signal clearly a return to good liquidity conditions from early 2009 and, given the sample period considered, it is not tested around the outburst of the Eurozone sovereign debt crisis (August 2011).

Against this backdrop, the objective of the paper is twofold:

[2] The spread between the most recent issue (on.the-run) of Government bonds and the previous ones (off-the-run) is commonly interpreted as a liquidity indicator and can in principle be exploited for arbitrage strategies. However, Krishnamurthy (2002) shows that, considering the costs of shorting the on-the–run bonds, the arbitrage strategies are not profitable and Vayanos and Weill (2008) show that liquidity and specialness translate into price premia that are consistent with no-arbitrage.

i. to provide an estimation, over a period that includes also the Eurozone sovereign debt crisis, of a SLRI that is however derived from a more parsimonious set of elementary measures, and fully documented for data sources;

ii. to test the validity of such a revised SLRI in the two time intervals which include different financial crises by econometrically investigating the strength of its association with large banks' stock returns evolution, with particular reference to robustness issues (for which banks it turns out to be statistically significant) and to the implied empirical validation of the Financial Stability Board (FSB) list of global systemically important banks (*G-SIB*s). These institutions, because of the risk they impose for the resilience of the financial sector, in the Basel 3 framework should be charged with additional capital requirements (BCBS, 2013).

3. A parsimonious estimate of the SLRI

A well-known issue underlying the rapid transition from the financial to the economic international crisis in the semester following the Lehman bankruptcy is the dollar shortage for most European banks, heavily engaged in trade finance and in the international financial markets, and unable to tap the US interbank market because of the counterparty risk for potential lenders (McGuire and von Peter, 2009). On these grounds we contribute the literature proposing a parsimonious SLRI, fully documented for its elementary data sources, drawn from Thomson Reuters Datastream and Markit, and computed out of only two sets of arbitrage conditions that affect US and European headquartered operators. The first set refers to the CIP bases involving the U.S. dollar and 3 other currencies: the Euro, the British pound, the Swiss franc[3], at the 3-, 6- and 12-months horizons. The CIP basis at day *t* for the $/€ is computed as:

$$CIPbasis_{t,T} = (1+i^{\$}_{t,T})(F_{t,T}/S_t) - (1+i^{€}_{t,T}) \quad (1)$$

[3] Differently from Severo (2012) we do not consider, for parsimony, the Japanese yen, the Hong Kong dollar, and the Singapore dollar, although we check for robustness when including the first currency (results available upon request).

where *F* and *S* are the forward and spot exchange rates, *T* refers to the 3-, 6- and 12-months maturities, and *i*s are the LIBOR rates at the corresponding maturities. The same holds for the other currencies vs. the US dollar.

As for the CDS-Bond bases, arising from violations of the arbitrage relations equating CDS prices to credit spreads, we consider the relationship between the yields on 5-year corporate bonds and the 5-year CDS spreads for 8 large, publicly traded non-bank corporations in the United States, United Kingdom and Eurozone[4]. Following the literature, we take the 5-year CDS contract, which represents the conventional maturity and hence is the most liquid one; in addition, the liquidity degree for the selected reference entities is enhanced by the inclusion in the *iTraxx Europe* CDS index for the European corporations and in CDX.NA.IG CDS index for the US ones. To compare 5 year CDS spreads and bond yield spreads, the first problem is how to find a corporate bond matching the 5 year constant maturity of the CDS contracts. The second issue concerns the risk free rate. The bond yield spreads can be calculated by subtracting the risk-free interest rate from the synthetic 5 year constant bonds yield. Government bond yields are not however an ideal proxy for risk-free rate, due to taxation treatment, repo specials and legal constraint. An alternative proxy for the risk-free rate is the interest rate swap, that has the advantage of being quoted on a constant maturity basis (Blanco et al., 2005). To create a synthetic constant 5 years maturity bond spread we follow Fontana (2010). For each day in the sample and for each reference entity we search for a bond with less than 5 years left to maturity and another bond with more than 5 years to maturity; only senior, straight bonds are used. We extract the corporate bond spreads over the swap curve from Datastream using the datatype *SWSP* and by linearly interpolating them we approximate a 5 year to maturity bond spread.

Though reducing the arbitrage conditions from 36 to 17, the estimated SLRI, with a first factor in the PCA procedure that accounts for over 60% of the variance[5], is very close to Severo's one during the same interval, dropping dramatically in the last quarter of 2008 and recovering only around mid-2009 (Figures 1-2).

[4] Carrefour for France, Telecom for France, Deutsche Telekom for Germany, Vodafone Group for the UK, Cox Communication, IBM, Dominion Resources and Kinder Morgan Energy for the US.
[5] 40% in Severo's paper, as expected given the higher dimensionality of the arbitrage conditions.

[Figures 1-2 about here]

3.1 Robustness checks

We perform different robustness checks of our estimated SLRI:

a. considering only CIP bases, in order to avoid the subjective choice of corporations for the Bond-CDS bases (Fig. 3). Having checked that the inclusion of yen did not change materially the results, we choose, for estimation parsimony, to stick to the SLRI index based on four currencies;

b. considering only three-months CIP bases, on the assumption that counterparty risks increase with a lengthened maturity. As expected, the variability of the index increased, but with no material changes in its pattern. We therefore decide, also for ease of comparison, to maintain the three maturities at three-, six- and twelve- months;

c. substituting in the CIP bases calculations the US Dollar Libor rates with the Eurodollar interest rates at the same maturities.

It is worth discussing the last case, also in the light of the doubts cast on how US Libor rates are computed, being posted rates that do not reflect effective transactions[6]. In addition, as shown by the investigations on malpractices on Libor determination, some large banks in the respondents' panel could have had the incentive to indicate lower interest rates, especially during the hottest months of the crisis from mid-September 2008 to the first half of 2009, to counteract doubts of their lenders on potential counterparty risks (Edmonds, 2013). An alternative benchmark for the average cost of raising offshore US dollar deposits is the Eurodollar rate downloadable from the US Federal Reserve site under the heading *H.15 Eurodollar deposit rate*. During the peak period of the crisis, the spread of the Eurodollar rate to US dollar LIBOR at corresponding maturities increased sharply, suggesting that average US dollar borrowing costs across the broader range of banks did exceed LIBOR rates. In contrast, the average rate to borrow euros, measured using Euribor, tracked the euro LIBOR rate closely throughout the crisis. The evidence that US dollar LIBOR was below the actual

[6]A Libor rate is computed as the interquartile trimmed mean of reported interbank offer (ask) rates provided each day by a panel of large banks in the London trading session. Each responding bank estimates the rate at which it could borrow unsecured on the interbank market at different maturities and for 10 currencies.

cost of borrowing US dollars in the market is consistent with the large measured bases in the foreign exchange swap market: the Eurodollar spreads to US dollar LIBOR correspond indeed closely with the premia paid to receive US dollars under swap (Ossolinski and Zurawski, 2010).

The Eurodollar rate has however its own weaknesses: it is in fact an offered broker quote that reflects, by construction, the upper end of rates paid by banks, reported in the Federal Reserve's H.15 report based on data from ICAP (Kuo et al., 2012). In addition, comparing the Libor and the Eurodollar interest rate series the differences concentrate in a very narrow time interval (October 2008/June 2009) and the results for our estimated SLRI are negligible (results available upon request).

[Figure 3 about here]

All in all, the robustness checks do not show relevant differences across estimates of a SLRI with a reduced number of arbitrage conditions. Major differences emerge only when considering the January 2010 - early December 2012 interval, because the estimated SLRI including only CIP bases signals much more sharply liquidity stresses tied to the euro crisis. Figure 3 shows that, had we left out the Bond-CDS bases, the resulting SLRI is much better to signal liquidity stresses in the Eurozone sovereign debt crisis period, of a somewhat comparable order of magnitude with the 2008/09 period, a finding that is consistent with Allen and Moessner (2012) and Ivashina *et al* (2012).

4. Banks' stock returns and liquidity risk

In this section, following Severo (2012), we investigate the impact of the SLRI on the stock returns of a group of large banks in Australia, Europe, India, Japan, Korea the United Kingdom, and the United States. The underlying hypothesis is that their high interconnectedness within the international financial markets should result in a significant link between their market valuations and global liquidity conditions. Our own contribution is to check for the robustness of the coefficient estimates for the SLRI as a regressor along four dimensions:

1. parsimony of the SLRI estimation w.r.t. that presented in Severo (2012);

2. time dimension, by considering a lagged rather than contemporaneous (same day) effects of liquidity on stock returns (level and variability);
3. relevance of the SLRI as an indicator of liquidity stress during the Eurozone sovereign debt crisis;
4. empirical selection of systemically important banks, to the extent that their market valuations are significantly impacted by the SLRI.

The rationale for the last criterion is that a poor statistical significance for the indicator has relevant implications for its proposed regulatory use. In fact, IMF (2011) and Severo (2012) suggest to use the index in order to estimate, in a contingent claims analysis (CCA) framework, liquidity premia to be charged, on macroprudential grounds, on large systemically important banks, because of the externalities on the global financial system that their exposition to systemic liquidity risk, proxied by the statistical association between their stock returns and the SLRI. The list of banks used in the econometric investigation includes 25 out of 28 *gSIB*s in the 2012 updated FSB (2012) classification. An interesting research question is whether and for which *G-SIB*s such an exposure to systemic liquidity risk is statistically significant and whether the same *G-SIB*s are singled out in the two time windows.

Our starting point is to compare the estimation results for jointly modeling, in a maximum likelihood setting, level and daily variability in stock returns for a group of 51 (53 in Severo) large international banks, including among the regressors, besides the SLRI, an expanded set of controls for market returns, idiosyncratic and sector credit risk and market uncertainty [7].

The econometric specification to model the impact of the SLRI on the level and the volatility of bank *i*'s stock returns assumes an ARCH(1) process whereby the conditional volatility is directly affected by the SLRI:

$$R_t^i = \beta_0^i + \beta_1^i R_t^M + \beta_2^i SLRI_t + \beta_X^i X_t + e_t^i \sigma_t^i \qquad (2)$$

$$(\sigma_t^i)^2 = exp(\omega_0^i + \omega_1^i SLRI_t + \omega_Y^i Y_t) + \gamma^i (e_{t-1}^i)^2;\ e_t^i \sim N(0,1) \qquad (3)$$

[7] Some tables report results for less than 51 banks when the statistical algorithm, implemented in MATLAB, fails to converge.

where R^i is the log daily difference of the *i*-th bank dollar-denominated stock price and R^M is the return on the market portfolio, proxied by the return on the dollar-denominated MSCI world index covering 24 developed countries. The vectors *X* and *Y* represent controls included in the model – individual and group average CDS and the volatility index VIX[8] - in order to try to purge the effects of systemic liquidity stresses on stock returns from idiosyncratic and sector credit risk factors and stock market uncertainty. For ease of comparison we follow Severo (2012) in the choice of the exponential functional form for the conditional heteroskedasticity, in order to avoid negative fitted values for the volatility process. We expect $\beta_2^i > 0, \omega_1^i < 0$, , because more liquidity should sustain return levels whereas lower liquidity, being a proxy for market uncertainty, would raise return volatility.

We report and comment the econometric findings for the time intervals, 2004-2010 and 2010-2012; the overlap in 2010 allows a comparison with the econometric results in Severo (2012) when using different SLRIs.

[Table 1 about here]

4.1 Systemic liquidity stress and the 2007/08 crisis

From inspection of Table 1, reporting the estimates of the baseline specification without controls, a first striking result is that, in spite of the very close approximation between Severo's and our own estimated SLRI, different banks are singled out when considering the ones with at least a 90% p-value for the SLRI in both equations: three (among which only one *G-SIB*) instead of seven (with three other *G-SIB*s).

[Table 2 about here]

Table 2 reports results when considering for robustness a one day lagged SLRI, simply to take into account that investors may not be able to gather in real time information on global markets to act upon: even such a slight modification

[8] The SBOE SPX Volatility VIX index, produced by the Chicago Board Options Exchange, estimates the implicit volatility of a synthetic option on the S&P 500 dollar-denominated index over the next 30-day period. It represents one widely adopted measure of expectations of stock market volatility.

yields among the four banks selected only one overlap (Bank of America) with Table 1. It is worth mentioning that this difference emerges although the correlation of contemporaneous and lagged SLRI with other variables are almost identical. We interpret these findings as a hint of the lack of robustness of the SLRI for regulatory use.

Table 3 highlights a second main result, again witnessing that non robust effects of the SLRI are obtained when controlling for individual CDS, in order to take into account idiosyncratic credit risk: for only three banks instead of four the regressor is statistically significant on stock returns (level and variability); what's more interesting, only three *G-SIB*s are singled out (Credit Suisse, Goldman Sachs and Wells Fargo).

[Table 3 about here]

A third relevant result is that, controlling for bank sector average CDS and the VIX as a classical indicator of market uncertainty, the SLRI does not turn significant in the variance equation in 15 (among which Wells Fargo) out of 51 banks, compared to 10 out of 53 in Severo (Table 4). The outcome is not surprising because liquidity stresses are bound to increase market uncertainty, as shown by the negative correlation between SLRI and log VIX (- 0,90 over the sample 2004-2010 and - 0,66 over the 2010-2012 period).

Finally, in Table 5 we report results when all controls are included, namely both individual and bank group average CDS (to consider idiosyncratic and banking sector credit risk), and the VIX as well. The SLRI becomes insignificant in the variance equation for almost three fifths of banks whereas it is highly significant in only 11 *G-SIB*s.

[Tables 4-5 about here]

4.1 The Eurozone sovereign debt crisis

The pattern of econometric findings for the 2010-2012 period is similar to the one for the previous crisis, though with some interesting differences when considering Eurozone headquartered banks. First, the SLRI is highly significant

almost always in the variance equation and hardly so for the level of stock returns. Experimenting with a one-day lagged SLRI yields again that the regressor is more often significant, at least at the 10 per cent confidence, and that there is lack of robustness in identifying specific banks when allowing for an even small timing variation (Tables 6-7).

[Tables 6-7 about here]

An interesting feature that emerges when inserting all controls – individual CDS and average CDS and VIX, all in logs - is that within the small group of banks where the SLRI is statistically significant, there is a neat split between Eurozone banks that are headquartered in sovereign-risk hit countries (Greece, Portugal, Spain) or have received a public capital infusion (Commerzbank, in 2008, only partially refunded in 2012) and four other ones, among which three US, *G-SIB*s. Whereas for the latter group the negative sign in the variance equation is intuitively explained because a larger SLRI, meaning a lack of liquidity, increases uncertainty and therefore the volatility in stock returns, the opposite sign for the former group is *prima facie* rather puzzling. Our suggested interpretation is that for these banks, mostly depending on public support for their viability, a lack of liquidity could strengthen the belief, on grounds of moral hazard considerations, of a further infusion of public resources, inducing to bet for a less bumpy stock returns evolution (Table 8)[9].

[Table 8 about here]

It is worth to stress a technical detail that however further highlights the lack of robustness of possible regulatory policy uses of the SLRI. We checked that simply changing from logs to levels of individual CDS spreads alters the sample of banks where the convergence in the statistical algorithm is attained and the banks associated to a statistical significant SLRI coefficient, though the different sign among Eurozone and US based *G-SIB*s remains.

[9] The results on the split between euro-based banks and US ones are qualitatively robust when inserting lagged instead of contemporaneous SLRI.

5. Conclusions

We provide estimates of a SLRI comparable to the one proposed in IMF (2011) and Severo (2012) but derived from a more parsimonious, and fully documented, set of elementary measures of market liquidity stress, extending the period to 2012, in order to include also the Eurozone sovereign debt crisis. We then perform an econometric investigation of the association between the SLRI and a group of large banks' stock prices, with particular reference to robustness issues (i.e. for which banks the indicator turns out to be statistically significant) and to an empirical validation of the systemically important banks (*G-SIB*s) list proposed by the Financial Stability Board. We assess the issues across the subprime financial crisis and its developments up to 2010 in the first time interval, and the Eurozone sovereign debt crisis in the second one.

In connection with our parsimonious SLRI estimation, main findings are that the indicator is close to Severo's but provides a stronger signal of liquidity stress and recovery episodes over the same period. Moreover robustness checks do not show relevant differences across estimates built on a reduced number of arbitrage conditions, except when considering the 2010-2012 interval. In fact, a SLRI including only CIP bases signals more sharply liquidity stresses in the Eurozone sovereign debt crisis period, comparable with the 2008/09 period, a finding that is consistent with Allen and Moessner (2012) and Ivashina et al. (2012).

As for the econometric investigation on banks' exposure to liquidity risk, results for the baseline specification with no controls are *prima facie* consistent with Severo (2012) and show that the effect of liquidity on stock returns is in practice absent, whereas it is positive on their volatility. However, different banks are singled out when considering the ones with significant p-values for the SLRI in both equations: three (among which only one *G-SIB*) instead of seven (with three other *G-SIB*s) in Severo (2012). When introducing controls for idiosyncratic and group credit risk and stock market uncertainty, the statistical significance of the SLRI is reduced and varies across banks. These results motivate a sceptical assessment of the IMF suggestion), to use a SLRI as an input to compute a Pigouvian tax to charge on highly interconnected banks for the externality on the international banking system out of their risk exposure to a global liquidity risk.

The pattern of findings during the Eurozone sovereign debt crisis is similar, but for the interesting result of a neat split between two groups of banks: the Eurozone banks that are headquartered in sovereign-risk hit countries or have received a public capital infusion, on the one hand, and four other, among which three US, *G-SIB*s, on the other hand. Results highlight that, contrary to expectations, liquidity stresses are associated with a reduced volatility of stock returns in the first group, possibly on ground of moral hazard.

We envisage two main themes for research. The ambiguous implications of our results on the issue of systemic liquidity risk and stock performance of differently headquartered *G-SIBs,* and hence of their resilience against such a risk, call for a deeper investigation of their (expected) dependence on domestic and foreign central banks as providers of their home and foreign liquidity. The very same elementary measures of market liquidity stresses can be different across financial crises and/or financial markets, because of the effective transaction costs and of the markets' convention on how a price basis falls outside a normal range and therefore signals a liquidity stress. An empirical investigation on non linear effects of a SLRI could help to shed some light on these issues, which are left for future research work.

References

Allen, W.A. and R. Moessner 2012. *The liquidity consequences of the euro area sovereign debt crisis*, BIS wp no 390.

Bank for International Settlements 2010. *80th Annual Report*, June.

Bank of England 2007. *Financial Stability Report*, April.

Bank of England 2009. *Financial Stability Report*, June.

Basel Committee on Banking Supervision 2013. *Global systemically important banks: updated assessment methodology and the higher loss absorbency requirement,* July.

Blanco, R., S. Brennan and I. Marsh 2005. An empirical analysis of the dynamic relation between investment-grade bonds and credit default swaps. *Journal of Finance* 60: 2255-81.

Brunnermeier, M. 2009. Deciphering the Liquidity and Credit Crunch 2007-08. *Journal of Economics Perspectives* 23(1): 77-100.

Brunnermeier, M. e L. H. Pedersen 2009. Market Liquidity and Funding Liquidity. *Review of Financial Studies* 22(6): 2201-2238.

De Larosière Report 2009. *Report of the High-level Group on Financial Supervision in the EU*.

Edmonds, T. 2013. *Libor, Public Inquiries & FSA Disciplinary Powers*, House of Commons, SN/BT/6376.

Financial Stability Board (FSB) 2012. *Update of group of global systemically important banks (G-SIBs)*, November.

Fontana, A. 2010. *The persistent negative cds-bond basis during the 2007/08 financial crisis*. Working Paper 2010-13, University of Venice Ca' Foscari, Department of Economics.

International Monetary Fund (IMF) 2011. *Global Financial Stability Report,* April, Chapter 2.

Ivashina, V., D.S. Scharfstein and J.C. Stein 2012. *Dollar Funding and the lending behavior of global banks*, NBER wp no 18528.

Kerry, W. 2008. Measuring financial market liquidity. *Journal of Risk Management in Financial Institutions*, 1(2): 181–190.

Krishnamurthy, A. 2002. The bond/old-bond spread. *Journal of Financial Economics* 66: 463–506.

Kuo, D., D. Skeie and J. Vickery 2012. *A comparison of Libor to other measures of bank borrowing costs*, NY Fed, mimeo.

McGuire, P. and G. von Peter, 2009. The US dollar shortage in global banking, *BIS Quarterly Review*, March: 47–63.

Ossolinski, C. and A. Zurawski, 2010. The Financial Crisis through the Lens of Foreign Exchange Swap Markets, *Australian Central Bank, Bulletin*, June: 47-53.

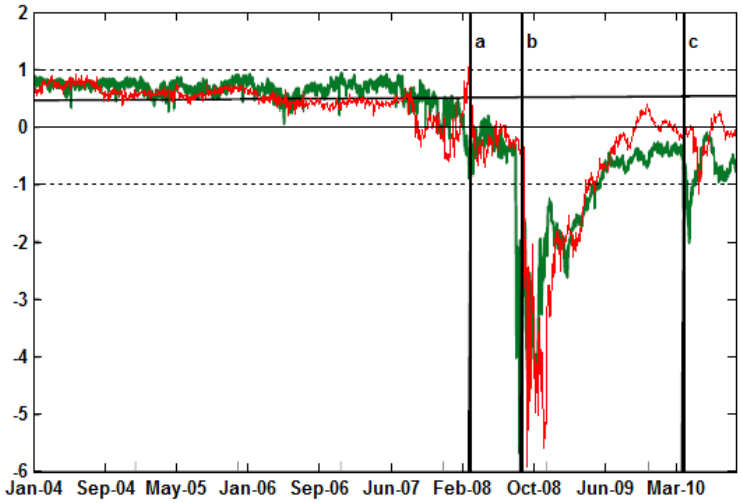
Severo, T. 2012. *Measuring Systemic Liquidity Risk and the Cost of Liquidity Insurance*, IMF WP/12/194.

Vayanos, D. and P. Weill, 2008. A search-based theory of the on-the-run phenomenon. *Journal of Finance* 63: 1361–1398.

Figures

Figure 1. Parsimonious and Severo's SLRI.

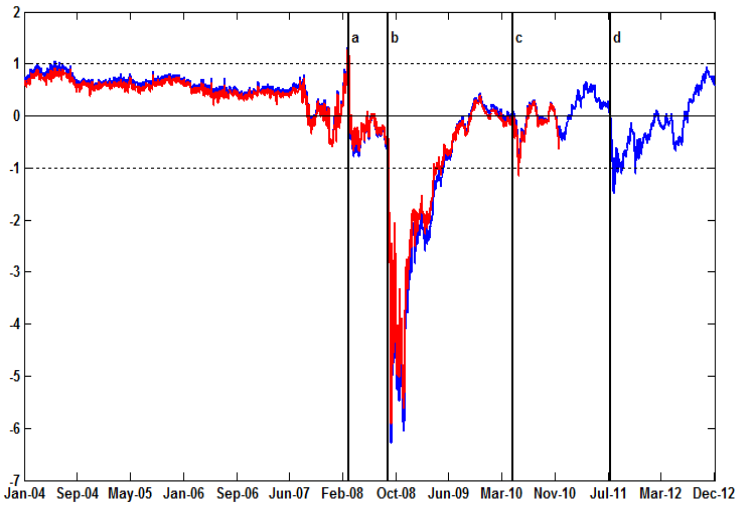
01/01/2004 – 31/10/2010 (1804 obs); on the *y*-axis: standard deviations



Sources: (red) own estimates and (green) Severo (2012).

Figure 2. Full sample parsimonious SLRI

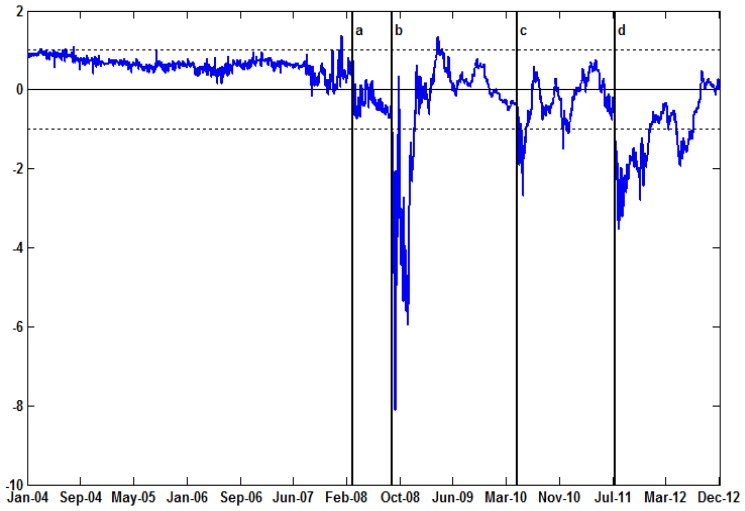
01/01/2004 – 05/12/2012 (2330 obs)



Source: own estimates; full sample (blue), reduced sample (red)

Figure 3. Parsimonious SLRI excluding CDS-Bond bases

01/01/2004 – 05/12/2012 (2330 obs)



Source: own estimates.

Tables

Table 1. Baseline specification (01/01/2004 – 31/10/2010; 1804 obs)

Bank	β_1^i	β_2^i	ω_1^i
National Australia Bank	0.923***	-0.077	-0.744***
Commonwealth Bank Australia	0.976***	-0.066	-0.681***
Erste Group Bank	1.669***	0.030	-0.884***
Dexia	1.454***	0.184**	-1.216***
KBC Group	1.505***	0.038	-1.354***
BNP Paribas	1.658***	0.021	-0.963***
Société Générale	1.764***	0.064	-0.905***
Crédit Agricole	1.720***	0.097	-0.795***
Deutsche Bank	1.694***	-0.029	-0.897***
Commerzbank	1.739***	0.091	-0.897***
National Bank of Greece	1.477***	0.040	-0.622***
Alpha Bank	1.292***	0.090	-0.546***
Bank of Piraeus	1.326***	0.124	-0.572***
Unicredit	1.532***	0.047	-0.923***
Intesa Sanpaolo	1.401***	0.084	-0.692***
Banco Commmercial Portugues	1.047***	0.105*	-0.452***
Banco Espirito Santo	0.893***	0.064	-0.878***
Banco Santander	1.539***	-0.004	-0.736***
BBV Argentaria	1.524***	0.034	-0.756***
Banco Popular Español	1.349***	0.069	-0.764***
UBS	1.529***	0.023	-1.008***
Credit Suisse Group	1.521***	0.018	-0.789***
Nordea Bank	1.560***	0.017	-0.841***
Svenska Handbkn	1.376***	-0.040	-0.821***
Swedbank	1.668***	-0.003	-0.997***
DNB Nor	1.414***	0.028	-0.944***
Danske Bank	1.240***	-0.020	-0.814***
State Bank Of India	0.822***	0.020	-0.297***
Mizuho Financial Group	0.578***	0.128	-0.548***
Sumitomo Mitsui Fin Group	0.541***	0.076	-0.606***
Mitsubishi UFJ Fin Group	0.578***	0.015	-0.451***
Shinhan Financial Group	0.880***	0.042	-0.605***
Australia & New Zealand Bank	0.950***	-0.108	-0.777***
HSBC Holding	1.061***	0.014	-1.064***
Barclays	1.527***	0.049	-1.391***
Royal Bank of Scotland Group	1.436***	0.107	-1.640***
Lloyds Banking Group	1.352***	0.075	-1.533***
Standard Chartered	1.579***	-0.026	-0.842***
Bank of America	1.075***	0.205**	-1.831***
JP Morgan Chase & Co	1.239***	0.046	-1.328***
Citigroup	1.364***	-0.147	-1.611***
Wells Fargo & Co	1.100***	-0.135	-1.567***
Morgan Stanley.	1.565***	0.061	-1.160***
Goldman Sachs Group	1.358***	-0.054	-0.853***
US Bancorp	1.012***	-0.057	-1.388***
PNC Financial Services Group	1.032***	0.069	-1.448***
SunTrust Banks	1.162***	-0.068	-1.611***
BB&T	0.992***	0.025	-1.262***
Regions Bank	1.184***	0.096	-1.510***
Bank of New York Mellon	1.231***	0.009	-0.995***
State Street	1.357***	-0.142	-1.553***

Notes: *** 99%, **95%, *90% p-values. In Tables (2-5) 2010 short for 31/10/2010.

Table 2. Baseline specification with one-day lagged SLRI (02/01/2004 – 31/10/2010; 1803 obs)

Bank	β_1^i	β_2^i	ω_1^i
National Australia Bank	0.926***	-0.075	-0.743***
Commonwealth Bank Australia	0.987***	-0.095	-0.693***
Erste Group Bank	1.675***	0.035	-0.874***
Dexia	1.469***	0.142	-1.237***
KBC Group	1.521***	0.000	-1.333***
BNP Paribas	1.655***	0.008	-0.980***
Société Générale	1.777***	0.022	-0.910***
Crédit Agricole	1.725***	0.101	-0.785***
Deutsche Bank	1.706***	-0.009	-0.902***
Commerzbank	1.741***	0.106	-0.903***
National Bank of Greece	1.470***	0.034	-0.620***
Alpha Bank	1.277***	0.064	-0.548***
Bank of Piraeus	1.312***	0.101	-0.575***
Unicredit	1.531***	0.047	-0.924***
Intesa Sanpaolo	1.393***	0.054	-0.703***
Banco Commmercial Portugues	1.032***	0.102	-0.456***
Banco Espirito Santo	0.881***	0.035	-0.893***
Banco Santander	1.532***	-0.022	-0.761***
BBV Argentaria	1.515***	0.030	-0.776***
Banco Popular Español	1.341***	0.062	-0.771***
UBS	1.522***	0.087	-1.027***
Credit Suisse Group	1.527***	0.022	-0.768***
Nordea Bank	1.557***	0.013	-0.843***
Svenska Handbkn	1.386***	-0.037	-0.824***
Swedbank	1.670***	-0.023	-0.999***
DNB Nor	1.419***	-0.020	-0.937***
Danske Bank	1.249***	-0.016	-0.815***
State Bank Of India	0.824***	0.033	-0.292***
Mizuho Financial Group	0.588***	0.145	-0.563***
Sumitomo Mitsui Fin Group	0.553***	0.097	-0.615***
Mitsubishi UFJ Fin Group	0.586***	0.023	-0.454***
Shinhan Financial Group	0.869***	0.063	-0.614***
Australia & New Zealand Bank	0.967***	-0.081	-0.782***
HSBC Holding	1.053***	0.051	-1.059***
Barclays	1.537***	0.013	-1.367***
Royal Bank of Scotland Group	1.488***	0.005	-1.633***
Lloyds Banking Group	1.399***	0.001	-1.524***
Standard Chartered	1.584***	-0.025	-0.829***
Bank of America	1.036***	0.189**	-1.852***
JP Morgan Chase & Co	1.196***	0.050	-1.278***
Citigroup	1.321***	0.006	-1.670***
Wells Fargo & Co	1.084***	-0.241***	-1.591***
Morgan Stanley	1.542***	0.109	-1.144***
Goldman Sachs Group	1.364***	-0.006	-0.831***
US Bancorp	1.032***	-0.025	-1.335***
PNC Financial Services Group	1.023***	0.139	-1.360***
SunTrust Banks	1.189***	-0.088	-1.592***
BB&T	0.957***	0.059	-1.278***
Regions Bank	1.019***	0.432***	-1.549***
Bank of New York Mellon	1.213***	0.102	-0.999***
State Street	1.358***	-0.109	-1.551***

Notes: *** 99%, **95%, *90% p-values. β_2^i and ω_1^i refer to $SLRI_{t-1.}$

Table 3. Baseline specification augmented for individual CDS (2004 – 2010)

Bank	β_1^i	β_2^i	β_{CDS}^i	ω_1^i	ω_{CDS}^i	**obs**
National Australia Bank	0.896***	-0.253**	-0.0035**	-0.265***	0.014***	1804
Commonwealth Bank Australia	0.936***	-0.085	-0.0012	-0.269***	0.013***	1804
Erste Group Bank	1.589***	0.217*	0.0014	-0.548***	0.005***	1804
Dexia	1.357***	0.087	-0.0006	-0.517***	0.007***	1804
KBC Group	1.444***	0.206	0.0012	-0.399***	0.012***	1804
BNP Paribas	1.599***	0.060	0.0008	-0.730***	0.011***	1804
Crédit Agricole	1.613***	0.067	0.0001	-0.544***	0.011***	1804
Deutsche Bank	1.671***	-0.097	-0.0013	-0.545***	0.010***	1804
Commerzbank	1.748***	0.079	-0.0008	-0.683***	0.009***	1804
Unicredit	1.397***	-0.003	-0.0010	-0.569***	0.009***	1804
Intesa Sanpaolo	1.291***	0.024	-0.0010	-0.457***	0.009***	1804
Banco Santander	1.445***	-0.035	-0.0005	-0.386***	0.011***	1804
BBV Argentaria	1.438***	-0.014	-0.0007	-0.483***	0.009***	1804
Banco Popular Español	1.206***	0.079	-0.0003	-0.307***	0.006***	1804
UBS	1.397***	0.090	-0.0002	-0.218***	0.014***	1804
Credit Suisse Group	1.496***	-0.076	-0.0014	-0.474***	0.009***	1804
Nordea Bank	1.480***	0.033	0.0002	-0.305***	0.015***	1804
Svenska Handbkn	1.343***	-0.021	0.0001	-0.345***	0.015***	1804
Swedbank	1.610***	0.223**	0.0022*	-0.429***	0.007***	1804
DNB Nor	1.844***	0.119	0.0038	-0.405***	0.018***	718
Danske Bank	1.189***	0.116	0.0016	-0.261***	0.013***	1804
Mizuho Financial Group	0.588***	0.092	-0.0008	-0.401***	0.006***	1804
Sumitomo Mitsui Fin Group	0.568***	0.111	0.0010	-0.385***	0.009***	1761
Mitsubishi UFJ Financial Group	0.587***	0.046	0.0008	-0.300***	0.006***	1761
Australia &New Zealand Banking	0.927***	-0.183*	-0.0021	-0.384***	0.012***	1804
HSBC Holding	0.982***	0.145**	0.0022**	-0.485***	0.017***	1804
Barclays	1.464***	0.151	0.0003	-0.452***	0.016***	1804
Royal Bank of Scotland Group	1.331***	0.096	-0.0003	-1.219***	0.010***	1804
Lloyds Banking Group	1.275***	0.211	0.0010	-1.005***	0.012***	1804
Standard Chartered	1.674***	0.066	0.0011	-0.553***	0.005***	1447
Bank of America	0.953***	0.291***	0.0009	-0.582***	0.018***	1804
JP Morgan Chase & Co	1.196***	0.079	0.0007	-0.323***	0.023***	1804
Citigroup	1.210***	0.104	-0.0003	-0.620***	0.009***	1804
Wells Fargo & Co	0.898***	0.260**	0.0027*	-0.296***	0.024***	1804
Goldman Sachs Group	1.338***	-0.231*	-0.0021*	-0.106	0.009***	1804
PNC Financial Services Group	1.388***	0.301	-0.0021	-0.820***	0.004***	718

Notes: *** 99%, **95%, *90% p-values.

Table 4. Variance equation augmented for average CDS and VIX (2004 – 2010)

Bank	ω_1^i	$\omega_{logAVCDS}^i$	ω_{logVIX}^i
National Australia Bank	-0.102*	0.181***	1.641***
Commonwealth Bank Australia	0.025	0.081	2.019***
Erste Group Bank	-0.156**	-0.041	1.941***
Dexia	-0.288***	0.437***	1.744***
KBC Group	-0.218***	0.362***	1.940***
BNP Paribas	-0.244***	0.001	1.935***
Société Générale	-0.110*	0.198***	1.897***
Crédit Agricole	-0.267***	0.378***	0.764***
Deutsche Bank	-0.162***	0.133**	1.724***
Commerzbank	-0.324***	0.024	1.493***
National Bank of Greece	-0.102*	0.541***	0.462**
Alpha Bank	-0.105	0.780***	-0.235
Bank of Piraeus	-0.083	0.725***	0.082
Unicredit	-0.328***	0.217***	1.220***
Intesa Sanpaolo	-0.218***	0.090	1.074***
Banco Commmercial Portugues	0.172***	0.118*	1.603***
Banco Espirito Santo	-0.222***	0.740***	0.306
Banco Santander	0.042	0.259***	1.635***
BBV Argentaria	-0.117*	0.318***	1.148***
Banco Popular Español	-0.010	0.666***	0.881***
UBS	-0.181***	0.391***	1.496***
Credit Suisse Group	-0.251***	0.051	1.503***
Nordea Bank	-0.219***	-0.078	1.781***
Svenska Handbkn	-0.276***	-0.151**	1.682***
Swedbank	-0.230***	0.123*	1.631***
DNB Nor	-0.235***	-0.127*	2.005***
Danske Bank	-0.147**	0.292***	1.250***
State Bank Of India	0.065	-0.302***	1.653***
Mizuho Financial Group	0.109*	-0.127*	2.265***
Sumitomo Mitsui Fin Group	-0.096	-0.168**	1.789***
Mitsubishi UFJ Fin Group	0.060	-0.320***	2.121***
Shinhan Financial Group	-0.080	-0.348***	2.139***
Australia & New Zealand Bank	-0.075	0.053	1.956***
HSBC Holding	-0.058	0.346**	2.001***
Barclays	-0.164**	0.084	2.758***
Royal Bank of Scotland Group	-0.358***	0.444***	2.207***
Lloyds Banking Group	-0.425***	0.586***	1.471***
Standard Chartered	-0.292***	-0.020	1.537***
Bank of America	-0.339***	0.771***	1.915***
JP Morgan Chase & Co	-0.231***	0.243***	2.282***
Citigroup	-0.423***	0.660***	1.751***
Wells Fargo & Co	-0.081	0.509***	2.627***
Morgan Stanley	-0.340***	0.077	2.052***
Goldman Sachs Group	-0.245***	0.194***	1.253***
US Bancorp	-0.009	0.463***	2.291***
PNC Financial Services Group	-0.118	0.295***	2.472***
SunTrust Banks	-0.139**	0.681***	2.104***
BB&T	-0.038	0.540***	2.054***
Regions Bank	-0.210***	0.589***	2.203***
Bank of New York Mellon	-0.463***	0.106	1.309***
State Street	-0.465***	-0.085	2.481***

Notes: *** 99%, **95%, *90% p-values.

Table 5 Variance equation augmented for individual CDS and logs of average CDS and VIX (2004 – 2010)

Bank	ω_1^i	ω_{CDS}^i	$\omega_{logAVCDS}^i$	ω_{logVIX}^i	**obs**
National Australia Bank	-0.049	0.006**	-0.009	1.590***	1804
Commonwealth Bank Australia	0.044	0.003	-0.051	2.003***	1804
Erste Group Bank	-0.097	0.003***	-0.258***	1.938***	1804
Dexia	-0.088	0.005***	-0.059	2.000***	1804
KBC Group	-0.094	0.009***	-0.056	1.469***	1804
BNP Paribas	-0.260***	0.004	-0.152	1.962***	1804
Société Générale	-0.133**	0.009**	-0.205	1.935***	1804
Crédit Agricole	-0.279***	0.003	0.217	0.834***	1804
Deutsche Bank	-0.239***	-0.012**	0.600***	1.752***	1804
Commerzbank	-0.346***	0.004	-0.121	1.462***	1804
Unicredit	-0.329***	0.007***	-0.137	1.166***	1804
Intesa Sanpaolo	-0.244***	0.011***	-0.330***	1.057***	1804
Banco Santander	0.040	0.012***	-0.471***	2.030***	1804
BBV Argentaria	-0.146**	0.008***	-0.287**	1.505***	1804
Banco Popular Español	0.070	0.002***	0.339***	1.224***	1804
UBS	0.007	0.011***	-0.081	1.270***	1804
Credit Suisse Group	-0.239***	0.004**	-0.083	1.330***	1804
Nordea Bank	0.047	0.019***	-0.579***	1.805***	1804
Svenska Handbkn	-0.010	0.021***	-0.599***	1.563***	1804
Swedbank	-0.026	0.006***	-0.160**	1.694***	1804
DNB Nor	0.164	0.019***	-1.415***	2.720***	718
Danske Bank	-0.070	0.004**	0.159*	1.213***	1804
Mizuho Financial Group	0.103	-0.001	-0.104	2.258***	1804
Sumitomo Mitsui Fin Group	-0.082	0.002	-0.162	1.655***	1761
Mitsubishi UFJ Financial Group	0.072	0.002	-0.328***	2.047***	1761
Australia&NewZeland Banking	-0.046	0.004	-0.093	1.951***	1804
HSBC Holding	0.082	0.010***	-0.038	2.222***	1804
Barclays	0.067	0.015***	-0.560***	2.538***	1804
Royal Bank of Scotland Group	-0.434***	-0.008***	0.997***	1.913***	1804
Lloyds Banking Group	-0.421***	0.001	0.519***	1.513***	1804
Standard Chartered	-0.210***	0.002	-0.162**	1.649***	1447
Bank of America	-0.204***	0.011***	0.136	1.800***	1804
JP Morgan Chase & Co,	-0.028	0.022***	-0.369***	1.708***	1804
Citigroup	-0.284***	0.004***	0.358***	1.601***	1804
Wells Fargo & Co	0.107*	0.017***	-0.127	2.121***	1804
Goldman Sachs Group	-0.003	0.006***	-0.026	1.040***	1804
PNC Financial Services Group	0.110	0.003***	-0.210	3.183***	718

Notes: *** 99%, **95%, *90% p-values.

Table 6. Baseline specification (01/01/2010 – 05/12/2012: obs 764)

Bank	β_1^i		β_2^i		ω_1^i	
National Australia Bank	0.954	***	0.047		-0.862	***
Erste Group Bank	2.051	***	0.495	***	-1.199	***
Dexia	2.087	***	-0.038		-0.750	***
KBC Group	2.409	***	0.388		-0.911	***
BNP Paribas	2.340	***	0.303	*	-1.327	***
Société Générale	2.636	***	0.375	*	-1.078	***
Crédit Agricole	2.492	***	0.357	*	-0.765	***
Deutsche Bank	2.136	***	0.300	**	-0.846	***
Commerzbank	2.129	***	0.146		-0.605	***
National Bank of Greece	1.805	***	0.280		-0.342	**
Alpha Bank	1.810	***	0.529		-0.404	***
Bank of Piraeus	1.512	***	0.191		-0.122	
Unicredit	2.409	***	0.356		-0.898	***
Intesa Sanpaolo	2.506	***	0.115		-0.665	***
Banco Commmercial Portugues	1.507	***	0.576	***	-0.460	***
Banco Espirito Santo	1.682	***	0.404	*	-0.971	***
Banco Santander	2.043	***	0.100		-0.580	***
BBV Argentaria	2.123	***	0.097		-0.529	***
Banco Popular Español	1.711	***	-0.098		0.107	
UBS	1.599	***	0.327	**	-0.625	***
Credit Suisse Group	1.653	***	0.279	*	-0.843	***
Nordea Bank	1.815	***	-0.080		-0.596	***
Svenska Handbkn	1.524	***	-0.087		-0.536	***
Swedbank	1.889	***	0.021		-0.683	***
DNB Nor	1.777	***	0.143		-0.555	***
Danske Bank	1.550	***	0.017		-0.528	***
State Bank Of India	0.677	***	0.044		-0.312	**
Mizuho Financial Group	0.288	***	-0.065		0.238	*
Sumitomo Mitsui Fin Group	0.327	***	-0.027		0.018	
Mitsubishi UFJ Fin Group	0.351	***	-0.003		-0.113	
Shinhan Financial Group	0.704	***	0.026		-0.878	***
Australia & New Zealand Bank	1.038	***	-0.092		-0.866	***
HSBC Holding	1.224	***	0.090		-0.624	***
Barclays	2.213	***	0.168		-0.917	***
Royal Bank of Scotland Group	1.958	***	0.231		-0.971	***
Lloyds Banking Group	1.948	***	0.203		-0.624	***
Standard Chartered	1.433	***	0.000		-0.637	***
Bank of America	1.493	***	-0.100		-1.241	***
JP Morgan Chase & Co	1.312	***	-0.031		-1.080	***
Citigroup	1.666	***	0.034		-0.779	***
Wells Fargo & Co	1.292	***	-0.170		-0.456	***
Morgan Stanley	1.514	***	0.055		-1.340	***
Goldman Sachs Group	1.107	***	0.076		-0.740	***
US Bancorp	1.069	***	-0.150		-0.871	***
PNC Financial Services Group	1.153	***	-0.166		-0.522	***
SunTrust Banks	1.590	***	-0.072		-0.775	***
BB&T	1.127	***	-0.230	*	-0.465	***
Regions Bank	1.732	***	-0.158		-0.668	***
Bank of New York Mellon	1.239	***	-0.009		-0.573	***
State Street	1.223	***	0.087		-0.761	***

Notes: *** 99%, **95%, *90% p-values.

Table 7. Baseline specification with lagged SLRI (2010 – 2012; obs. 763)

Bank	β_1^i	β_2^i	ω_1^i
National Australia Bank	0.952***	0.051	-0.871***
Erste Group Bank	2.050***	0.503***	-1.161***
Dexia	2.093***	-0.026	-0.802***
KBC Group	2.395***	0.418*	-0.910***
BNP Paribas	2.298***	0.389**	-1.311***
Société Générale	2.627***	0.425**	-1.131***
Crédit Agricole	2.478***	0.408**	-0.776***
Deutsche Bank	2.137***	0.319**	-0.862***
Commerzbank	2.135***	0.151	-0.638***
National Bank of Greece	1.809***	0.260	-0.421***
Alpha Bank	1.820***	0.590	-0.456***
Bank of Piraeus	1.544***	0.120	-0.242
Unicredit	2.403***	0.410*	-0.910***
Intesa Sanpaolo	2.504***	0.136	-0.714***
Banco Commmercial Portugues	1.510***	0.541***	-0.525***
Banco Espirito Santo	1.666***	0.358	-0.988***
Banco Santander	2.029***	0.116	-0.616***
BBV Argentaria	2.108***	0.110	-0.557***
Banco Popular Español	1.713***	-0.084	0.051
UBS	1.594***	0.332**	-0.639***
Credit Suisse Group	1.638***	0.329**	-0.849***
Nordea Bank	1.805***	-0.063	-0.605***
Svenska Handbkn	1.517***	-0.088	-0.575***
Swedbank	1.880***	0.017	-0.711***
DNB Nor	1.773***	0.142	-0.620***
Danske Bank	1.538***	-0.049	-0.519***
State Bank Of India	0.676***	0.072	-0.271**
Mizuho Financial Group	0.290***	-0.082	0.162
Sumitomo Mitsui Fin Group	0.328***	-0.055	-0.033
Mitsubishi UFJ Fin Group	0.353***	-0.013	-0.174
Shinhan Financial Group	0.701***	0.035	-0.873***
Australia & New Zealand Bank	1.035***	-0.075	-0.878***
HSBC Holding	1.221***	0.090	-0.639***
Barclays	2.198***	0.217	-0.918***
Royal Bank of Scotland Group	1.932***	0.263	-0.985***
Lloyds Banking Group	1.938***	0.208	-0.537***
Standard Chartered	1.424***	-0.007	-0.697***
Bank of America	1.495***	-0.100	-1.231***
JP Morgan Chase & Co	1.318***	-0.021	-1.052***
Citigroup	1.683***	0.041	-0.732***
Wells Fargo & Co	1.292***	-0.160	-0.408***
Morgan Stanley	1.528***	0.081	-1.323***
Goldman Sachs Group	1.110***	0.094	-0.745***
US Bancorp	1.072***	-0.146	-0.772***
PNC Financial Services Group	1.153***	-0.181	-0.498***
SunTrust Banks	1.604***	-0.071	-0.690***
BB&T	1.133***	-0.233*	-0.369***
Regions Bank	1.738***	-0.164	-0.610***
Bank of New York Mellon	1.243***	-0.005	-0.548***
State Street	1.228***	0.093	-0.751***

Notes: *** 99%, **95%, *90% p-values. β_2^i and ω_1^i refer to $SLRI_{t-1.}$

Table 8. Variance equation augmented for logs of individual and average CDS and VIX (2010 – 2012)

Bank	ω_1^i	ω_{logCDS}^i	$\omega_{logAVCDS}^i$	ω_{logVIX}^i	**obs**
Commonwealth Bank Australia	0.245	-0.054	-0.472	2.644***	764
Erste Group Bank	-0.018	1.872***	-0.500	1.001***	764
Dexia	0.294	2.762***	-1.067*	1.153***	764
KBC Group	0.024	1.270**	0.042	1.201***	764
BNP Paribas	0.261	0.119	1.058	2.433***	764
Société Générale	-0.088	0.794	0.021	1.177***	764
Crédit Agricole	0.290	0.067	1.081**	1.331***	764
Deutsche Bank	0.087	-0.332	1.067***	1.293***	764
Commerzbank	0.523**	-0.983**	2.637***	0.783**	764
National Bank of Greece	0.348*	0.935*	0.122	0.976***	764
Alpha Bank	0.041	0.074	1.410	-0.185	764
Bank of Piraeus	1.725***	0.608	-1.010	-0.184	195
Unicredit	-0.230	0.589	0.721	0.564*	764
Intesa Sanpaolo	0.263	0.842	-0.041	1.351***	764
Banco Commmercial Portugues	0.519*	0.023	1.715***	0.442	764
Banco Espirito Santo	-0.110	0.124	1.651***	-0.173	764
Banco Santander	-0.100	2.659***	-2.412***	1.977***	764
BBV Argentaria	-0.090	1.705***	-1.252***	1.299***	764
Banco Popular Español	0.538**	1.320***	-0.932*	0.763***	764
UBS	0.075	-0.272	0.343	1.607***	764
Credit Suisse Group	-0.252	-0.142	0.751**	0.656**	764
Nordea Bank	0.277	0.934*	-0.579	1.513***	764
Svenska Handbkn	0.192	0.227	0.240	1.195***	764
Swedbank	0.183	0.080	-0.050	1.869***	764
DNB Nor	0.255	0.252	0.319	1.517***	764
Danske Bank	0.291	0.297	-0.202	1.671***	764
State Bank Of India	0.109	-0.872*	1.396***	0.338	764
Mizuho Financial Group	0.124	-0.007	-0.521**	0.310	764
Mitsubishi UFJ Financial Group	0.092	-0.300	-0.916**	0.655	195
Shinhan Financial Group	0.167	1.140***	-0.234	1.335***	764
Australia & New Zealand Banking	0.070	0.515	-0.763**	2.150***	764
HSBC Holding	-0.243	2.352***	-1.379***	0.822***	764
Barclays	-0.181	-0.349	0.802*	1.015***	764
Royal Bank of Scotland Group	-1.042***	-1.621*	0.869	0.604*	764
Lloyds Banking Group	0.024	-0.268	0.542	1.307***	764
Standard Chartered	-0.043	0.816	-0.811	1.366***	764
Bank of America	-0.450	1.355**	-0.647	0.397	764
JP Morgan Chase & Co	-0.545***	1.228**	-0.341	0.543	764
Citigroup	-0.484**	0.431	-0.295	0.528*	764
Wells Fargo & Co	-0.145	0.896**	-1.219***	1.034***	764
Morgan Stanley	-0.209	0.313	0.432	1.485***	764
Goldman Sachs Group	-0.334*	1.958***	-2.096***	0.841***	764
US Bancorp	0.201	0.864**	0.034	1.809***	195
PNC Financial Services Group	-0.227	0.208	-0.887***	1.404***	764

Notes: *** 99%, **95%, *90% p-values.

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