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MEASURING CONTAGION POTENTIAL AMONG SOVEREIGNS AND BANKS USING A MIXED-CROSS-SECTION GVAR

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Abstract

This paper aims to illustrate how a Mixed-Cross-Section Global Vector Autoregressive (MCS-GVAR) model can be set up and solved for the purpose of forecasting and scenario simulation. The application involves two cross-sections: sovereigns and banks for which we model their credit default swap spreads. Our MCS-GVAR comprises 23 sovereigns and 41 international banks from Europe, the US and Japan. The model is used to conduct systematic shock simulations and thereby compute a measure of *spill-over potential* for within and across the group of sovereigns and banks. The results point to a number of salient facts: i) Spill-over potential in the CDS market was particularly pronounced in 2008 and more recently in 2011-12; ii) while in 2008 contagion primarily went from banks to sovereigns, the direction reversed in 2011-12 in the course of the sovereign debt crisis; iii) the index of spill-over potential suggests that the system of banks and sovereigns has become more densely connected over time. Should large shocks of size similar to those experienced in the early phase of the crisis hit the system in 2011/2012, considerably more pronounced and more synchronized adverse responses across banks and sovereigns would have to be expected.

Keywords: Macro-financial linkages, global macroeconometric modeling, models with panel data, forecasting and simulation, contagion, spill-overs, network analysis

JEL classification: C33, C53, C61, E17

Non-technical summary

Global Vector Autoregressive (GVAR) models have become increasingly prominent for applied macroeconomic research as well as for practitioners in central banks and other policy institutions where they are employed for scenario simulation and forecasting. While virtually all so far existing GVAR applications operate with countries in their cross-section dimension, the present paper aims to set up a GVAR for two combined cross-sections, namely countries and banks, for the specific application to model credit default risk for sovereigns and financial institutions. Our model comprises 23 sovereigns and 41 international banks from Europe, the US and Japan.

The relevance of developing model tools that allow for endogenous feedback between banks and sovereigns has increased substantially in the course of the global financial crisis from 2007-9, in particular in light of the euro area sovereign debt crisis that erupted in 2010 and which triggered severe spill-over effects between banks and sovereigns. A multitude of mechanisms create channels of contagion between banks and sovereigns, for instance via government guarantees on bank liabilities and large-scale bank capital injections that burden the fiscal position of sovereigns or via banks' exposure to sovereign debt that is no longer perceived as riskless. The MCS-GVAR is a model framework that allows capturing such endogenous feedback loops between banks and sovereigns (in either direction), as well as within cross-sections.

For operating a GVAR with cross-sections other than countries, despite some general ideas of how weights that are needed to estimate and solve the global model could in principle be constructed from data, the weight matrices for banks to banks, banks to sovereigns, sovereigns to sovereigns, and sovereigns to banks will instead be estimated along with the MCS-GVAR's other parameters; following the approach set out in [21].

Systematic shock simulations based on the global model for banks and sovereigns help identify and rank the banks and sovereigns that are most vulnerable to shocks arising elsewhere in the system, respectively those who are influential in exerting most widespread and intense responses when being shocked themselves. Moreover, we propose to construct an index that summarizes the *spill-over potential* within, across, and in total for the group of sovereigns and banks. Re-estimating and re-simulating the global model in a recursive fashion over time allows generating a time series of the spill-over indices.

The time-varying spill-over index suggests that the extent to which banks and sovereigns are connected (through direct and indirect channels) is roughly comparable in the early phase of the financial crisis (2008) when shocks hit the financial system and the later phase (2011-12) when rather the sovereigns were the source of market turbulence. Through the intermediate period between 2009H1 and 2011H1, spill-over potential has been measured to be relatively contained. The sizes of shocks that perturbed markets on average have been found to have fallen steadily over the period from 2008-2012. To take account of that finding, a variant of the spill-over index that uses normalized shock sizes instead of time-varying ones reveals that spill-over potential toward the end of the sample (2011-12) is considerably higher compared to 2008. Hence, if unexpected large shocks of size equal to those seen in the early phase of the financial crisis would have materialized in 2011-12, considerably more adverse and synchronized responses would be expected.

1 Introduction

The financial crisis erupting in 2007 and the ensuing euro area sovereign debt crisis amply illustrated the potential for contagion from vulnerable banks to other banks and from distressed sovereigns to other sovereigns. Recent events also highlighted the potential for adverse feedback loops between sovereigns and banks to arise; in particular as the former had to inject substantial amounts of capital into banks, thereby worsening its fiscal position, while banks in turn suffered from the deteriorating values of their sovereign bond holdings as well as higher funding costs. This experience points to the importance of developing analytical tools that can capture such dynamics and allow for identifying and assessing interdependencies and possible shock propagation channels across banks and sovereigns.

The empirical literature on financial contagion is rich on studies analyzing interdependencies between entities within closed networks (e.g. between banks in the same market), whereas studies exploring contagion across different cross-sections are more scarce.[1] Furthermore, the academic literature on financial contagion has largely been divided along two different strands: one area of research has focused on capturing contagion using financial market data.[2] A second strand has focused instead on balance sheet exposure data (such as interbank exposures and bank capital) with the aim of conducting counterfactual simulations of the potential effects on the network of exposures if one or more financial institutions are assumed to encounter problems.[3] Useful references as an entry point to the literature related to 'systemic risk' more generally are [10] and [9].

The modeling approach taken in this paper attempts to bridge across these different strands of the literature by first of all allowing for exploring interdependencies across different types of cross-sections (in this case between individual banks and sovereigns). Moreover, while not pursued in the applications presented in this paper, the model allows for combining market data and balance sheet data when studying shock propagation across banks and countries.

The Global Vector Autoregressive (GVAR) model methodology which lies at the

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[1] See e.g. [27], and [2].

[2] For some recent examples see e.g. [28], [24], [25], [20], [32], [6], [14], [37], [13] and [1].

[3] Some recent examples include [15], [35], [4], [36], [34], [12], [18], [16], [29] and [22].

heart of the model set up in this paper has gained widespread interest in recent years (see e.g. [30], [31], and [11] for initial methodological and empirical contributions). Interlinkages between countries can be modeled by combining a set of country-specific VARs that contain weighted foreign variable vectors. The approach allows modeling simultaneously a large number of cross-section items, while also accommodating a broad set of economic variables in one model, which if modeled in an otherwise unrestricted conventional VAR would be unfeasible to be estimated due to a too high number of parameters. Empirical applications of GVARs are meanwhile quite numerous.[4]

From a methodological viewpoint, the present paper aims to advance the GVAR methodology by illustrating how it can be set up for two, or in principle more, cross-sections. It is a framework to which we refer as a *Mixed-Cross-Section* (*MCS*-GVAR). The model for the individual items in the cross-sections is set up in a way to allow for endogenous interaction between the model variables both *within* and *across* cross-sections. As in the traditional GVAR framework, also in the combined cross-section version presented here the weights for constructing weighted foreign variable vectors determine the model structure. Operating with more than one cross-section necessitates a different strategy to solving the global model.

We employ the MCS-GVAR to model CDS market dynamics, comprising a sample of 23 sovereigns and 41 international banks from Europe, the US and Japan and covering the period from 2008-2013. The model allows us analyzing the spill-over potential in the CDS market for banks and sovereigns over a sample that covers in particular two exceptional episodes of distress: the global financial crisis in its most intense phase during 2008 as well as the more recent euro area sovereign debt crisis that erupted in 2010.

We find evidence of notable spill-over potential in the CDS market during this period. Not surprisingly the most pronounced cross-sectional CDS spread contagion is observed during the second half of 2008, around the time of Lehman Brothers' default, and again in late 2011 and early 2012 when the euro area sovereign debt crisis intensified. It is furthermore notable that the spill-over potential from banks to sovereigns was relatively stronger in 2008, possibly reflecting the substantial government measures at the time to support the domestic banking sectors (e.g. capital injections, government guarantee bond programmes, enhanced deposit insurance) that in turn adversely

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[4] Recent applications are e.g. [17], [7], [8], [5], [3], and [19].

affected the fiscal position of the sovereign. The sovereign-to-bank spill-overs were in turn relatively stronger in 2011 and 2012 at the height of the euro area sovereign debt crisis, when doubts arose about the debt sustainability of several euro area sovereigns.

Another notable observation is that shock sizes hitting the bank and sovereign CDS spreads vary over time. Specifically, shock sizes appear to have had a steady downward trend over the sample period that we base our model upon. The results, furthermore, suggest that if shocks of sizes equal to those experienced in the early phase of the financial crisis would have hit the sovereigns or banks in 2011 and 2012, responses across markets would have been expected to be considerably more pronounced compared to those measured in 2008. According to the estimates, the bank and sovereign sphere have become more densely connected, both within and across the two cross-sections. This finding is corroborated by network centrality measures that are based on the same systematic shock simulation that we conduct to compute the measure of spill-over potential.

The findings from our analysis point to the importance of taking a systemic (and macro-prudential) perspective to banking stability and of aiming to break the sovereign-bank link that has haunted euro area economies in recent years. Recent EU initiatives, such as the introduction of a single supervisory mechanism, the establishment of a common resolution authority and allowing the European Stability Mechanism to take direct stakes in euro area banks, among other things, all aim at weakening the adverse bank-sovereign feedback loop and at imposing a more systemic perspective to bank supervision, which should help reducing the pronounced contagion potential observed in recent years.

2 Model setting

2.1 Local models

Two cross-sections $i = 1, ..., N$ and $j = 1, ..., M$ will in the following be considered for illustrating how the local models of an MCS-GVAR can be designed. A $k_i \times 1$ vector $\mathbf{x}_{it}$ and a $g_i \times 1$ vector $\mathbf{y}_{jt}$ comprise the respective endogenous model variables for the two cross-sections. If N is thought of as a country dimension, the $\mathbf{x}_{it}$ may comprise macroeconomic or financial variables at country level; if M is thought e.g. as a bank cross-section, the $\mathbf{y}_{jt}$ may contain selected bank-specific variables such as balance sheet items, measures of credit risk, stock prices, etc.

$$\mathbf{x}_{it} = \mathbf{a}_i + \sum_{p_1=1}^{P_1} \mathbf{\Phi}_{ip_1} \mathbf{x}_{i,t-p_1} + \sum_{p_2=0}^{P_2} \mathbf{\Lambda}_{i,0,p_2} \mathbf{x}^{*NN}_{i,t-p_2} + \sum_{p_3=0}^{P_3} \mathbf{\Lambda}_{i,1,p_3} \mathbf{y}^{*NM}_{i,t-p_3} + \mathbf{\Theta}_i \mathbf{v}_t + \epsilon_{it} \tag{1}$$

$$\mathbf{y}_{jt} = \mathbf{b}_j + \sum_{q_1=1}^{Q_1} \mathbf{\Pi}_{jq_1} \mathbf{y}_{j,t-q_1} + \sum_{q_2=0}^{Q_2} \mathbf{\Xi}_{j,0,q_2} \mathbf{y}^{*MM}_{j,t-q_2} + \sum_{q_3=0}^{Q_3} \mathbf{\Xi}_{j,1,q_3} \mathbf{x}^{*MN}_{j,t-q_3} + \mathbf{\Upsilon}_j \mathbf{v}_t + \omega_{jt} \tag{2}$$

The $\mathbf{a}_i$, $(\mathbf{\Phi}_{i1}, ..., \mathbf{\Phi}_{iP_1})$, $(\mathbf{\Lambda}_{i,0,0}, ..., \mathbf{\Lambda}_{i,0,P_2})$, and $(\mathbf{\Lambda}_{i,1,0}, ..., \mathbf{\Lambda}_{i,1,P_3})$ are coefficient matrices of size $k_i \times 1$, $k_i \times k_i$, $k_i \times k_i^*$, and $k_i \times g_i^*$ respectively. Likewise, $\mathbf{b}_j$, $(\mathbf{\Pi}_{j1}, ..., \mathbf{\Pi}_{jQ_1})$, $(\mathbf{\Xi}_{j,0,0}, ..., \mathbf{\Xi}_{j,0,Q_2})$ and $(\mathbf{\Xi}_{j,1,0}, ..., \mathbf{\Xi}_{j,1,Q_3})$ are of size $g_j \times 1$, $g_j \times g_j$, $g_j \times g_j^*$, and $g_j \times k_j^*$. The $v \times 1$ vector $\mathbf{v_t}$ contains further exogenous variables with coefficient matrices $\mathbf{\Theta}_i$ and $\mathbf{\Upsilon}_j$ being of size $k_i \times v$ and $g_j \times v$, respectively. The idiosyncratic shock vectors ϵ_{it} and ω_{jt}, respectively of size $k_i \times 1$ and $g_j \times 1$, have zero mean, are serially uncorrelated and have covariance matrices $\mathbf{\Sigma}^x_{ii}$ and $\mathbf{\Sigma}^y_{jj}$.

2.2 Weight matrices

To compute the weighted variable vectors $\mathbf{x}^{*NN}_{it}$, $\mathbf{y}^{*NM}_{it}$, $\mathbf{y}^{*MM}_{jt}$ and $\mathbf{x}^{*MN}_{jt}$, four weight matrices are needed which shall be denoted as $\mathbf{W}^{NN}$, $\mathbf{W}^{NM}$, $\mathbf{W}^{MM}$ and $\mathbf{W}^{MN}$.

$$\underset{(NxN)}{\mathbf{W}}^{NN} = \begin{bmatrix} w_{11} & w_{12} & \cdot & w_{N1} \\ w_{12} & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ w_{1N} & \cdot & \cdot & w_{NN} \end{bmatrix}, \underset{(MxN)}{\mathbf{W}}^{NM} = \begin{bmatrix} w_{11} & w_{12} & \cdot & w_{N1} \\ w_{12} & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ w_{1M} & \cdot & \cdot & w_{NM} \end{bmatrix} \tag{3}$$

$$\underset{(MxM)}{\mathbf{W}}^{MM} = \begin{bmatrix} w_{11} & w_{12} & \cdot & w_{M1} \\ w_{12} & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ w_{1M} & \cdot & \cdot & w_{MM} \end{bmatrix}, \underset{(NxM)}{\mathbf{W}}^{MN} = \begin{bmatrix} w_{11} & w_{12} & \cdot & w_{M1} \\ w_{12} & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ w_{1N} & \cdot & \cdot & w_{MN} \end{bmatrix} \tag{4}$$

That notation implies, for the time being, that weights are assumed not to be variable-specific. The model set-up can be generalized to allow for different weights to be used for $K > 1$ or $G > 1$ variables.

While the diagonal elements w_{ii}^{NN} and w_{jj}^{MM} are assumed to equal zero for all i and all j, no such constraints are imposed on any of the cells in $\mathbf{W}^{NM}$ and $\mathbf{W}^{MN}$. Constraints that apply to all four matrices are that their columns sum to unity and that all weights individually be non-negative.

2.3 Model estimation

If the weight matrices $\mathbf{W}^{NN}$, $\mathbf{W}^{NM}$, $\mathbf{W}^{MM}$ and $\mathbf{W}^{MN}$ are constructed based on external data sources, the weighted foreign variable vectors in equations (1) and (2) can be computed and the local models be estimated equation-by-equation using OLS. The weights would be considered free of any uncertainty.

The alternative is to estimate the weight matrices jointly with the MCS-GVAR's other parameters, as proposed in [21].[5] In that case, the local models would be estimated item-by-item, if $K > 1$ or $G > 1$ then jointly for the set of equations per item in the cross-section, by means of a constrained optimization. The objective and constraints would be formulated as follows:

$$\underset{\Gamma_i, w^{NN}, w^{NM}}{min} \sum_{t=1}^{T} \epsilon_{it}^2 \tag{5}$$

subject to

$$w_{ij}^{NN} \geq 0, i = 1, ..., N, j = 1, ..., N$$

$$w_{ij}^{NM} \geq 0, i = 1, ..., N, j = 1, ..., M$$

$$\textstyle\sum_{n=1}^{N} w_{ij}^{NN} = 1, j = 1, ..., N$$

$$\textstyle\sum_{n=1}^{M} w_{ij}^{NM} = 1, j = 1, ..., M$$

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[5] [21] emphasizes that misspecified weight matrices might bias the global model and therefore may distort its dynamics and deteriorate its forecast performance. Estimating the weights can help avoid such bias. Moreover, it is useful for applications in which it is not obvious how weight matrices can otherwise be constructed from data.

where Γ_i comprises all local model coefficients contained in equation (1). The minimization problem for item i would exclude w_{ii}^{NN} and set that to zero.

For items in the second cross-section the objective and accompanying constraints read as follows.

$$\underset{\Gamma_j, w^{MM}, w^{MN}}{min} \sum_{t=1}^{T} \omega_{jt}^2 \tag{6}$$

subject to

$$w_{ji}^{MM} \geq 0, j = 1, ..., M, i = 1, ..., M$$
$$w_{ji}^{MN} \geq 0, j = 1, ..., M, i = 1, ..., N$$
$$\textstyle\sum_{j=1}^{M} w_{ji}^{MM} = 1, i = 1, ..., M$$
$$\textstyle\sum_{j=1}^{N} w_{ji}^{MN} = 1, i = 1, ..., N$$

where Γ_j comprises all local model coefficients contained in equation (2). The minimization problem for item j would exclude w_{jj}^{MM} and set that to zero.

For minimizing that constrained objective, an iterative, numerical optimization has been implemented, using a sequential quadratic programming method to solve the constrained multivariate function. Useful entry points to the literature on sequential quadratic programming are [23], [33] and [26].[6]

Since the model set-up involves inequality constraints for the weights, error bounds cannot be computed via the usual t-statistics (i.e. as a ratio of the mean estimate of a weight and its standard error) because one would not account for the boundary constraints that are imposed on the weights.[7] Intuitively, if some weight mean estimate was already close to or at zero, an estimated standard error would suggest that the weight could fall into negative territory and thereby violate the constraint. To deal with that feature, a pseudo-data resampling approach has been employed to generate weight error bounds. The procedure is to generate a large number of pseudo-data

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[6] A toolbox for estimating and solving the MCS-GVAR model including the weights is available from the authors on request.

[7] Standard errors could in principle be computed from the inverse Hessian matrix that is involved at the quadratic programming stage.

samples from the model to then re-estimate the parameters to obtain their distribution and selected moments thereof, respectively. A nonparametric bootstrap has been used, thus no distributional assumptions are imposed on either the marginal distributions or the copula that together constitute the joint distribution of the global model's residuals. Moreover, the joint dependence of banks' and sovereigns' residuals across the two cross-sections was in no way constrained.

2.4 Global solution

A strategy for solving the global model has to be developed; it is a step that arises due to the fact that there appear time-contemporaneous endogenous variable vectors on the right hand-sides of equations (1) and (2). For ease of notation, it will be assumed that $P_1 = P_2 = P_3 = 1$, $Q_1 = Q_2 = Q_3 = 1$ and that $\mathbf{v}$ be empty.

First we define two vectors $\mathbf{z}^x_{it}$ and $\mathbf{z}^y_{jt}$:

$$\underset{(k_i+k_i^*+g_i^*)x1}{\mathbf{z}^x_{it}} = \begin{pmatrix} \mathbf{x}_{it} \\ \mathbf{x}^{*NN}_{it} \\ \mathbf{y}^{*NM}_{it} \end{pmatrix}, \qquad \underset{(g_j+g_j^*+k_j^*)x1}{\mathbf{z}^y_{jt}} = \begin{pmatrix} \mathbf{y}_{jt} \\ \mathbf{y}^{*MM}_{jt} \\ \mathbf{x}^{*MN}_{jt} \end{pmatrix} \tag{7}$$

With the $\mathbf{z}^x_{it}$ and $\mathbf{z}^y_{jt}$ at hand, equations (1) and (2) can be reformulated as follows.

$$\underbrace{\begin{pmatrix} \mathbf{I}_{k_i} & -\mathbf{\Lambda}_{i,0,0} & -\mathbf{\Lambda}_{i,1,0} \end{pmatrix}}_{\equiv \mathbf{A}_i} \mathbf{z}^x_{it} = \mathbf{a}_i + \underbrace{\begin{pmatrix} \mathbf{\Phi}_i & \mathbf{\Lambda}_{i,0,1} & \mathbf{\Lambda}_{i,1,1} \end{pmatrix}}_{\equiv \mathbf{B}_i} \mathbf{z}^x_{i,t-1} + \epsilon_{it} \tag{8}$$

$$\underbrace{\begin{pmatrix} \mathbf{I}_{g_j} & -\mathbf{\Xi}_{j,0,0} & -\mathbf{\Xi}_{j,1,0} \end{pmatrix}}_{\equiv \mathbf{C}_j} \mathbf{z}^y_{jt} = \mathbf{b}_j + \underbrace{\begin{pmatrix} \mathbf{\Pi}_j & \mathbf{\Xi}_{j,0,1} & \mathbf{\Xi}_{j,1,1} \end{pmatrix}}_{\equiv \mathbf{D}_j} \mathbf{z}^y_{j,t-1} + \omega_{jt} \tag{9}$$

where the here-defined matrices $\mathbf{A}_i$ and $\mathbf{B}_i$ are of size $k_i \times (k_i + k_i^* + g_i^*)$ and $\mathbf{C}_j$ and $\mathbf{D}_j$ of size $g_j \times \left(g_j + g_j^* + k_j^*\right)$.

The two local variable collections $\mathbf{z}^x_{it}$ and $\mathbf{z}^y_{jt}$ have now to be mapped into a global variable vector $\mathbf{z}_t = (\mathbf{x}'_{1t}, \mathbf{x}'_{2t}, ..., \mathbf{x}'_{Nt}, \mathbf{y}'_{1t}, \mathbf{y}'_{2t}, ..., \mathbf{y}'_{Mt})'$ which is accomplished by means of a set of link matrices $\mathbf{L}^x_i$ and $\mathbf{L}^y_j$ (the next subsection will illustrate how they have to be designed).

$$\mathbf{z}_{it}^{x} = \mathbf{L}_{i}^{x}\mathbf{z}_{t}, \qquad \mathbf{z}_{jt}^{y} = \mathbf{L}_{j}^{y}\mathbf{z}_{t} \tag{10}$$

With the link matrices the local models can once more be rewritten.

$$\mathbf{A}_{i}\mathbf{L}_{i}^{x}\mathbf{z}_{t} = \mathbf{a}_{i} + \mathbf{B}_{i}\mathbf{L}_{i}^{x}\mathbf{z}_{t-1} + \epsilon_{it} \tag{11}$$

$$\mathbf{C}_{j}\mathbf{L}_{j}^{y}\mathbf{z}_{t} = \mathbf{b}_{j} + \mathbf{D}_{j}\mathbf{L}_{j}^{y}\mathbf{z}_{t-1} + \omega_{jt} \tag{12}$$

The two sets of model coefficients of NK and MG equations, respectively, can now be stacked:

$$\mathbf{G}_{0}^{x} = \begin{pmatrix} \mathbf{A}_{1}\mathbf{L}_{1}^{x} \\ ... \\ \mathbf{A}_{N}\mathbf{L}_{N}^{x} \end{pmatrix}, \mathbf{G}_{1}^{x} = \begin{pmatrix} \mathbf{B}_{1}\mathbf{L}_{1}^{x} \\ ... \\ \mathbf{B}_{N}\mathbf{L}_{N}^{x} \end{pmatrix}, \mathbf{a} = \begin{pmatrix} \mathbf{a}_{1} \\ ... \\ \mathbf{a}_{N} \end{pmatrix} \tag{13}$$

$$\mathbf{G}_{0}^{y} = \begin{pmatrix} \mathbf{C}_{1}\mathbf{L}_{1}^{y} \\ ... \\ \mathbf{C}_{M}\mathbf{L}_{M}^{y} \end{pmatrix}, \mathbf{G}_{1}^{y} = \begin{pmatrix} \mathbf{D}_{1}\mathbf{L}_{1}^{y} \\ ... \\ \mathbf{D}_{M}\mathbf{L}_{M}^{y} \end{pmatrix}, \mathbf{b} = \begin{pmatrix} \mathbf{b}_{1} \\ ... \\ \mathbf{b}_{N} \end{pmatrix} \tag{14}$$

The two cross-sections can here be combined to a global system:

$$\mathbf{G}_{0} = \begin{pmatrix} \mathbf{G}_{0}^{x} \\ \mathbf{G}_{0}^{y} \end{pmatrix}, \mathbf{G}_{1} = \begin{pmatrix} \mathbf{G}_{1}^{x} \\ \mathbf{G}_{1}^{y} \end{pmatrix}, \mathbf{c} = \begin{pmatrix} \mathbf{a} \\ \mathbf{b} \end{pmatrix} \tag{15}$$

The model would now be

$$\mathbf{G}_{0}\mathbf{z}_{t} = \mathbf{c} + \mathbf{G}_{1}\mathbf{z}_{t-1} + \upsilon_{t} \tag{16}$$

Pre-multiplying the system by the inverse of $\mathbf{G}_0$ gives the final reduced form of the global model.

$$\mathbf{z}_{t} = \mathbf{G}_{0}^{-1}\mathbf{c} + \mathbf{G}_{\mathbf{0}}^{\mathbf{-1}}\mathbf{G}_{1}\mathbf{z}_{t-1} + \mathbf{G}_{0}^{-1}\upsilon_{t} \tag{17}$$

2.5 Link matrix construction

To illustrate what form the link matrices $\mathbf{L}_i^x$ and $\mathbf{L}_j^y$ shall have, an example for $N = 2$, $M = 3$, $K = 2$, and $G = 3$ is outlined in the following.

The $\mathbf{z}_{it}^x$, $\mathbf{z}_{jt}^y$ and the global variable vector $\mathbf{z}_t$ are assumed to have the following content:

$$
\begin{aligned}
\underset{(2K+G)x1}{\mathbf{z}_{it}^x} &= \left(o_{it}, p_{it}, o_{it}^{*NN}, p_{it}^{*NN}, q_{it}^{*NM}, r_{it}^{*NM}, s_{it}^{*NM}\right)' \\
\underset{(2G+K)x1}{\mathbf{z}_{jt}^y} &= \left(q_{jt}, r_{jt}, s_{jt}, q_{jt}^{*MM}, r_{jt}^{*MM}, s_{jt}^{*MM}, o_{jt}^{*MN}, p_{jt}^{*MN}\right)' \\
\underset{(NK+MG)x1}{\mathbf{z}_t} &= \left(o_{1t}, p_{1t}, o_{2t}, p_{2t}, ..., o_{Nt}, p_{Nt}, q_{1t}, r_{1t}, s_{1t}, q_{2t}, r_{2t}, s_{2t}, ..., q_{Mt}, r_{Mt}, s_{Mt}\right)'
\end{aligned}
$$

For $i = 1, 2$, the $\mathbf{L}_i^x$, each of size $(2K + G) \times (NK + MG)$, would look as follows.

$$
\mathbf{L}_1^x = \begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
w_{11}^{NN} & 0 & w_{12}^{NN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & w_{11}^{NN} & 0 & w_{12}^{NN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & w_{11}^{NM} & 0 & 0 & w_{12}^{NM} & 0 & 0 & w_{13}^{NM} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & w_{11}^{NM} & 0 & 0 & w_{12}^{NM} & 0 & 0 & w_{13}^{NM} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & w_{11}^{NM} & 0 & 0 & w_{12}^{NM} & 0 & 0 & w_{13}^{NM}
\end{bmatrix}
$$

$$
\mathbf{L}_2^x = \begin{bmatrix}
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
w_{21}^{NN} & 0 & w_{22}^{NN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & w_{21}^{NN} & 0 & w_{22}^{NN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & w_{21}^{NM} & 0 & 0 & w_{22}^{NM} & 0 & 0 & w_{23}^{NM} & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & w_{21}^{NM} & 0 & 0 & w_{22}^{NM} & 0 & 0 & w_{23}^{NM} & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & w_{21}^{NM} & 0 & 0 & w_{22}^{NM} & 0 & 0 & w_{23}^{NM}
\end{bmatrix}
$$

For $j = 1, 2, 3$, the $\mathbf{L}_j^y$, each of size $(2G + K) \times (NK + MG)$, would be

$$\mathbf{L}_1^y = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & w_{11}^{MM} & 0 & 0 & w_{12}^{MM} & 0 & 0 & w_{13}^{MM} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{11}^{MM} & 0 & 0 & w_{12}^{MM} & 0 & 0 & w_{13}^{MM} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{11}^{MM} & 0 & 0 & w_{12}^{MM} & 0 & 0 & w_{13}^{MM} \\ w_{11}^{MN} & 0 & w_{12}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & w_{11}^{MN} & 0 & w_{12}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\mathbf{L}_2^y = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & w_{21}^{MM} & 0 & 0 & w_{22}^{MM} & 0 & 0 & w_{23}^{MM} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{21}^{MM} & 0 & 0 & w_{22}^{MM} & 0 & 0 & w_{23}^{MM} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{21}^{MM} & 0 & 0 & w_{22}^{MM} & 0 & 0 & w_{23}^{MM} \\ w_{21}^{MN} & 0 & w_{22}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & w_{21}^{MN} & 0 & w_{22}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\mathbf{L}_3^y = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & w_{31}^{MM} & 0 & 0 & w_{32}^{MM} & 0 & 0 & w_{33}^{MM} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & w_{31}^{MM} & 0 & 0 & w_{32}^{MM} & 0 & 0 & w_{33}^{MM} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & w_{31}^{MM} & 0 & 0 & w_{32}^{MM} & 0 & 0 & w_{33}^{MM} \\ w_{31}^{MN} & 0 & w_{32}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & w_{31}^{MN} & 0 & w_{32}^{MN} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

3 Assessing sovereign-bank interconnectedness

The MCS-GVAR comprises 23 sovereigns (21 EU countries plus Japan and the US) and 41 banks for which the endogenous model variable will be their 5-year credit default swap (CDS) spread. The bank sample is composed of the major banking groups in the the EU, Japan and the US. The selection of banks aimed at covering the most systemic banks, yet was also determined by data availability, with the objective being to cover a sufficiently long sample period. We employ a daily data sample covering the period from 02/01/2008-22/04/2013 (1,386 observations). Table 1 summarizes the sovereigns and banks contained in the sample and presents basic summary statistics. All variables are modeled in day-on-day logarithmic differences in order to render them stationary.

Four common, global factors enter each of the 64 equations as time-contemporaneous, exogenous variables. The four factors are returns and realized volatilities (5-day window) of a bank and a sovereign CDS index which are constructed based on the set of banks and sovereigns listed in Table 1. See Figures 1-3 for the indices in levels and the resulting return and volatility series.[8] Equal weights were used to average the daily log returns.[9]

The local model equations for banks and sovereigns all have been set to contain one autoregressive lag as well as time-contemporaneous and first lags of the two weighted cross-section vectors, thus have ten right hand-side variables (including an intercept and four exogenous variables). Figures 4-7 summarize the resulting R-square, adjusted R-square and Durbin-Watson (DW) statistics for all 64 model equations. Adjusted R-squares range between 42% for Japan and 81% for Spain. The median adjusted R-square across sovereigns equals 67%. For banks, adjusted R-squares range between 17% for Bank of Ireland (IE) and 87% for Intesa Sanpaolo (IT) with an equally high cross-bank median at 70%. Residuals across banks and sovereigns are reasonably free of serial correlation, with DW statistics estimated between 1.9 and 2.2 (with cross-country and cross-bank medians equalling 2.02 and 2.01, respectively). The absolute eigenvalues of the companion coefficient matrix of the global model are shown in Figure 8; they confirm that the global model is stable since all eigenvalues fall into the unit circle.

Weight matrix estimates for sovereigns to sovereigns, sovereigns to banks, banks to banks, and banks to sovereigns are summarized in Tables 2-13, including the mean estimates as well as lower and upper bounds, marking the 10th and 90th percentiles of the weights' distributions, respectively. Two features are worth highlighting: First, regarding the sovereign-sovereign weights (Table 2), there is a tendency for the weights to be larger among sovereigns in the Southern part of Europe (see e.g. the weights connecting sovereigns in Spain, Italy and Portugal). Another cluster with rather concentrated weights includes Central and Eastern European countries such as Bulgaria, the Czech Republic, Hungary, Latvia, Lithuania, Poland and Slovakia. Second, with respect to the bank-bank weights we observe a pronounced clustering of banks within

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[8] Alternatively, one could have used market-based CDS indices such as iTraxx indices. However, for the sake of consistency we use self-constructed indices to ensure that all sovereigns and banks in our sample are represented in the respective indices.

[9] Alternative weighting schemes based on risk weighted or total assets for the banks, or nominal GDPs for countries, do not materially change the dynamics of the global factors. Model results presented in the paper remain robust when the alternative weighting schemes were used.

the same country (Table 4).[10]

3.1 Systematic shock simulation

While weight estimates as such might be suggestive of how shocks that one applies to sovereigns or banks might propagate, they do not yet provide any insight into either how *significant* shock responses would be or how the *dynamics* of the shock responses would look like.

To address the dynamics of the responses, a systematic impulse response simulation was conducted by considering each sovereign and bank once (one after another) a shock origin. Generalized Impulse Responses (G-IRs) were simulated with a 25-day horizon and shock responses across the two cross-sections recorded. The sizes of the shocks were calibrated to 1-STD of respective shock origin equations' residuals.[11]

An $NK \times MG$ (here 64×64) impact matrix results from the systematic simulation. It can be segmented into four partitions, as illustrated in Figure 9. Shock origins are listed in rows; shock respondents along the columns of the matrix. Analyzing the matrix in its four partitions allows us to assess shock responses from sovereigns to other sovereigns, from sovereigns to banks, from banks to other banks and from banks to sovereigns.

The information contained in the matrix can be further compressed by averaging along its rows or columns, and in either case for individual banks, sovereigns, or for the total system of banks and sovereign. To averages along columns we refer as *impact* of banks and sovereigns, while averages along rows will be referred to as a measure of *vulnerability*, signalling the average extent to which banks and sovereigns are vulnerable to shocks arising elsewhere in the system.

The impact and vulnerability measures can be derived and presented along various dimensions. Different approaches are conceivable; the following three will be employed:

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[10] We do not discuss the weight estimates in more detail and leave the attached Tables 2-13 for the reader's information.

[11] For presentational tractability, detailed dynamic impulse response paths are not presented. The impact matrices presented later in the section aim to provide a compressed summary of the model dynamics.

1. Using *5-day cumulative responses* derived from the G-IRs (Table 14).
2. Using *10-day cumulative responses* derived from the G-IRs (Table 15).
3. Using the *most adverse cumulative responses* derived from the G-IRs (Table 16).

The impact matrices resulting from the third approach combine information from different horizons, that is, from the positions along the forecast horizon at which respective maxima in responses were identified.

A look across the three different measures and resulting rankings suggests that in terms of *impact* among the sovereigns the US, France, and Portugal have overall had strong potential to exert propagation effects. Spain appears high in the ranking under the first two measures. As concerns the banks, according to the 5- and 10-day response measures, some US banks attain high ranks, e.g. Goldman Sachs and Citigroup. Further, Italian, Spanish and Portuguese banks attain high ranks. Apart from peripheral Southern European banks, there appear Commerzbank and Deutsche Bank from Germany.

With respect to vulnerability rankings of sovereigns, peripheral European countries appear high in the ranking: Greece, Ireland, Spain, and Portugal. France ranks fourth according to the 5-day response based ranking, and seventh and third according to 10-day and maximum cumulative based rankings. Regarding the banks, institutions from France and the US appear vulnerable, e.g. Credit Agricole, Goldman Sachs, Bank of America, and KBC from Belgium. Further among the top-10 appear in particular Italian and Spanish banks. In general, the vulnerability rankings contain names that experienced significant funding and/or liquidity problems during some period of the crisis (e.g. Dexia, KBC, Bank of Ireland, Banco Populare, Bank of America and some Portuguese banks).

3.2 Measuring spill-over potential over time

Our proposed measure of spill-over potential, the average over the four compartments and the total of the impact matrix described in the previous section, can be computed in a recursive fashion in order to reveal how spill-over potential evolves over time. To that end, we re-estimate the MCS-GVAR on half-year samples from 2008H1 to 2012H2 and conduct the systematic shock simulation separately for each sub-sample to then compute the average spill-over.[12]

The systematic shock simulations were conducted twice, once using G-IRs as above for obtaining the impact rankings, and once using Non-factorized (N-)IRs. While the shock sizes at the outset of a simulation horizon for a bank or a sovereign were equal under the G-IR and N-IR modi, the dynamic responses for the respondents differ because the N-IRs assume that shocks are not correlated at $T = 0$. To the extent that G-IR responses and the resulting average spill-over measures across banks and sovereigns differ from the N-IRs, the G-IR based measure signals the additional spill-over potential due to shock correlation (captured by the covariance matrix of the model residuals). N-IRs on the other hand reflect the connectedness of the system only with regard to observed dependence (captured by model coefficients).

Figure 10 shows the resulting spill-over indices over time, with the *direct* impact being the result of the N-IR simulation and the sum of the *direct* and *indirect* component being the result of the G-IR simulation. The left panel of indices is based on the 5-day cumulative responses; the indices on the right side use 10-day cumulative responses as a basis.

A bird-eye view at spill-over measures suggest that 2008H2 and 2011H2 were two periods over which the shock transmission through bank and sovereign CDS markets was of comparably large magnitude. Notable but somewhat smaller spill-overs are observed for 2008H1 and 2012H1. The spill-over effects appear more contained in the interim period between these extreme periods.

A notable difference with respect to how 5-day versus 10-day cumulative response measures compare is that they identify 2011H2 and 2012H1 as the periods in which spill-over potential has increased markedly. This finding points to the fact that the way shocks propagate through the CDS market has become more persistent in 2012H1; thereby allowing shocks to cumulate further over a 10 as opposed to only a 5-day forward horizon.

Regarding the distinction between indirect and direct effects, we observe in partic-

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[12] The underlying weight matrices were not re-estimated and have instead been calibrated to the full-sample estimates. Only the core model coefficients have been re-estimated recursively. For estimating the model including the weights, a half-year sample of data is not sufficient.

ular for the 2011H2 period (based on the 5-day measure) that indirect effects predominate, that is, a large part of the spill-over effects owes to correlated shocks hitting the system. In contrast to that, the 10-day based measures for 2012H1 suggest that the direct effects dominate, suggesting that spill-over effects more recently and to a larger extent have reflected observed dependencies.

Distinguishing between the different groups of cross-sections also provides some interesting insights. For example, it is observed that in terms of the 5-day based index the bank-to-bank spill-overs were of roughly similar magnitudes in 2008H2 and 2011H2. The bank-to-sovereign spill-overs were however considerably stronger in 2008H2, possibly reflecting the substantial government measures at the time to support the domestic banking sectors (e.g. capital injections, government guarantee bond programmes, enhanced deposit insurance) that in turn adversely affected the fiscal position of the sovereign. The sovereign-to-bank spill-overs were in turn slightly stronger in 2011H2 at the height of the euro area sovereign debt crisis.

While the spill-over indices as shown in Figure 10 and discussed above might provide a first and reasonable measure of the intensity of potential shock transmission, it is confounded possibly by the fact that shock sizes that were used to simulate the responses vary over time. Figure 12 shows the median of the shock sizes across banks and sovereigns that were used to generate the indices in Figure 10 over time. Shock sizes appear to have a steady downward trend. For that reason, we present a variant of the spill-over indices that uses 1-unit shocks instead of residual-based 1-STD impulses that were applied to all banks and sovereigns. Figure 11 shows the resulting indices.

A bird-eye view suggests that spill-over potential now appears much more pronounced toward the end of the sample in 2012H1, in particular when looking at the index based on 10-day cumulative responses.[13] The result suggests that if shocks of sizes equal to those experienced in the early phase of the financial crisis would have hit the sovereigns or banks in 2011H2/2012H1, responses across markets would have

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[13] Employing 1-unit impulses means that the individual shocks to banks and sovereigns equal 100 log percentage points, which facilitates the interpretation of the resulting index measure (which is also measured in log percentage points). For instance, a 100-log percentage point impulse to the CDS of the banks induces at maximum an 80 log percentage point response of the banks (on average) in 2011H2. While the units of measurement of the spill-over indices in Figures 10 and 11 are the same, the basic index is somewhat less convenient to interpret because one has to relate it to the underlying (potentially time-varying) average shock sizes (as presented in Figure 12).

been expected to be considerably more pronounced compared to those measured in 2008. The estimates thus suggest that the bank and sovereign sphere have become more densely connected, both within and across the two cross-sections.

3.3 Network visualization and metrics

A network visualization is presented in Figure 13. It is based on the same systematic shock simulation that was used to infer the impact and vulnerability rankings discussed in the first subsection of this chapter.

Nodes (banks and sovereigns) are connected with directed graphs if the simulated maximum adverse response in some direction was significant at a self-defined threshold p-value (in this case set to 85%). The size of the nodes is proportional to the total impact on the system when being shocked. The width of the connecting lines is proportional to the maximum adverse response that a shock to one node induces to another.

Figure 14 illustrates how many banks and sovereigns would be connected while gradually shifting the p-value from zero to one. With the threshold approaching 0%, all nodes would eventually get connected (4,084 connections). For the threshold set to 85% as in Figure 13, the number of connections equals 211.

While it is difficult to make firm inferences based on a network visualization as in Figure 13, some intuitive findings nevertheless emerge from the illustration.[14] For example, we observe that US banks have strong connections to each other. A similar feature is observed for the Japanese banking sector. This is also found to be the case within the banking sectors of European countries, although at the same time we observe many pronounced cross-border links among EU banks. The latter may both reflect the rather strong banking sector integration in the EU and the fact that during our sample period European banks were hit by a number of common systemic shocks, such as the global financial shocks emerging from the sub-prime crisis and especially the shocks related to the euro area sovereign debt crisis.

We further explore the network properties by calculating the betweenness centrality

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[14] It has to be kept in mind that any conclusions drawn from such a visualization is contingent upon the chosen threshold p-value.

metric based on the outcome of the systematic shock simulation. This metric measures how connected specific nodes are to the overall system. It illustrates how often a node serves to bridge along a shortest path between any two other nodes and hence indicates the extent to which a node controls the network activity of the system.[15]

Figure 15 shows the betweenness centrality across the sovereigns and banks in our sample. We split the sample in two. The first part of the sample (2008H1-2009H2) broadly reflects the time of the global financial crisis, whereas the second part of the sample (2010H1-2012H2) broadly reflects the time of the euro area sovereign debt crisis. Splitting the sample in two parts allows us to make inference about how the degree of connectedness among the nodes in the system has changed over time. For a notable number of banks and sovereigns, the betweenness measure increases in the second compared to the first half of the sample period. This suggests, at least in a qualitative way and in line with our findings based on the spill-over indices that the network has become more densely connected over time.

4 Conclusions

The purpose of the paper has been to provide an assessment as to the extent to which sovereigns and financial institutions (based on samples covering Europe, the US and Japan) have been inter-dependent during the global financial crisis. To that end, we have developed a Mixed-Cross-Section GVAR that can accommodate two (or in principle more) cross-sections in a way to allow for endogenous feedback within and across cross-sections. In comparison to a traditional GVAR framework, a GVAR with more than one cross-section necessitates a different strategy to solving the global model.

In addition to the estimated weights that are used to connect the banks and sovereigns in the model, systematic shock simulations were conducted in order to compute a measure of *Spill-over Potential* for within and across the two cross-sections of banks and sovereigns. A recursive estimation and simulation scheme, a resulting time-series of the spill-over measure, respectively, suggests that the extent to which banks

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[15] We do not employ other commonly used network topology measures, such as "degree centrality" (that measures network activity through the number of links nodes have with each other) or "closeness centrality" (that measures the time a shock needs to propagate through the system based on how close nodes are to each other), because our spill-over index serves to address such features.

and sovereigns are connected is roughly comparable in the early phase of the financial crisis (2008) when shocks originated from the financial system and the later phase (2011-12) when rather the (euro area) sovereigns were the source of market turbulence. Through the intermediate period between 2009H1 and 2011H1, spill-over potential has been measured to be relatively contained. In our analysis of how spill-over potential evolves over time we made a distinction between direct and indirect channels, referring respectively to contagion via observed dependence and via correlation of shocks hitting the markets.

The sizes of shocks that perturbed markets on average have been found to fall steadily over the period from 2008-2012. To take account of that finding, we have proposed a variant of the spill-over index that uses normalized shock sizes instead of time-varying ones. It reveals that spill-over potential toward the end of the sample (2012H1) has been considerably higher compared to 2008. Hence, if unexpected large shocks of size equal to those seen in the early phase of the financial crisis would have materialized in 2011/2012, considerably more adverse and synchronized responses would have to expected.

The findings point to the fact that the contagion channels between banks and sovereigns have intensified in recent years, underlining the importance of taking a systemic (and macro-prudential) perspective to banking stability and for breaking the sovereign-bank link that has haunted euro area economies in recent years. Recent EU initiatives, such as the introduction of a single supervisory mechanism, the establishment of a common resolution authority and allowing the European Stability Mechanism to take direct stakes in euro area banks, aim at weakening the adverse bank-sovereign feedback loop and at imposing a more euro area-wide systemic perspective to bank supervision, which shall help reduce the pronounced contagion effects observed in recent years.

While the application presented in this paper was focused on conducting systematic shock simulations, the model can be used also for examining concrete shock scenarios, involving e.g. joint shocks to a group of sovereigns or banks. In a macro stress-test context it can be used to analyze the impact of sovereign contagion shocks upon individual bank CDS spreads, which in turn can be employed to calibrate the banks' funding cost profile.

Future research might find the MCS-GVAR model a useful frame for exploring further the linkages between the macro and financial sphere, for instance by considering the inclusion of balance sheet items in the bank cross-section, and indicators of real or nominal activity at macro level (which would in either case require one to operate at a lower frequency). For stress-test purposes, the approach can be useful as macroeconomic shocks can be translated into bank balance sheet items; in the endogenous model set-up, deleveraging on the side of banks would be allowed to feed back into the real economy.

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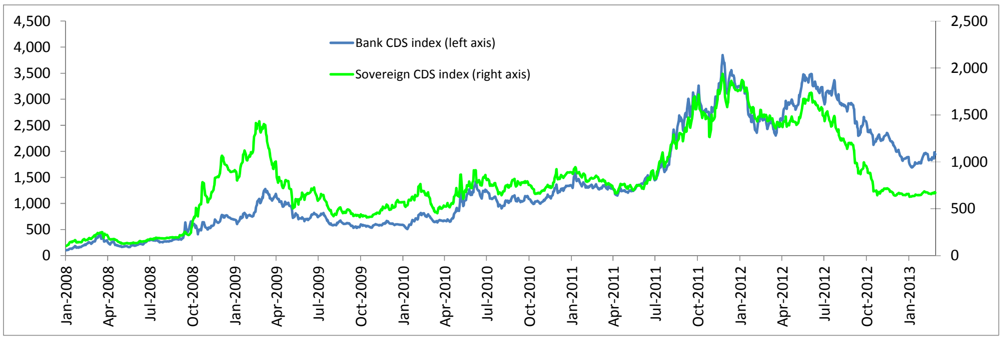
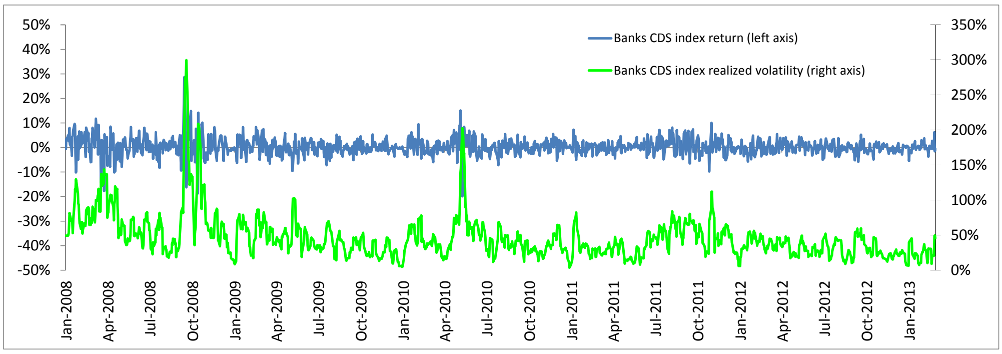
Appendix

Figure 1: Sovereign and bank CDS level indices



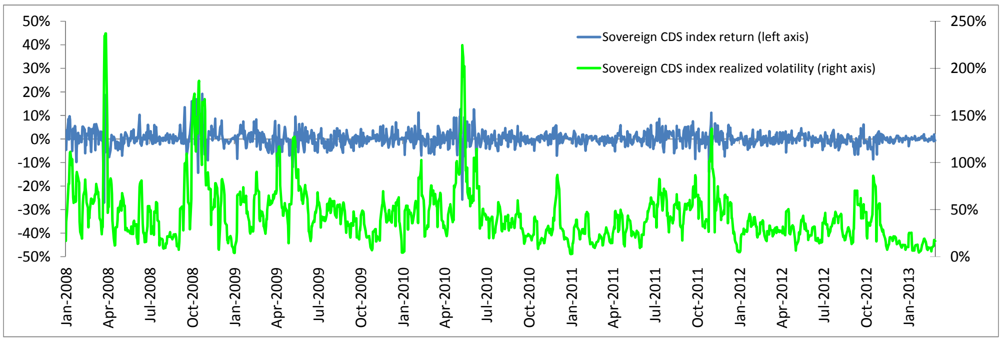
Note: The indices are computed from 5-year CDS spread data using equal weights for the banks and sovereigns listed in Table 1. The indices are normalised to 100 at the beginning of the sample period (at 02/01/2008).

Figure 2: Returns and realized volatility based on bank CDS index



Note: The realized volatility was computed based on a 5-day rolling window of the underlying index returns and has been annualized. The two series enter as global exogenous factors in all MCS-GVAR model equations.

Figure 3: Returns and realized volatility based on sovereign CDS index



Note: The realized volatility was computed based on a 5-day rolling window of the underlying index returns and has been annualized. The two series enter as global exogenous factors in all MCS-GVAR model equations.

Figure 4: R-squares for sovereign model equations

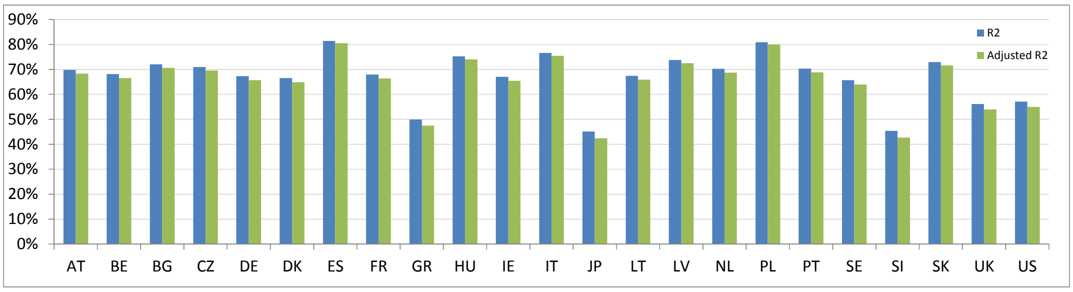


Figure 5: R-squares for bank model equations

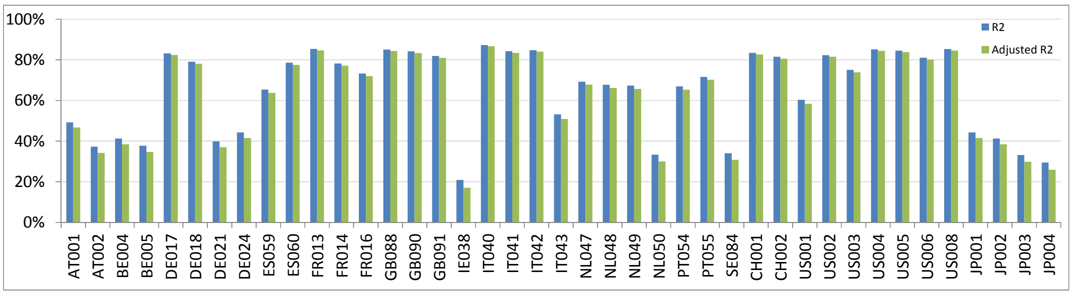


Figure 6: Durbin-Watson statistics for sovereign model equations

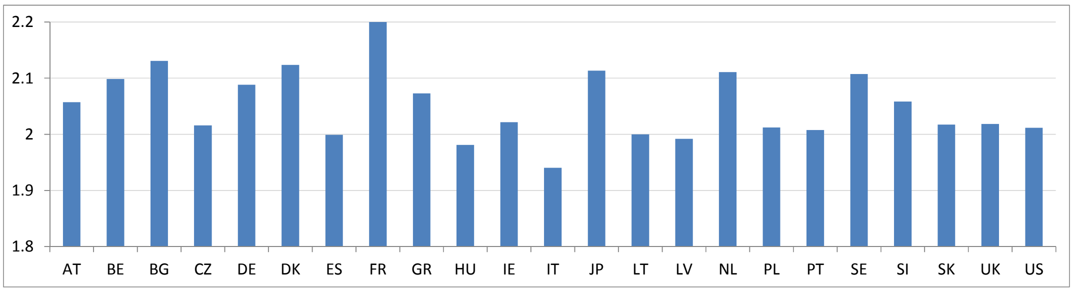


Figure 7: Durbin-Watson statistics for bank model equations

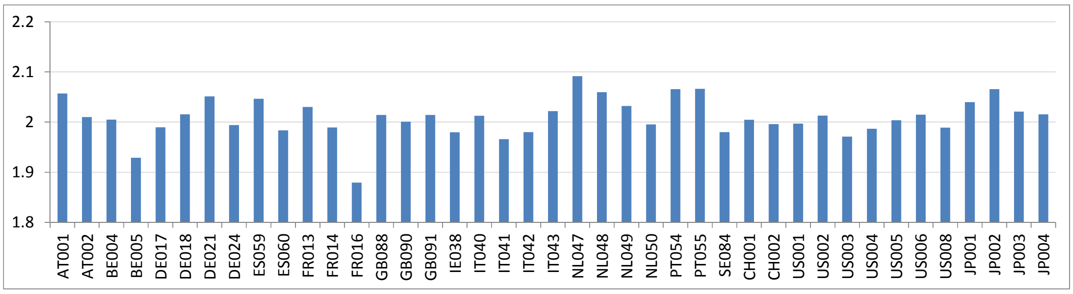
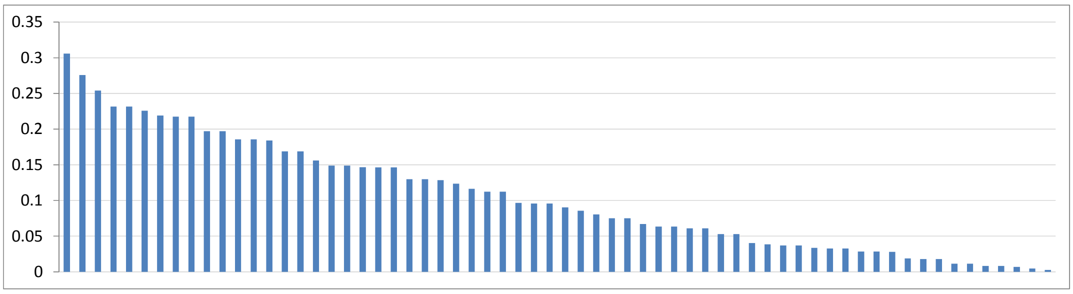
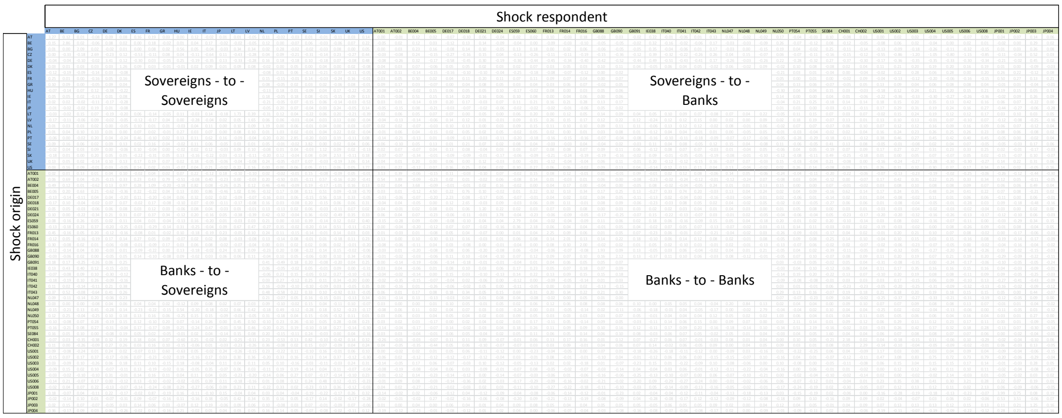


Figure 8: Stability of the global model (modulus of eigenvalues of companion matrix)



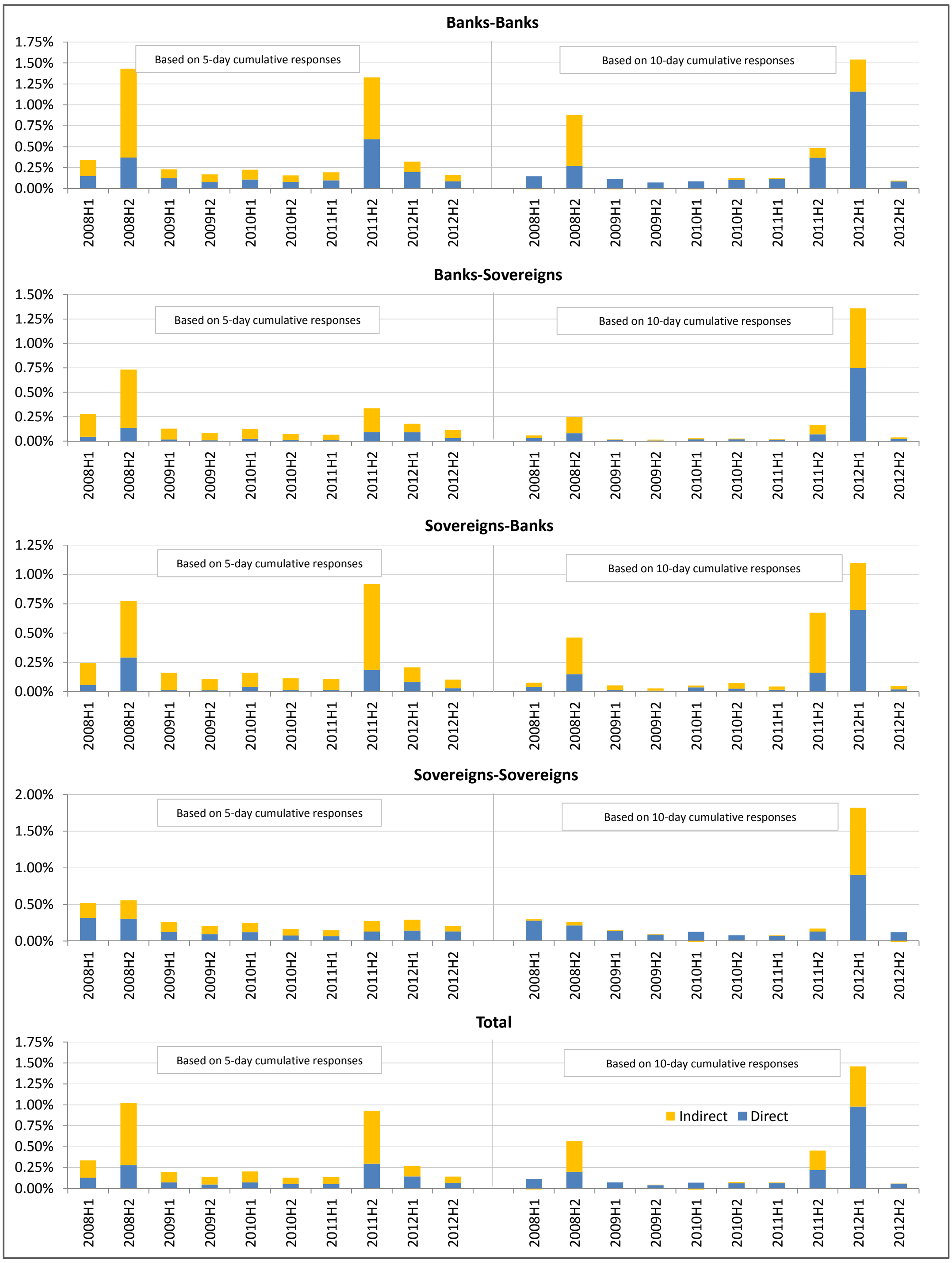
Note: The figure shows the modulus of the 64 eigenvalues of the global model's companion coefficient matrix. See text for details.

Figure 9: Impact matrix (schematic)



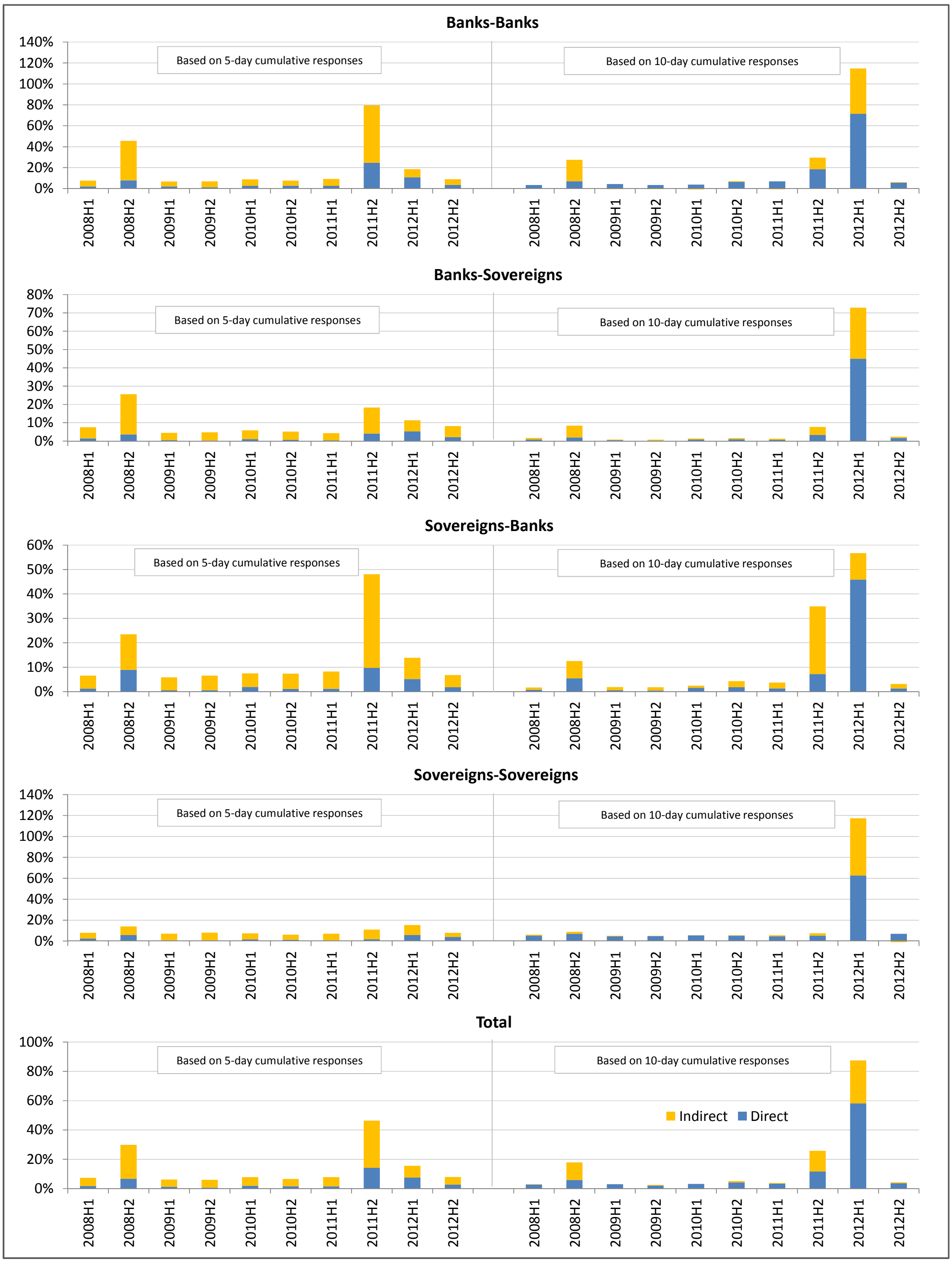
Note: The impact matrix is meant to summarize some feature of either simulated G-IR or N-IR responses, e.g. their maximum along a horizon, the cumulative sum, or the like. See text for details.

Figure 10: Spillover Indices



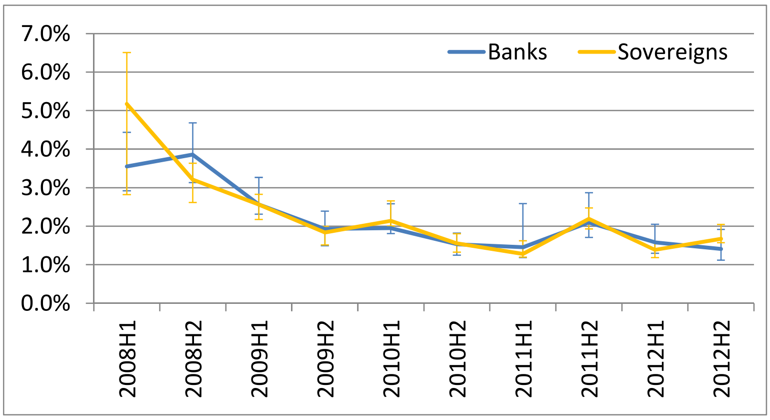
Note: The Spillover Index is based on a systematic shock simulation from the MCS-GVAR model for all banks and sovereigns contained in the model. The 'direct' component of the index is obtained based on a simulation using *non-factorized* impulse responses (IRs), while the sum of the 'direct' and 'indirect' component is computed based on *generalized* IRs. The gap between the two (the 'indirect' component) shall be seen as being reflective of spillover potential due to shock correlation. See text for further details.

Figure 11: Spillover Indices (using 1-unit shocks)



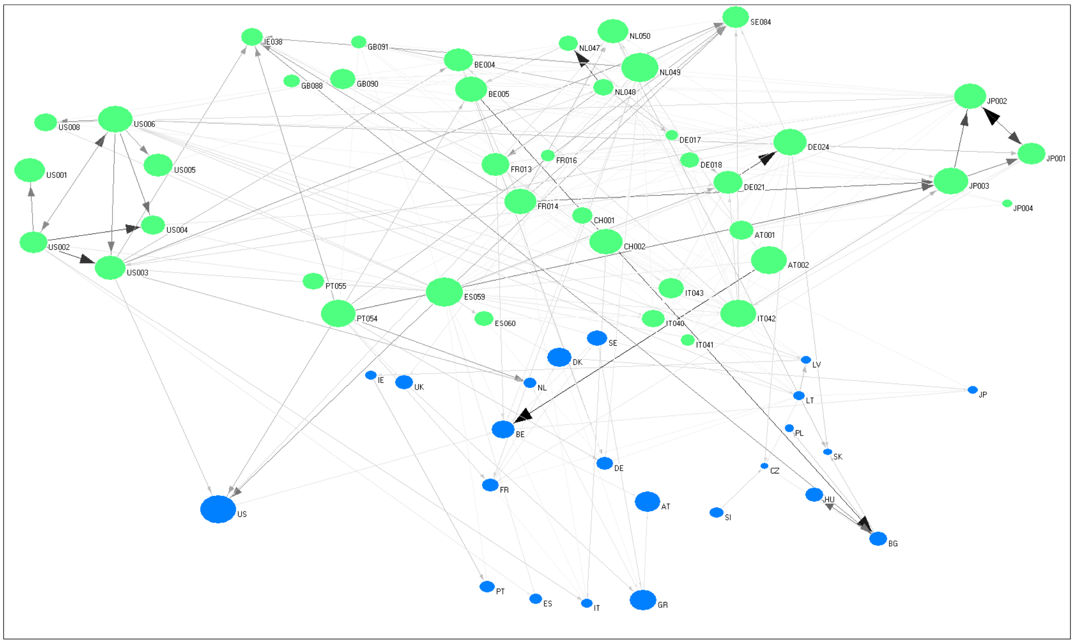
Note: The Spillover Index is based on a systematic shock simulation from the MCS-GVAR model for all banks and sovereigns contained in the model. The 'direct' component of the index is obtained based on a simulation using *non-factorized* impulse responses (IRs), while the sum of the 'direct' and 'indirect' component is computed based on *generalized* IRs. The gap between the two (the 'indirect' component) shall be seen as being reflective of spillover potential due to shock correlation. See text for further details.

Figure 12: Median shock sizes for banks and sovereigns



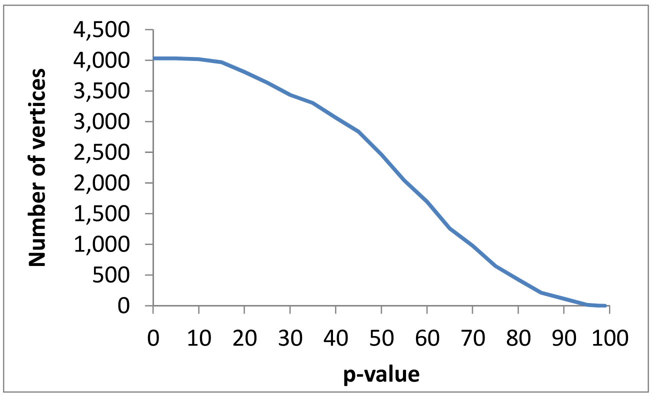
Note: The error bounds around the median shock sizes (all measured in log percentage points) represent the upper and lower quartiles of the shock size distribution across banks and sovereigns, respectively.

Figure 13: Network visualization



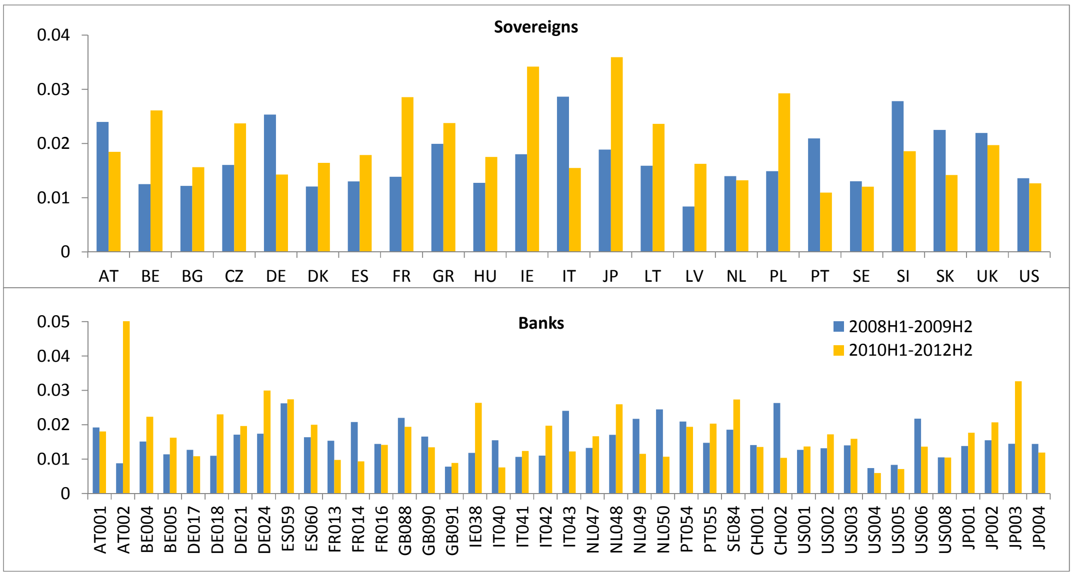
Note: The sovereigns' nodes are blue; banks' nodes are green. The size of the nodes is proportional to the average impact (measured by the maximum adverse responses) on the overall system of banks and sovereigns obtained in the systematic shock simulation. The threshold *p*-value (with respect to the significance of the maximum adverse response along the simulation horizon) for displaying a connection between any two vertices has been set to 85% (resulting in 211 connections out of 4,032 if all nodes were connected). See text for further details.

Figure 14: Denseness of the network as a function of the threshold *p*-value



Note: The threshold *p*-value refers to the maximum Generalized Impulse Responses (G-IRs) obtained from a systematic shock simulation based on the MCS-GVAR. Decreasing the *p*-value toward zero means that all vertices will eventually be connected, with the total number of connections equalling 4,032 (4,094 less 64 *p*-values from the diagonal which equal one).

Figure 15: Betweenness centrality for sovereigns and banks



Note: Betweenness is a network metric that measures how often a node (here a sovereign or a bank) serves to bridge along a shortest path between any other two nodes. The measures are based on the outcome from a systematic shock simulation based on the MCS-GVAR, specifically from the *p*-values referring to the maximum Generalized Impulse Responses (G-IRs) along a 25-day simulation horizon. The threshold *p*-value has been set to 85% for a connection to be considered. The betweenness measures have been computed for each half-year sample (resulting from the underlying model estimation and simulation), and then been averaged to the two periods 2008H1-2009H2 and 2010H1-2012H2 (blue and orange in the figure).

Table 1: Banks, sovereigns and common factors in the MCS-GVAR model

Alias	Name	Mean	Median	Skew	Kurtosis	Min	Max
AT001	Erste Bank Group	0.11	0.00	0.74	9.61	-23.47	32.13
AT002	Raiffeisen Bank International	0.12	0.00	0.62	22.47	-44.93	41.04
BE004	Dexia Group	0.26	0.00	5.81	122.53	-29.41	98.47
BE005	KBC Group	0.18	0.00	9.23	222.48	-50.09	128.72
DE017	Deutsche Bank AG	0.21	0.08	0.31	6.15	-37.89	38.07
DE018	Commerzbank AG	0.25	0.00	1.05	13.19	-31.58	59.01
DE021	Bayerische Landesbank	0.12	0.00	1.18	12.59	-28.19	46.42
DE024	WestLB AG	0.15	0.00	1.21	13.50	-34.43	49.26
ES059	Banco Santander	0.28	0.00	0.08	6.34	-33.01	38.82
ES060	Banco Bilbao Vizcaya Argenteria	0.29	0.18	0.18	4.72	-32.51	33.75
FR013	BNP Paribas	0.28	0.08	0.30	4.11	-30.27	39.35
FR014	Credit Agricole	0.24	0.03	0.20	4.56	-35.58	34.52
FR016	Societe Generale	0.26	0.02	0.40	4.54	-34.02	30.79
GB088	Royal Bank of Scotland Group	0.21	0.04	-0.54	14.04	-50.68	33.16
GB090	Barclays	0.22	0.06	-0.30	5.84	-35.78	28.21
GB091	Lloyds Banking Group	0.24	0.02	-0.04	6.80	-34.58	27.20
IE038	Bank of Ireland	0.30	0.00	3.02	56.63	-47.88	83.05
IT040	Intesa Sanpaolo	0.32	0.04	0.26	4.06	-31.52	30.72
IT041	Unicredit	0.30	0.12	0.70	11.51	-33.50	55.40
IT042	Banca Monte Dei Paschi Di Siena	0.33	0.08	0.14	3.70	-33.79	25.34
IT043	Banco Popolare	0.25	0.00	2.50	26.94	-26.56	52.38
NL047	ING Bank	0.21	0.01	0.59	8.03	-22.22	41.03
NL048	Rabobank	0.19	0.00	0.26	6.52	-31.08	31.94
NL049	ABN Amro	0.21	0.01	0.78	10.36	-26.16	39.57
NL050	SNS Bank	0.22	0.00	3.68	62.42	-24.17	61.64
PT054	Banco Comercial Portugues	0.28	0.07	0.10	6.26	-29.82	32.44
PT055	Banco Espirito Santo	0.27	0.05	-0.02	6.32	-32.74	28.45
SE084	Nordea Bank	0.26	0.00	10.20	206.97	-24.70	131.99
CH001	Credit Suisse Group	0.18	0.05	0.81	12.39	-28.28	51.72
CH002	UBS AG	0.18	0.06	0.67	14.93	-33.66	55.23
US001	American Express	0.10	-0.09	1.99	20.99	-21.73	61.48
US002	Bank of America	0.21	-0.04	0.61	7.80	-30.34	43.98
US003	Citigroup	0.21	-0.01	0.99	20.18	-49.36	54.76
US004	Goldman Sachs	0.23	-0.04	1.63	24.10	-47.84	74.13
US005	JPMorgan Chase	0.18	-0.05	0.59	6.36	-31.82	33.68
US006	Morgan Stanley	0.21	-0.11	2.62	49.78	-60.55	89.65
US008	Wells Fargo	0.16	0.00	0.28	6.42	-32.63	35.78
JP001	Mitsubishi UFJ	0.21	0.00	0.61	17.30	-47.78	48.70
JP002	Mizuho Bank	0.17	0.00	1.31	13.59	-24.33	39.30
JP003	Mitsui Sumitomo	0.17	0.00	7.97	155.16	-32.57	128.44
JP004	Nomura Securities	0.22	0.00	1.85	22.35	-33.89	48.45

Alias	Name	Mean	Median	Skew	Kurtosis	Min	Max
AT	Austria	0.12	0.00	0.69	22.55	-62.67	53.90
BE	Belgium	0.14	0.00	0.32	3.83	-23.74	30.60
BG	Bulgaria	0.04	0.00	0.24	5.57	-24.18	20.79
CZ	Czech Republic	0.08	0.00	-0.16	25.41	-50.05	42.29
DE	Germany	0.13	0.00	-0.55	15.29	-62.22	39.79
DK	Denmark	0.11	0.00	-0.73	25.51	-62.42	60.61
ES	Spain	0.20	0.07	-0.40	29.22	-62.39	55.90
FR	France	0.16	0.00	-0.61	17.28	-62.57	34.25
GR	Greece	0.38	0.15	-3.00	59.97	-104.45	50.10
HU	Hungary	0.13	0.00	1.07	11.41	-25.35	35.09
IE	Ireland	0.19	0.01	0.55	36.71	-62.57	60.09
IT	Italy	0.19	0.00	0.06	8.15	-40.43	33.13
JP	Japan	0.16	0.00	0.00	14.64	-43.67	31.92
LT	Lithuania	-0.01	0.00	0.32	10.26	-23.64	21.85
LV	Latvia	0.04	0.00	0.54	8.50	-23.30	25.13
NL	Netherlands	0.14	0.00	-0.01	23.10	-62.78	64.00
PL	Poland	0.10	0.00	0.33	10.41	-36.83	35.07
PT	Portugal	0.23	0.08	-0.56	15.54	-54.32	28.00
SE	Sweden	0.11	0.00	0.56	24.79	-62.08	62.08
SI	Slovenia	0.19	0.00	-0.27	20.39	-47.96	29.27
SK	Slovakia	0.12	0.00	0.26	15.21	-46.86	35.57
UK	United Kingdom	0.13	0.00	-0.91	34.47	-62.78	51.08
US	United States	0.11	0.00	1.51	39.20	-61.99	69.86

Alias	Name	Mean	Median	Skew	Kurtosis	Min	Max
SOV_CDS_R	Sovereign CDS index returns	0.14	0.05	-0.16	8.66	-27.01	19.15
FIN_CDS_R	Banks CDS index returns	0.22	0.08	0.32	7.50	-19.91	28.61
SOV_CDS_V	Sovereign CDS index realized volatility	44.00	37.90	2.37	9.14	2.63	237.18
FIN_CDS_V	Banks CDS index realized volatility	46.20	40.08	2.85	13.82	3.54	299.55

Note: The underlying sample of 5-year CDS spreads has a daily frequency ranging from 02/01/2008-22/04/2013 (1,386 observations). All series are taken in first differences of logarithmic levels, expressed in percent. The two realized volatility series (annualized) were computed based on a 5-day rolling window.

Table 2: Estimated MCS-GVAR weights – Sovereigns versus Sovereigns – Mean estimates

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT	0.0	5.8	5.3	5.8	3.6	3.5	8.7	0.6	4.1	1.4	3.5	0.7	3.8	0.8	0.0	3.3	5.3	4.9	4.3	5.6	0.0	3.4	4.0
BE	7.2	0.0	6.3	0.0	5.0	3.8	0.8	1.6	4.9	1.2	5.8	16.5	7.5	0.6	0.0	4.1	8.0	2.0	5.9	5.6	1.4	4.0	6.0
BG	7.8	6.9	0.0	0.0	7.0	7.3	0.0	4.6	5.3	28.5	5.0	0.1	5.8	10.7	12.2	6.7	0.0	8.9	5.8	4.3	3.9	6.0	4.7
CZ	0.9	6.0	4.4	0.0	7.0	2.7	0.0	5.4	3.6	0.7	4.4	0.9	3.5	0.0	4.7	3.7	0.0	4.1	5.9	1.2	33.4	6.2	4.1
DE	4.9	4.9	7.1	0.0	0.0	5.8	1.4	2.2	5.7	0.0	4.0	1.1	6.4	0.8	0.7	3.6	8.5	5.5	4.6	4.4	1.8	3.1	4.1
DK	3.9	4.0	8.2	2.5	5.7	0.0	2.3	6.6	5.1	0.3	4.5	0.0	6.9	0.0	0.0	4.0	7.2	7.2	1.9	7.4	1.5	5.1	4.2
ES	0.0	4.2	4.2	0.0	3.9	2.5	0.0	4.2	4.0	0.0	0.0	32.5	1.5	0.0	0.0	3.9	4.9	0.0	1.0	5.4	0.0	0.6	1.1
FR	0.3	1.3	3.8	0.0	1.1	4.4	1.6	0.0	4.0	0.0	3.8	2.1	2.8	0.0	0.0	3.6	3.9	4.3	4.7	4.3	0.1	4.1	0.9
GR	4.8	4.4	4.9	1.9	5.2	4.5	0.1	4.8	0.0	0.4	4.2	3.2	4.6	0.3	0.6	5.0	6.9	2.5	5.0	5.5	0.5	5.7	4.4
HU	2.5	3.4	0.0	0.2	6.4	4.6	0.0	5.7	4.1	0.0	6.3	0.9	4.3	11.5	4.7	3.1	0.0	4.1	2.9	2.3	1.1	5.2	5.2
IE	3.1	4.4	4.1	0.2	2.1	2.7	15.9	3.9	3.1	0.0	0.0	0.0	4.7	0.4	0.0	3.1	4.9	0.0	4.7	3.7	0.3	2.6	3.3
IT	4.2	0.0	6.1	0.5	5.1	5.9	31.1	3.5	3.1	0.0	3.2	0.0	3.6	0.3	0.0	6.1	3.2	0.0	6.2	3.3	0.0	4.5	7.3
JP	5.1	7.0	6.2	2.5	6.0	7.0	3.5	4.8	5.1	1.6	6.5	2.5	0.0	0.0	0.7	4.5	5.3	5.5	5.4	4.6	1.2	4.5	5.4
LT	4.2	5.5	0.6	1.1	4.1	4.6	0.0	5.7	4.9	13.1	4.4	1.2	4.9	0.0	57.4	5.8	1.9	5.3	6.0	4.0	7.7	7.1	5.5
LV	6.8	5.3	0.0	5.6	4.4	4.2	0.0	6.5	3.6	4.7	8.6	2.1	4.2	67.7	0.0	2.6	0.1	4.7	3.3	5.2	13.9	2.9	4.9
NL	4.7	5.0	7.7	0.8	4.7	3.9	0.4	4.8	5.8	1.6	5.2	0.0	4.0	0.0	1.3	0.0	9.1	7.6	3.5	4.8	0.0	6.3	5.1
PL	7.8	6.9	0.0	31.8	6.7	7.2	0.1	4.1	7.8	36.9	6.7	9.1	4.9	3.2	7.2	8.2	0.0	5.5	7.0	8.7	17.8	5.0	8.2
PT	5.7	1.2	6.6	0.8	4.3	5.4	13.9	5.0	1.0	0.8	0.0	22.4	4.6	0.7	0.0	5.0	4.7	0.0	4.5	3.3	1.1	6.1	5.8
SE	4.5	5.5	5.4	0.0	4.8	1.5	4.2	5.9	5.2	2.0	5.7	0.0	5.1	0.0	1.2	3.7	6.5	5.9	0.0	5.2	1.3	4.1	4.9
SI	6.9	4.6	4.4	7.6	2.9	6.0	0.0	5.3	5.1	4.2	4.9	3.7	3.6	0.8	0.5	3.7	5.9	4.3	4.7	0.0	10.1	4.8	5.6
SK	6.2	3.2	2.9	37.9	3.4	3.7	0.0	7.5	4.3	1.5	5.3	0.2	4.2	2.1	8.0	6.5	0.0	4.6	3.9	0.1	0.0	5.0	2.5
UK	3.5	3.9	5.6	0.0	2.5	4.4	10.3	4.8	5.5	0.0	3.0	0.8	3.8	0.0	0.8	4.6	5.6	6.3	3.5	4.9	0.0	0.0	2.9
US	5.1	6.3	5.9	0.8	4.0	4.5	5.7	2.4	5.0	0.9	5.0	0.0	5.3	0.0	0.0	5.2	8.3	6.8	5.3	6.2	2.8	3.8	0.0

Note: Weights on the diagonal were constrained to be zero. Weights in columns sum to 100%.

Table 3: Estimated MCS-GVAR weights – Sovereigns versus Banks – Mean estimates

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT001	2.2	4.5	7.0	3.7	2.0	1.7	0.9	2.8	1.5	1.4	5.3	1.0	4.2	0.6	1.3	1.9	1.7	1.0	4.1	0.1	4.3	1.4	3.1
AT002	5.3	12.5	7.3	2.2	8.7	7.2	3.0	8.9	11.9	7.3	2.4	6.1	4.4	1.9	3.1	5.6	6.7	5.8	4.7	5.7	1.2	8.0	5.4
BE004	5.5	1.4	4.3	5.8	4.9	8.6	2.8	12.8	3.2	2.9	9.5	0.7	3.5	4.8	6.1	3.0	2.8	3.4	2.7	3.3	14.2	3.3	5.2
BE005	3.9	4.7	6.6	4.2	6.5	5.5	0.6	0.7	5.3	3.6	3.3	9.4	4.3	6.0	6.6	0.9	4.2	5.4	5.5	2.7	4.1	2.9	3.0
DE017	0.4	0.0	0.0	1.4	0.9	0.5	5.7	0.7	2.1	0.0	7.6	0.7	1.7	0.0	0.6	0.5	0.9	2.0	0.6	5.9	0.1	9.4	1.4
DE018	0.0	2.0	1.7	0.0	1.0	0.5	0.4	3.3	0.6	2.2	1.0	0.3	1.0	0.0	1.4	1.6	0.0	2.5	1.9	0.0	0.2	0.1	2.2
DE021	1.0	1.7	1.4	4.4	1.8	1.2	0.2	1.9	1.2	1.5	1.8	0.9	2.8	1.1	0.6	1.7	2.6	1.5	1.3	3.0	1.1	2.5	2.1
DE024	0.6	0.1	1.0	2.1	1.4	1.3	2.7	4.5	3.7	0.7	2.1	0.5	2.0	0.7	1.1	2.4	2.8	2.8	2.7	1.6	5.8	5.0	1.3
ES059	3.5	0.5	8.3	0.8	3.2	2.8	5.6	0.6	3.2	6.0	4.4	0.5	1.6	1.0	2.3	3.6	1.8	0.9	7.7	1.5	0.3	2.0	3.0
ES060	0.6	1.2	1.7	5.5	0.3	1.0	16.4	0.3	0.2	1.9	0.6	0.0	0.3	13.1	2.2	1.2	0.9	1.1	0.7	0.8	0.0	1.5	0.4
FR013	12.7	0.0	2.7	0.0	4.1	2.2	0.0	0.6	4.3	1.9	0.0	0.0	2.9	0.0	2.6	8.8	0.9	1.9	0.2	0.2	0.7	5.4	1.2
FR014	1.8	0.8	0.6	1.7	0.5	0.2	10.1	0.8	0.6	1.1	0.9	0.0	1.0	1.2	0.0	0.8	1.9	1.1	1.2	3.0	1.6	0.8	1.4
FR016	3.7	0.0	1.1	0.0	2.3	0.4	0.0	0.3	1.4	0.7	0.7	1.6	1.9	0.0	0.9	0.8	1.7	1.1	0.1	0.5	0.9	0.3	3.4
GB088	0.6	0.1	1.2	6.1	1.0	1.6	1.0	0.2	2.8	0.9	0.0	4.4	1.3	1.3	2.3	1.4	0.7	1.4	0.0	2.4	2.0	1.5	5.7
GB090	0.7	0.3	2.1	0.0	0.3	0.4	2.5	0.8	1.1	0.0	0.8	0.0	1.5	0.0	1.3	2.5	1.3	0.7	0.3	0.0	0.4	9.5	0.2
GB091	4.9	1.6	0.8	1.2	2.5	1.9	0.1	0.9	3.7	1.4	0.4	0.9	2.1	0.0	0.7	2.4	8.8	0.9	1.8	1.2	3.2	0.0	1.6
IE038	4.3	6.8	4.6	2.4	3.8	3.7	3.2	2.3	3.9	4.4	1.9	1.8	2.8	4.5	4.1	3.4	2.9	2.1	3.4	3.6	0.8	2.4	3.7
IT040	0.1	4.7	1.0	1.8	4.3	0.5	0.0	1.3	0.0	2.1	4.3	1.4	0.0	0.1	3.3	1.3	0.0	0.1	0.8	1.9	0.0	0.6	2.1
IT041	0.4	1.1	2.8	1.3	3.2	0.1	3.8	0.8	0.6	0.7	0.1	0.2	0.9	0.7	4.5	4.7	4.4	0.8	5.1	1.5	0.0	0.5	2.6
IT042	2.6	0.8	1.0	1.5	1.1	7.9	0.0	8.7	2.2	1.8	5.0	2.0	4.6	2.6	2.8	1.6	1.0	3.7	2.0	2.0	0.0	2.2	0.0
IT043	3.5	8.0	2.6	2.6	3.5	3.2	2.7	6.1	2.5	4.2	6.8	0.3	3.3	0.5	2.7	1.9	1.5	3.0	2.5	3.0	10.1	2.3	1.7
NL047	0.8	0.1	0.8	5.5	1.6	0.9	0.0	1.8	1.3	0.1	2.6	0.5	1.9	0.5	0.4	1.5	0.9	1.7	1.5	1.2	1.4	0.1	3.2
NL048	0.6	0.8	3.8	2.8	2.4	3.3	0.0	2.8	3.5	5.4	4.7	2.6	4.3	3.3	1.3	1.4	2.5	7.5	6.3	2.6	5.0	5.1	4.8
NL049	0.9	0.2	0.0	1.8	2.6	4.2	1.0	0.5	1.1	0.1	2.2	1.4	1.4	11.4	0.8	0.7	3.3	3.6	0.0	1.4	0.8	0.6	2.9
NL050	2.8	9.4	2.4	3.5	2.1	3.8	2.8	2.1	2.7	6.7	1.9	2.2	3.2	1.4	1.5	6.8	6.7	3.8	1.9	3.1	9.1	2.1	2.3
PT054	2.0	0.6	1.1	2.7	4.1	1.6	1.8	2.0	2.7	5.3	1.1	5.9	1.8	7.4	10.3	0.8	2.5	3.8	3.4	4.9	1.6	2.7	5.9
PT055	1.1	0.1	1.0	1.8	2.6	4.3	1.6	2.0	4.0	0.9	1.2	12.1	2.6	9.6	1.9	4.6	2.4	2.1	3.1	2.1	4.1	1.9	1.7
SE084	8.3	5.8	6.7	8.0	4.7	4.9	2.7	3.9	4.1	0.7	3.3	2.3	4.9	4.2	0.4	6.1	5.8	9.0	5.5	6.7	0.2	3.9	4.7
CH001	0.0	2.1	0.3	1.7	1.2	1.2	1.0	1.7	1.0	10.0	3.3	0.1	2.0	0.0	8.1	0.0	5.5	1.1	11.3	0.5	2.9	0.0	1.0
CH002	1.4	0.1	0.0	1.6	1.3	3.6	0.6	1.6	1.2	0.8	1.5	2.8	1.6	0.6	0.0	1.9	1.8	0.8	1.1	7.4	1.1	1.1	0.2
US001	3.4	0.0	1.3	2.1	1.3	1.3	0.0	1.9	7.2	11.3	0.9	1.8	2.7	2.4	3.0	4.0	1.3	1.5	0.6	2.5	0.6	1.6	2.0
US002	0.8	2.0	1.4	0.4	0.7	1.0	1.4	1.7	0.6	0.5	3.1	1.2	0.6	0.7	5.1	1.4	0.1	0.9	0.6	1.5	0.8	0.7	1.2
US003	0.5	0.4	3.2	3.9	0.8	3.3	4.6	1.5	0.8	0.3	0.8	0.6	1.0	0.4	3.0	0.3	0.6	3.0	0.0	0.0	2.3	4.9	0.7
US004	2.0	7.3	1.8	0.4	1.0	0.9	2.6	0.3	0.3	0.4	1.7	7.7	1.2	0.7	0.0	0.9	1.3	0.9	0.5	0.0	3.7	0.0	3.0
US005	0.9	0.7	1.0	0.0	2.0	0.6	2.2	1.4	2.1	0.3	1.0	3.2	2.9	0.2	0.1	0.4	5.4	2.7	1.6	3.2	1.8	0.0	2.7
US006	0.3	4.0	2.4	5.2	1.3	0.8	3.5	0.0	0.6	1.7	1.5	6.9	0.1	0.1	0.0	1.0	0.0	2.9	6.9	4.1	0.4	0.2	2.5
US008	2.0	5.6	0.2	1.2	2.3	2.1	3.8	0.4	0.6	1.0	1.7	0.8	1.1	8.9	1.8	0.3	2.1	0.4	0.3	1.2	1.8	0.7	1.0
JP001	1.6	0.3	1.8	2.0	1.2	2.0	1.8	9.2	2.0	1.3	1.1	0.5	4.5	0.4	4.1	0.8	1.7	1.6	0.3	4.0	3.2	4.8	1.1
JP002	3.6	0.8	2.8	2.9	3.4	2.7	1.8	1.2	1.9	2.7	1.9	7.4	7.0	5.6	6.2	8.4	1.9	4.2	0.9	1.6	4.2	2.2	3.6
JP003	1.3	6.4	5.8	1.9	4.8	2.4	4.1	1.4	4.6	2.3	4.0	4.6	2.8	1.1	0.0	4.0	2.4	4.3	3.7	5.2	0.5	4.6	2.9
JP004	7.4	0.4	2.3	1.9	1.4	2.6	1.0	3.4	1.4	1.3	1.5	2.7	3.9	0.8	1.8	2.8	2.3	1.2	1.0	2.9	3.6	1.1	1.4

Note: Weights in columns sum to 100%.

Table 4: Estimated MCS-GVAR weights – Banks versus banks – Mean estimates

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT001	0.0	64.8	2.4	3.0	4.2	1.2	1.5	4.9	0.3	2.7	1.9	1.6	0.6	0.8	1.1	1.3	2.0	0.8	1.9	1.3	2.2	3.6	2.6	1.1	2.8	1.0	0.0	3.0	1.5	1.3	1.4	0.6	0.0	0.2	2.1	0.6	1.1	0.0	1.0	2.0	0.0
AT002	45.9	0.0	2.7	3.0	0.7	2.4	2.5	2.7	0.0	3.7	1.4	3.7	1.6	2.3	1.3	0.3	4.0	2.7	0.3	1.8	4.0	1.6	7.1	3.3	3.1	0.9	0.8	4.5	1.6	0.5	0.8	2.5	0.6	0.0	0.5	1.8	1.6	2.0	2.3	1.7	1.4
BE004	1.2	2.8	0.0	4.0	2.1	3.5	2.2	4.5	1.6	4.9	2.3	2.7	2.0	0.5	2.6	1.3	5.7	3.2	1.9	2.6	8.0	2.0	4.8	3.5	5.7	1.8	0.2	5.4	3.4	0.0	3.1	1.2	1.5	1.2	1.6	3.4	0.0	0.6	1.4	8.1	0.0
BE005	1.9	2.4	5.3	0.0	0.6	8.3	0.1	1.2	0.0	3.2	1.4	1.9	2.8	1.0	1.0	1.7	2.0	1.4	6.7	1.0	2.3	0.7	9.4	2.7	4.9	0.0	2.1	2.6	6.8	0.2	3.4	0.0	2.3	2.4	0.0	1.1	0.0	1.8	1.7	1.8	3.1
DE017	4.5	0.0	0.7	0.3	0.0	20.2	3.4	5.8	0.0	1.7	3.5	1.1	0.8	5.6	6.2	0.0	2.4	4.4	0.0	0.0	1.4	0.1	0.0	0.1	0.0	0.0	1.8	2.8	3.8	9.7	0.8	0.0	0.0	5.5	0.0	0.0	0.6	0.0	0.0	0.4	0.0
DE018	0.0	0.0	0.1	3.0	16.5	0.0	0.0	6.1	0.0	1.8	5.8	1.4	0.0	5.0	1.4	0.0	3.3	0.1	6.4	0.1	1.5	1.8	0.7	1.6	0.1	0.0	0.0	3.1	2.0	1.4	0.0	0.0	0.0	1.8	0.0	0.0	1.0	3.5	0.0	2.0	0.0
DE021	5.4	3.1	8.1	2.8	1.3	3.1	0.0	12.8	0.2	2.3	2.1	1.8	3.0	0.0	2.3	1.7	2.7	0.6	0.6	1.4	1.5	1.4	2.3	1.5	3.2	1.1	3.8	1.7	1.0	0.3	1.2	0.6	1.3	0.0	0.3	2.7	0.5	3.2	0.7	1.8	2.0
DE024	5.6	0.8	3.6	1.9	3.2	3.1	0.0	0.0	2.0	0.6	2.4	0.1	1.4	0.1	0.0	1.0	1.2	0.3	0.7	2.2	1.6	3.8	1.7	2.4	1.6	0.8	1.3	2.7	0.8	0.1	0.0	0.8	0.0	0.7	0.0	1.0	1.3	0.0	0.0	0.8	1.9
ES059	0.0	0.0	0.8	1.6	0.5	0.1	3.1	2.2	0.0	13.2	0.5	0.6	0.0	2.0	1.7	0.1	0.9	4.9	0.0	0.0	12.7	1.1	1.4	0.1	3.6	0.0	5.6	2.4	1.1	0.0	0.8	1.8	0.8	0.3	0.1	0.0	0.0	0.8	0.0	2.0	11.4
ES060	4.2	1.2	0.7	2.3	3.1	2.5	0.6	0.1	38.3	0.0	3.5	0.7	0.4	0.0	1.0	4.7	0.6	2.3	1.8	7.6	0.0	0.0	0.5	0.2	0.0	12.8	3.2	0.0	0.8	1.5	0.0	0.0	0.0	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.1
FR013	1.0	0.0	0.0	0.0	4.1	7.5	0.0	4.2	0.0	3.3	0.0	7.8	17.8	0.0	2.0	3.6	2.9	0.6	0.0	2.2	1.8	0.0	0.0	3.4	2.9	0.0	1.4	1.5	4.6	1.5	0.0	2.6	0.1	0.0	0.1	0.5	0.0	0.0	0.0	0.1	0.0
FR014	6.2	0.0	8.0	2.1	2.8	3.1	1.1	0.8	0.1	1.2	16.3	0.0	30.3	0.0	3.2	2.5	5.2	0.1	3.5	5.9	2.9	0.0	0.8	0.1	2.5	0.0	0.6	3.5	4.6	1.4	0.8	0.6	0.6	0.0	1.3	0.0	0.0	0.0	0.0	1.8	0.0
FR016	0.0	0.0	0.0	0.0	1.8	0.2	0.0	1.0	0.0	1.2	20.8	14.8	0.0	0.0	5.4	3.8	0.0	0.9	0.0	2.7	0.0	5.5	0.0	0.0	1.7	0.0	4.4	0.0	5.8	0.0	0.1	0.4	0.0	0.0	0.1	0.9	0.0	0.0	0.0	0.9	0.0
GB088	0.0	0.0	1.9	1.8	7.5	6.5	8.4	1.0	2.1	0.0	0.0	0.0	0.1	0.0	23.9	26.8	0.5	1.4	5.0	0.0	0.0	4.4	0.1	22.0	2.0	0.0	0.2	5.9	0.0	0.6	2.0	0.0	8.2	0.0	0.0	0.0	0.0	4.6	0.0	1.1	0.0
GB090	0.0	0.0	0.0	0.0	7.1	1.9	0.0	1.0	1.4	0.7	1.4	0.6	4.5	21.4	0.0	9.0	4.5	1.5	1.2	0.0	0.0	6.0	1.0	0.0	0.0	0.0	2.1	0.0	7.2	2.0	0.0	0.0	0.0	0.0	0.1	0.6	0.0	0.0	0.0	0.7	0.0
GB091	0.9	0.0	1.9	2.1	0.0	0.1	2.2	0.6	0.0	4.1	2.8	1.3	3.2	24.3	8.8	0.0	0.1	5.5	0.0	1.2	3.1	3.8	0.0	0.7	0.6	0.0	5.0	0.5	0.6	7.3	0.0	0.4	0.0	3.2	0.0	0.0	1.6	1.2	2.9	0.9	0.0
IE038	1.7	0.8	4.4	2.6	1.6	0.9	3.4	2.5	2.4	2.8	1.5	4.4	2.9	2.4	0.1	2.0	0.0	0.9	1.2	2.2	2.8	3.8	2.0	1.9	4.3	0.0	2.2	3.9	1.6	1.2	0.8	0.1	3.3	0.5	0.0	1.2	0.8	1.5	0.0	2.8	0.6
IT040	0.0	0.0	0.0	0.0	5.8	0.1	3.7	0.9	6.2	2.4	0.4	0.0	1.2	0.0	1.8	5.2	1.5	0.0	18.4	23.9	1.5	3.8	0.0	0.1	0.5	1.0	0.8	1.8	0.3	0.0	0.0	1.7	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
IT041	2.2	0.0	0.8	2.6	0.0	7.5	4.3	0.0	0.0	2.1	0.3	1.7	0.0	3.2	1.9	0.1	1.9	14.8	0.0	16.4	4.1	1.1	0.2	5.1	1.0	0.0	0.0	0.0	3.1	3.8	0.0	2.4	0.0	1.2	0.3	0.0	0.0	0.0	0.0	2.1	0.0
IT042	4.1	0.0	2.9	1.4	0.7	0.8	5.6	3.3	0.0	6.7	2.0	3.4	2.7	0.0	0.0	3.3	0.0	26.5	20.7	0.0	4.5	2.2	3.6	0.3	1.0	4.0	2.6	3.4	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.4	1.6	0.0
IT043	0.1	1.4	9.4	5.7	0.0	3.8	3.9	3.0	12.5	1.4	0.0	1.9	1.1	2.7	2.5	0.4	4.3	2.2	2.8	2.5	0.0	0.5	7.5	1.9	7.7	0.8	1.3	4.4	2.4	1.9	7.0	0.3	1.6	0.0	1.9	0.8	0.0	0.0	0.0	9.3	0.0
NL047	2.8	0.0	0.7	4.1	0.5	1.8	5.9	6.0	1.4	0.1	0.5	0.0	3.6	2.2	2.5	2.6	0.0	2.0	1.3	1.0	1.8	0.0	0.0	13.2	1.7	0.8	0.0	0.0	2.6	0.0	0.0	0.0	0.7	0.0	0.1	0.7	2.2	0.0	0.0	0.5	3.5
NL048	3.7	0.0	3.3	9.7	4.7	1.5	2.4	3.1	2.7	2.3	5.1	1.2	0.7	1.2	0.2	5.3	2.8	2.1	2.0	1.2	3.0	19.4	0.0	6.9	4.5	2.3	0.0	6.8	2.6	6.0	4.3	1.2	0.0	0.0	0.0	4.4	2.3	0.0	0.0	2.1	4.2
NL049	0.0	1.7	2.8	1.1	0.9	1.5	2.2	3.6	0.0	1.8	3.5	0.6	0.0	10.9	0.0	0.8	5.5	0.9	3.6	0.0	1.7	11.6	0.0	0.0	1.0	0.0	2.6	2.4	1.0	4.0	0.0	2.2	0.8	0.1	0.0	0.7	0.3	0.0	0.0	0.7	0.0
NL050	0.0	7.6	5.9	3.1	2.5	1.8	1.8	3.1	3.8	2.6	1.0	7.4	0.1	1.5	2.7	1.9	5.0	2.0	1.3	1.8	8.4	3.7	1.3	1.6	0.0	4.3	0.0	2.3	1.9	5.2	3.3	0.2	1.2	0.0	0.2	7.0	0.0	1.5	0.0	15.0	1.4
PT054	0.9	0.9	0.6	6.7	0.0	1.7	0.0	1.9	0.2	6.7	0.0	1.5	0.0	2.0	0.7	0.2	4.8	2.2	0.4	4.3	1.2	0.8	0.8	0.9	3.9	0.0	54.5	3.2	1.1	4.0	0.0	3.1	0.0	0.0	3.3	1.0	0.0	0.1	0.2	2.1	0.0
PT055	0.0	0.0	1.7	2.0	2.1	0.4	0.0	2.2	8.9	1.7	0.4	0.5	2.1	0.0	2.6	3.2	0.7	1.2	0.0	2.5	1.3	0.0	4.6	3.2	2.4	63.5	0.0	3.0	0.7	0.8	0.0	0.0	1.2	2.4	0.9	0.0	0.0	0.0	0.0	1.6	0.0
SE084	3.3	2.4	3.6	4.7	0.8	1.1	4.1	3.1	1.4	4.1	2.0	5.1	5.0	0.0	3.4	3.2	4.6	2.6	4.1	2.0	2.9	3.4	8.5	2.3	4.3	0.4	0.4	0.0	2.0	0.6	5.3	1.9	0.0	0.9	0.3	2.0	1.5	1.4	0.8	3.9	2.3
CH001	0.0	0.0	0.9	0.7	4.7	3.1	0.8	1.7	0.0	2.0	4.5	2.6	4.8	0.0	8.2	0.2	4.0	1.0	3.5	0.0	1.2	3.4	0.0	2.7	1.3	0.3	0.0	3.4	0.0	29.8	0.0	0.0	0.0	3.2	0.5	1.2	0.0	1.1	0.2	0.9	2.4
CH002	0.0	0.0	2.5	1.4	8.8	1.7	3.1	1.9	0.0	1.7	1.3	1.3	0.0	0.0	1.6	5.2	0.8	0.3	4.2	0.0	0.5	0.0	0.0	4.8	5.1	1.9	0.1	2.0	23.4	0.0	0.0	0.0	0.0	0.2	0.0	1.6	0.1	5.1	2.1	2.2	0.0
US001	1.1	0.0	0.8	0.5	1.2	1.1	3.5	1.5	3.7	2.0	0.2	3.0	1.7	1.5	1.0	0.4	4.2	0.5	1.0	1.1	2.3	0.5	0.7	1.5	0.7	0.1	0.0	0.3	0.7	0.0	0.0	10.6	0.8	1.8	6.3	6.7	4.8	0.6	1.4	0.9	0.0
US002	0.0	0.8	1.0	2.0	0.0	0.4	4.2	0.6	1.6	1.1	1.8	1.4	0.1	0.0	2.0	0.1	2.2	0.9	1.9	0.0	1.0	0.0	2.1	1.8	1.0	0.5	0.0	0.3	0.0	0.2	21.0	0.0	16.6	9.8	11.1	2.7	26.4	0.0	0.0	1.5	0.0
US003	0.0	0.0	0.5	0.6	0.1	0.2	0.7	1.4	0.9	0.9	1.1	1.0	0.0	1.9	0.4	0.1	0.0	3.0	0.0	0.0	0.3	0.8	5.3	0.1	0.2	0.0	0.7	3.7	0.0	0.5	0.7	11.6	0.0	6.3	9.4	9.1	9.1	0.0	0.0	0.2	0.2
US004	0.0	0.0	0.6	0.3	3.9	0.3	5.3	0.5	0.0	0.3	0.3	0.1	0.1	0.0	0.0	0.8	1.6	0.1	0.5	0.0	2.1	0.2	7.1	0.6	0.7	0.0	1.4	2.3	1.7	0.1	2.4	8.9	9.0	0.0	11.8	39.7	2.5	0.7	0.0	1.3	0.0
US005	1.0	0.0	0.5	5.5	0.2	0.6	2.4	1.5	0.0	0.4	0.5	0.6	0.4	0.0	1.8	0.3	4.0	0.2	0.5	1.6	0.7	0.5	6.0	1.1	1.0	0.0	0.0	3.5	0.0	0.0	13.4	12.1	15.3	14.3	0.0	0.7	38.9	0.0	0.6	1.0	0.0
US006	0.0	0.0	1.0	0.8	0.1	0.3	0.1	0.9	0.1	1.8	0.7	2.1	1.2	0.0	1.3	0.1	0.4	0.4	0.1	1.0	0.4	1.5	0.0	1.3	4.1	0.0	0.0	1.0	0.5	2.0	10.9	2.6	11.9	37.5	1.2	0.0	0.6	9.1	0.0	1.1	0.0
US008	1.4	1.0	2.9	6.3	0.9	2.3	2.5	1.2	1.1	1.9	1.5	5.6	1.1	0.0	1.6	0.9	1.4	0.4	1.0	1.1	2.5	1.6	1.1	1.0	2.7	0.0	0.0	1.9	2.0	2.1	10.5	28.6	15.6	4.4	38.9	0.8	0.0	0.9	0.0	1.5	0.0
JP001	0.0	2.8	1.6	1.6	0.9	1.8	2.7	1.6	0.4	1.2	1.0	2.7	0.7	2.3	0.0	1.2	2.1	1.1	0.2	0.8	1.4	0.8	5.0	0.5	1.4	0.5	0.2	2.0	0.9	2.5	0.6	0.0	0.1	0.8	0.1	3.3	2.0	0.0	52.1	1.4	29.8
JP002	0.8	2.6	1.5	2.4	2.2	0.7	3.9	2.1	0.0	3.2	1.9	4.5	0.4	0.9	0.9	2.9	3.9	0.5	0.0	4.1	1.7	1.9	4.9	1.6	2.0	0.8	0.3	3.5	2.6	2.8	2.3	0.6	0.5	0.6	2.4	1.0	0.0	40.2	0.0	10.2	10.5
JP003	0.0	1.2	12.1	4.4	0.7	0.7	6.9	2.1	3.0	2.6	1.7	5.0	0.5	2.5	0.4	1.5	3.9	2.6	0.3	1.8	8.2	0.8	5.1	1.7	11.2	0.0	0.3	3.1	1.6	3.8	2.2	0.0	1.6	0.0	0.2	2.2	0.6	1.7	22.4	0.0	25.3
JP004	0.0	1.6	1.8	2.0	0.9	0.4	1.4	1.4	3.4	1.7	0.9	2.6	1.0	1.8	0.8	0.3	2.2	1.2	0.8	0.8	1.6	1.9	1.7	0.9	1.6	0.2	0.0	2.1	1.5	0.6	0.6	0.5	1.4	0.1	0.7	0.6	0.3	18.5	9.6	9.9	0.0

Note: Weights on the diagonal were constrained to be zero. Weights in columns sum to 100%.

Table 5: Estimated MCS-GVAR weights – Banks versus Sovereigns – Mean estimates

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT	6.5	2.3	1.2	2.8	4.2	7.3	2.3	5.3	4.5	2.9	15.4	3.3	6.6	3.7	5.1	5.2	5.6	4.1	3.9	2.8	2.7	3.0	5.3	3.0	2.2	3.4	3.8	4.9	7.2	1.9	1.3	2.6	2.4	2.1	3.6	2.5	3.2	2.0	5.4	5.9	5.1
BE	4.4	4.5	3.4	2.6	5.8	5.2	6.5	5.0	4.0	3.2	3.8	6.5	4.7	5.1	3.9	2.7	15.4	5.2	12.2	3.5	6.6	7.1	8.0	5.5	12.8	4.9	8.6	5.7	2.5	3.1	9.7	8.2	4.2	5.1	3.7	3.8	9.4	3.7	2.6	11.7	12.8
BG	8.2	4.9	4.1	6.5	5.4	7.4	2.7	7.4	15.5	5.8	5.4	3.9	5.9	8.2	3.8	3.7	16.0	5.1	3.1	3.7	4.7	8.2	3.9	13.0	6.8	5.1	5.7	5.6	3.4	18.6	6.9	9.7	6.6	2.7	5.2	3.0	3.7	2.2	3.0	9.0	2.3
CZ	4.2	5.7	3.6	12.1	5.0	4.5	11.0	2.5	6.8	5.7	5.5	2.8	11.9	5.8	3.6	4.4	4.9	4.7	5.4	7.2	2.9	6.3	2.7	3.3	9.8	4.8	4.4	17.7	4.0	4.2	3.9	10.8	14.1	2.9	3.2	3.8	5.7	3.6	1.3	7.1	2.1
DE	5.4	6.1	2.9	3.2	3.5	5.2	5.9	7.2	7.9	3.9	3.7	3.4	7.4	3.6	7.1	5.2	5.4	5.1	6.2	3.2	3.1	7.3	6.9	4.3	3.8	2.0	8.5	4.7	2.9	3.7	2.0	2.6	4.1	5.9	9.3	4.1	8.1	2.7	1.4	5.9	6.1
DK	2.1	3.0	2.4	2.5	3.0	3.5	1.4	1.1	1.7	2.6	2.3	1.4	1.3	2.8	1.9	3.6	1.5	2.7	6.7	5.4	3.2	2.4	1.6	3.5	5.0	4.3	1.3	1.7	7.0	1.4	1.2	1.8	4.0	3.6	3.1	1.8	3.7	2.8	1.9	1.9	6.1
ES	9.3	2.8	4.5	3.7	3.2	4.1	4.6	3.3	4.2	12.1	1.5	18.1	8.4	6.8	2.9	4.5	2.3	4.3	3.5	7.5	3.9	2.8	4.1	3.2	1.2	6.3	2.0	3.2	2.2	2.0	3.6	4.9	3.2	3.0	3.1	2.5	3.0	9.9	6.7	2.5	2.9
FR	3.9	4.0	0.0	1.3	2.1	1.2	2.0	2.1	0.1	2.5	1.2	1.7	2.7	1.9	7.2	3.1	1.8	4.9	0.4	6.6	7.9	1.5	1.1	1.3	1.3	1.8	9.2	2.1	3.6	0.8	1.1	3.9	2.6	1.8	3.9	1.9	1.8	11.2	1.6	0.8	2.2
GR	1.4	3.1	2.4	2.4	2.6	3.3	1.9	1.2	1.1	1.8	3.2	2.3	2.1	5.2	2.8	2.8	1.6	4.9	2.3	2.4	0.9	1.1	2.0	1.6	2.6	4.3	0.7	2.0	2.2	1.7	2.0	4.8	1.8	1.8	1.1	1.3	1.4	2.0	1.0	1.0	3.1
HU	13.1	5.7	2.9	3.1	4.6	7.6	3.8	2.4	3.7	2.7	3.3	4.7	5.4	2.6	2.5	3.6	0.0	4.6	4.1	2.7	7.3	3.6	10.4	4.5	0.6	6.8	3.4	3.1	19.7	2.9	31.5	2.8	6.9	7.5	4.9	2.5	4.5	12.2	2.9	3.8	3.7
IE	4.4	4.9	0.5	3.2	7.4	2.9	5.9	2.1	3.4	2.2	2.2	2.4	1.9	3.0	6.4	4.3	1.2	2.8	8.2	3.1	13.2	6.6	2.3	1.6	2.2	2.2	6.7	3.1	1.6	5.4	5.6	1.2	2.5	3.4	3.8	2.7	2.5	3.8	3.3	7.7	3.9
IT	2.5	3.3	10.6	7.5	4.3	3.2	2.4	10.0	3.1	6.3	6.3	9.5	1.9	4.3	9.0	4.4	2.3	1.9	3.1	1.8	3.3	5.9	7.6	5.4	3.2	2.7	4.7	2.2	5.4	0.2	1.8	2.6	4.9	14.6	2.2	11.6	1.9	4.3	7.7	4.9	2.0
JP	2.7	5.3	2.3	2.4	2.7	3.8	2.5	6.1	2.9	2.3	2.6	3.0	2.3	6.2	3.1	5.2	6.3	3.7	8.7	10.7	3.0	2.0	7.9	3.3	6.7	1.8	2.1	2.7	1.7	4.2	3.1	2.2	3.0	8.1	6.4	4.6	7.6	2.5	8.9	4.8	10.1
LT	3.0	6.0	2.2	4.9	3.3	6.7	12.3	5.3	12.0	19.4	4.7	7.8	4.7	6.8	12.7	6.4	11.6	5.2	3.3	5.9	2.7	6.5	4.3	12.0	3.5	3.6	5.1	4.5	4.0	9.2	6.1	0.8	4.9	1.4	5.2	7.2	10.5	5.6	10.2	8.0	4.2
LV	6.1	2.3	2.9	6.2	4.4	6.4	2.4	5.8	2.9	5.0	7.8	7.5	7.9	4.8	2.3	4.6	3.8	5.1	4.3	5.3	3.1	4.0	3.6	4.0	6.8	14.1	2.5	8.8	8.7	4.2	3.2	10.5	3.4	5.6	3.1	8.4	5.8	3.4	12.8	3.1	6.4
NL	2.1	2.1	3.4	2.7	2.2	2.3	1.9	1.3	2.0	2.5	8.5	2.1	5.5	4.1	1.7	2.9	3.0	4.1	1.5	1.4	1.2	8.2	3.1	2.5	8.2	3.5	1.0	1.7	2.8	2.0	1.1	2.4	4.0	3.6	2.1	1.5	1.7	3.1	5.1	1.0	1.8
PL	2.6	10.3	2.6	15.3	3.4	5.1	7.7	5.3	2.4	3.4	3.2	3.8	2.3	3.5	7.1	14.6	0.5	5.1	6.7	2.6	7.3	3.2	2.4	4.2	8.0	2.8	4.2	6.7	3.3	9.1	2.7	3.1	2.9	3.7	6.7	2.1	2.5	4.0	3.6	2.9	4.3
PT	3.1	4.1	3.9	3.1	4.9	4.4	2.0	2.7	6.1	2.6	3.2	2.9	2.5	5.8	2.5	2.9	1.5	6.5	3.8	8.2	2.7	2.7	4.5	3.9	5.6	7.7	14.3	3.1	2.2	7.4	2.4	3.8	8.0	6.2	10.5	7.8	9.6	2.4	0.7	3.4	2.2
SE	3.8	3.0	4.5	2.7	3.2	2.8	5.3	1.8	3.7	3.1	1.6	2.8	3.7	2.6	4.1	2.3	3.1	2.6	2.1	3.4	3.8	2.1	2.7	6.1	1.6	2.2	1.9	1.6	0.0	3.3	1.9	6.6	4.5	1.4	5.2	9.1	2.0	3.0	12.0	2.3	4.1
SI	3.0	4.6	1.1	1.5	8.2	4.6	2.7	3.1	3.4	2.8	2.1	2.1	2.3	3.4	1.9	3.6	1.3	5.3	1.5	2.9	6.4	1.8	2.1	2.6	2.3	3.4	1.3	6.2	0.4	5.5	2.3	2.7	2.4	8.5	4.6	9.5	2.3	3.4	1.6	1.5	3.3
SK	2.9	2.8	24.4	6.5	4.4	2.2	8.3	14.9	3.4	3.0	3.1	2.9	3.5	3.2	2.6	1.9	9.0	5.3	3.1	2.7	6.1	8.4	8.5	3.2	1.5	1.8	4.8	2.7	9.2	1.7	1.9	3.5	0.0	2.3	1.7	2.6	2.7	2.2	1.6	6.9	4.6
UK	2.2	3.4	10.3	2.3	7.2	3.5	1.6	1.8	1.4	2.3	7.2	2.7	2.2	3.8	0.3	3.4	1.6	3.2	2.8	3.8	1.0	3.0	2.5	4.2	2.3	3.8	2.3	4.0	4.5	5.6	1.8	5.8	6.6	1.7	2.8	3.0	1.9	5.5	2.9	1.8	5.0
US	2.9	5.9	3.9	1.6	5.1	2.9	3.0	2.3	4.0	1.7	2.2	2.5	2.9	2.8	5.5	4.7	0.3	3.6	3.1	3.0	3.1	2.4	2.4	3.7	2.0	6.7	1.3	2.2	1.6	2.0	2.8	2.6	3.0	2.8	4.7	2.5	4.5	4.3	1.6	2.1	1.5

Note: Weights in columns sum to 100%.

Table 6: Estimated MCS-GVAR weights – Sovereigns versus Sovereigns – Lower bounds

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT		5.1	3.9	2.7	2.6	1.9	5.9	0.0	3.9	0.0	1.9	0.0	3.3	0.0	0.0	2.0	4.6	3.7	3.0	5.2	0.0	1.9	3.3
BE	5.8		4.3	0.0	3.8	2.5	0.0	0.0	4.4	0.0	4.2	11.9	6.7	0.0	0.0	3.3	6.7	0.3	5.0	4.6	0.0	2.3	5.7
BG	6.2	5.9		0.0	6.0	6.7	0.0	3.0	4.4	26.0	2.9	0.0	4.9	7.7	9.9	6.2	0.0	7.4	4.8	2.8	0.8	4.0	3.6
CZ	0.0	5.3	2.1		6.1	1.8	0.0	1.6	3.1	0.0	3.1	0.0	2.7	0.0	2.7	2.8	0.0	2.6	5.0	0.0	30.1	5.2	3.1
DE	3.7	4.0	5.5	0.0		4.6	0.0	0.0	5.2	0.0	2.6	0.0	5.7	0.0	0.0	2.2	7.0	4.2	3.6	2.5	0.0	1.8	3.2
DK	3.0	3.1	6.0	1.6	4.8		0.5	5.2	4.8	0.0	2.7	0.0	6.2	0.0	0.0	2.5	6.0	5.8	1.2	6.6	0.0	4.1	3.4
ES	0.0	2.1	2.3	0.0	1.6	1.4		0.6	3.3	0.0	0.0	25.1	0.0	0.0	0.0	2.9	3.5	0.0	0.0	4.0	0.0	0.0	0.0
FR	0.0	0.0	2.4	0.0	0.0	3.8	0.0		3.4	0.0	2.2	0.0	1.8	0.0	0.0	1.6	2.6	2.1	3.1	3.6	0.0	2.1	0.0
GR	4.6	4.2	4.0	1.2	4.7	4.3	0.0	4.3		0.0	3.6	1.9	4.3	0.0	0.0	4.7	6.0	1.7	4.6	5.0	0.0	4.9	4.2
HU	0.0	1.9	0.0	0.0	4.4	3.2	0.0	1.8	2.9		3.9	0.0	3.2	8.9	1.4	2.0	0.0	2.0	1.3	0.0	0.0	2.4	3.9
IE	1.3	3.4	2.8	0.0	1.3	1.1	12.6	2.2	2.6	0.0		0.0	4.0	0.0	0.0	2.2	3.8	0.0	4.2	3.0	0.0	0.0	2.6
IT	2.6	0.0	1.6	0.0	3.5	5.0	27.4	0.9	2.3	0.0	0.2		2.1	0.0	0.0	4.8	1.0	0.0	4.9	1.2	0.0	1.5	6.1
JP	3.9	6.4	4.7	0.9	5.4	6.5	2.1	3.1	4.7	0.3	5.6	0.4		0.0	0.0	3.5	4.3	4.5	4.9	3.8	0.0	3.4	5.0
LT	2.5	4.5	0.0	0.0	1.8	2.4	0.0	2.7	4.0	5.3	1.2	0.0	3.7		54.2	4.4	0.0	1.3	4.7	2.2	3.3	4.2	4.4
LV	4.5	4.1	0.0	0.0	1.6	2.9	0.0	1.8	2.7	0.0	6.7	0.0	2.8	62.3		1.3	0.0	3.3	2.0	3.6	9.7	0.1	3.8
NL	3.1	4.2	5.5	0.0	2.8	2.6	0.0	2.9	5.4	0.0	4.1	0.0	3.4	0.0	0.0		7.6	6.0	2.2	4.1	0.0	4.6	4.5
PL	6.1	5.3	0.0	28.4	4.8	6.3	0.0	0.8	7.0	29.6	4.5	6.7	3.5	0.9	5.0	7.7		3.4	5.8	7.1	13.1	1.8	6.7
PT	4.5	0.0	4.9	0.0	3.4	4.7	10.7	2.3	0.3	0.0	0.0	19.0	3.8	0.0	0.0	4.3	3.9		3.8	2.3	0.0	5.0	4.8
SE	3.7	5.1	3.8	0.0	3.7	0.6	3.1	4.4	4.8	0.4	4.8	0.0	4.6	0.0	0.0	1.8	6.0	4.6		4.5	0.0	2.5	4.3
SI	6.2	3.6	2.8	5.7	1.4	5.4	0.0	3.6	4.7	2.3	3.9	0.7	2.8	0.0	0.0	3.1	4.8	2.9	4.2		7.6	3.8	5.1
SK	4.7	1.8	1.0	33.1	2.0	2.6	0.0	3.7	3.6	0.0	3.1	0.0	3.0	1.0	5.8	5.9	0.0	3.2	2.6	0.0		3.4	1.4
UK	2.2	2.8	3.4	0.0	1.6	3.5	7.7	2.8	5.0	0.0	0.4	0.0	3.1	0.0	0.0	3.4	4.7	5.5	2.0	4.1	0.0		2.1
US	4.5	5.4	4.3	0.0	3.1	3.4	3.6	0.8	4.6	0.0	3.8	0.0	4.9	0.0	0.0	4.6	6.9	5.8	4.6	5.7	0.7	2.5	

Note: Error bounds do not need to sum to 100% in columns. The lower bound marks the 10th percentile of the weights' distribution.

Table 7: Estimated MCS-GVAR weights – Sovereigns versus Banks – Lower bounds

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT001	0.0	1.6	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.8	0.0	3.1	0.0	0.0
AT002	2.1	9.8	4.6	0.0	0.4	0.0	0.9	3.4	0.0	6.2	0.0	5.2	0.3	1.0	0.9	3.2	5.5	0.0	0.0	0.0	0.2	3.6	1.8
BE004	3.9	0.0	2.9	1.0	2.7	0.0	0.0	10.4	0.2	0.0	7.5	0.0	0.4	3.9	4.5	0.4	1.5	1.8	0.3	2.4	12.0	0.0	0.0
BE005	2.0	3.2	4.6	1.3	0.0	0.1	0.0	0.0	2.4	1.5	1.7	7.7	3.1	4.6	5.5	0.0	2.7	1.0	3.9	1.6	3.0	0.4	1.6
DE017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0
DE018	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
DE021	0.0	0.6	0.1	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.6	1.4	0.0	0.1	0.0	0.1	1.1	0.0
DE024	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.9	0.0	0.8	0.0	4.5	2.4	0.0
ES059	0.0	0.0	6.4	0.0	0.0	0.0	1.0	0.0	0.0	3.4	1.3	0.0	0.0	0.0	0.1	0.6	0.2	0.0	4.8	0.0	0.0	0.0	0.5
ES060	0.0	0.0	0.0	0.0	0.0	0.0	11.5	0.0	0.0	0.0	0.0	0.0	0.0	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR013	8.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR014	0.0	0.0	0.0	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
FR016	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GB088	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
GB090	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0
GB091	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	0.0	0.0
IE038	3.5	5.8	4.0	0.0	0.7	1.3	1.2	1.3	1.8	3.8	0.7	0.5	1.6	4.2	3.2	2.1	1.7	1.2	2.2	0.7	0.2	1.2	1.4
IT040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT041	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT042	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.3	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT043	1.6	6.4	0.7	0.6	0.0	0.5	0.0	3.4	0.0	2.0	5.3	0.0	0.0	0.0	0.7	0.3	0.1	0.0	0.5	1.0	9.1	0.0	0.0
NL047	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL048	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.4	0.0	2.5	0.0	1.0	0.0	2.1	0.0	0.0	1.0	0.0	3.8	0.4	2.3	0.3	1.9
NL049	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL050	1.0	7.6	0.9	0.0	0.0	0.0	0.0	0.3	0.4	4.5	0.2	0.9	1.0	0.5	0.3	4.2	0.0	0.7	0.1	0.1	7.9	0.0	0.0
PT054	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	3.7	0.0	6.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT055	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	0.0	7.7	0.0	0.0	0.6	0.0	0.0	0.1	2.4	0.0	0.0
SE084	5.9	4.2	6.0	0.0	2.9	2.6	0.6	2.4	2.1	0.0	1.5	1.2	2.9	3.3	0.0	5.0	4.9	0.0	4.3	0.1	0.0	2.2	3.2
CH001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.0	0.0	5.0	0.0	3.9	0.0	5.9	0.0	1.6	0.0	0.0
CH002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
US001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	9.3	0.0	0.6	0.0	0.0	1.1	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
US002	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
US003	0.0	0.0	1.5	0.0	0.0	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
US004	0.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
US005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
US006	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0
US008	0.1	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
JP001	0.2	0.0	0.7	0.0	0.0	0.0	0.3	7.2	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	2.4	1.2	0.0
JP002	1.9	0.0	0.9	0.0	0.9	0.0	0.0	0.0	0.3	1.2	0.2	5.9	0.0	4.7	4.9	7.2	0.0	1.6	0.1	0.5	3.4	0.1	0.0
JP003	0.0	5.3	4.7	0.4	2.2	0.2	2.4	0.2	2.5	1.4	2.7	3.7	1.0	0.4	0.0	1.9	1.7	0.0	2.5	0.1	0.0	1.9	0.0
JP004	6.1	0.0	0.6	0.0	0.0	0.1	0.0	1.5	0.0	0.0	0.4	1.7	0.0	0.1	0.4	1.6	0.0	0.0	0.0	1.0	2.9	0.0	0.0

Note: Error bounds do not need to sum to 100% in columns. The lower bound marks the 10th percentile of the weights' distribution.

Table 8: Estimated MCS-GVAR weights – Banks versus Banks – Lower bounds

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT001		55.9	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.0
AT002	35.5		0.6	1.2	0.0	0.6	0.6	0.3	0.0	2.1	0.0	0.0	0.2	0.7	0.0	0.0	0.2	0.9	0.0	0.0	0.1	0.0	5.2	1.2	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.5	0.4	0.0	0.0	0.0	0.0
BE004	0.0	0.0		1.4	0.0	0.6	0.5	0.1	0.0	0.0	0.4	0.5	0.0	0.0	0.2	0.0	0.6	0.6	0.0	0.0	0.8	0.0	1.6	1.8	2.7	0.0	0.0	3.4	0.0	0.0	1.0	0.0	0.3	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0
BE005	0.0	0.0	0.8		0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	5.6	0.2	0.2	0.0	0.0	1.3	1.0	0.0	2.1	0.0	1.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DE017	0.0	0.0	0.0	0.0		16.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.5	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DE018	0.0	0.0	0.0	0.0	14.0		0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
DE021	0.1	0.0	0.6	0.0	0.0	1.5		0.0	0.0	0.3	0.8	0.0	1.6	0.0	1.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	2.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
DE024	1.2	0.0	0.0	0.0	0.1	1.6	0.0		0.1	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
ES059	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
ES060	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.6		0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR013	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0		0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR014	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8		25.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR016	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0		0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GB088	0.0	0.0	0.0	0.0	0.9	2.6	4.9	0.0	0.0	0.0	0.0	0.0	0.0		21.6	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
GB090	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	16.4		3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GB091	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.8	3.7		0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	0.0	4.0	0.0	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0	0.0	0.0
IE038	0.5	0.0	0.8	1.5	0.0	0.0	2.3	1.4	1.0	0.5	0.0	0.0	1.7	0.6	0.0	0.7		0.0	0.0	1.2	1.0	2.1	0.4	0.0	1.4	0.0	0.9	2.1	0.0	0.1	0.0	0.0	2.4	0.0	0.0	0.6	0.0	0.0	0.0	2.0	0.0
IT040	0.0	0.0	0.0	0.0	0.6	0.0	0.7	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		13.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT041	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT042	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	21.9	16.5		0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
IT043	0.0	0.0	0.0	0.0	0.0	1.8	2.2	0.0	9.7	0.0	0.0	0.0	0.0	0.9	1.1	0.0	0.7	0.4	0.8	0.0		0.0	5.1	0.0	0.1	0.0	0.0	1.5	0.0	0.1	3.9	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL047	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
NL048	0.0	0.0	0.0	0.0	0.9	0.0	0.5	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	12.3		0.7	0.0	0.4	0.0	3.5	0.0	1.8	0.3	0.0	0.0	0.0	0.0	2.3	0.3	0.0	0.0	0.0	0.0
NL049	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	5.5	0.0		0.0	0.0	0.0	0.0	0.0	2.6	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL050	0.0	0.4	0.2	0.0	0.9	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0		2.5	0.0	0.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0
PT054	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		48.6	0.0	0.0	2.0	0.0	0.7	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0
PT055	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	53.9		0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE084	0.0	0.0	2.0	3.2	0.0	0.0	2.6	0.0	0.0	2.0	0.0	0.0	2.9	0.0	1.6	0.7	3.3	0.0	2.1	0.0	1.5	1.6	6.3	0.0	2.7	0.0	0.0		0.0	0.0	3.2	0.6	0.0	0.0	0.0	1.0	0.6	0.0	0.0	2.7	0.2
CH001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		24.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CH002	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
US001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		8.3	0.0	0.0	4.1	3.7	3.1	0.0	0.0	0.0	0.0
US002	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9		12.3	7.1	9.1	0.0	22.4	0.0	0.0	0.0	0.0
US003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1		3.6	6.7	7.4	5.9	0.0	0.0	0.0	0.0
US004	0.0	0.0	0.0	0.0	0.2	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	4.9		8.8	36.5	0.4	0.0	0.0	0.0	0.0
US005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	9.9	12.3	10.7		0.0	35.4	0.0	0.0	0.0	0.0
US006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	9.4	32.1	0.0		0.0	6.1	0.0	0.0	0.0
US008	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	26.7	11.3	1.4	34.9	0.0		0.0	0.0	0.0	0.0
JP001	0.0	0.0	0.0	0.2	0.0	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	0.8	0.0	0.7	0.0	0.0	0.0	0.0	0.0	2.4	1.1		45.0	0.0	20.1
JP002	0.0	0.3	0.0	1.0	0.7	0.0	1.9	0.4	0.0	1.4	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	2.5	0.6	0.1	2.1	0.0	0.0	0.0	0.0	1.9	1.5	1.3	0.0	0.0	0.0	0.0	1.0	0.0	0.0	33.6		0.0	4.4
JP003	0.0	0.0	0.0	2.1	0.0	0.0	5.1	0.0	1.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	1.8	0.6	0.0	0.0	0.0	0.0	3.5	0.0	0.0	0.0	0.0	1.4	0.0	1.9	0.8	0.0	0.8	0.0	0.0	1.0	0.0	0.0	18.1		18.4
JP004	0.0	0.0	0.0	0.7	0.0	0.0	0.5	0.0	1.5	0.7	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.2	0.0	0.0	1.1	0.5	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	13.9	5.6	0.0	

Note: Error bounds do not need to sum to 100% in columns. The lower bound marks the 10th percentile of the weights' distribution.

Table 9: Estimated MCS-GVAR weights – Banks versus Sovereigns – Lower bounds

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT	0.0	0.0	0.0	0.0	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.0	9.8	0.0	3.0	0.0	0.0	0.0	0.0	1.3	2.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BG	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CZ	0.0	0.5	0.0	2.5	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.1	0.0	1.4	1.0	0.3	0.0	0.0	0.0	0.0	0.1	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DE	0.1	1.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.2	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
DK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GR	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
JP	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0
LT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SE	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
US	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Note: Error bounds do not need to sum to 100% in columns. The lower bound marks the 10th percentile of the weights' distribution.

Table 10: Estimated MCS-GVAR weights – Sovereigns versus Sovereigns – Upper bounds

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT		6.7	6.0	7.5	4.5	3.8	10.2	1.1	4.4	2.1	4.0	1.3	4.7	1.4	0.0	3.4	6.3	6.0	4.8	6.7	0.0	3.6	4.5
BE	8.6		7.1	0.0	5.8	3.9	1.4	2.9	5.3	1.9	7.2	20.9	8.3	0.8	0.0	4.8	8.3	2.4	6.6	6.2	2.4	5.1	6.7
BG	9.0	8.0		0.0	8.4	8.3	0.0	5.8	6.0	32.3	6.4	0.2	6.6	13.1	14.0	8.2	0.0	10.4	6.9	5.4	5.1	7.5	5.7
CZ	1.5	7.0	5.4		8.5	3.5	0.0	7.3	3.9	1.2	5.7	1.2	4.2	0.1	5.5	5.0	0.0	5.0	6.9	2.2	38.8	7.8	5.0
DE	5.8	5.6	8.0	0.0		6.8	2.1	4.0	6.1	0.0	4.5	1.5	7.1	1.6	1.3	4.8	8.8	6.8	5.4	4.7	2.8	3.9	4.3
DK	4.3	4.3	8.8	3.4	6.8		3.0	8.3	5.3	0.6	5.0	0.0	7.4	0.0	0.0	4.3	7.4	7.8	2.5	7.5	2.5	5.7	4.3
ES	0.1	5.4	5.0	0.0	5.2	3.5		5.5	4.6	0.0	0.0	38.8	3.1	0.1	0.0	5.0	6.2	0.0	1.9	6.8	0.0	1.1	1.3
FR	0.5	2.6	4.3	0.0	2.1	5.4	2.6		4.6	0.0	4.9	3.3	3.8	0.0	0.0	4.0	4.6	5.5	6.0	5.1	0.3	4.9	1.8
GR	5.3	4.6	5.4	2.1	5.3	4.7	0.1	5.5		0.8	4.5	3.7	4.8	0.4	0.8	5.1	7.4	2.8	5.4	5.5	0.9	5.7	4.8
HU	4.0	4.3	0.0	0.4	8.0	5.8	0.0	7.2	5.2		7.6	0.9	5.7	13.6	6.7	4.1	0.0	5.1	3.7	2.5	2.0	7.1	6.4
IE	4.0	5.2	4.7	0.3	2.7	3.0	19.7	4.9	3.6	0.0		0.0	5.2	0.4	0.0	3.8	6.0	0.0	5.4	4.6	0.5	3.5	3.9
IT	5.5	0.0	7.3	0.5	6.5	7.4	35.4	4.7	3.8	0.0	4.8		4.9	0.7	0.1	7.7	3.8	0.0	7.7	3.7	0.0	6.4	8.4
JP	6.2	7.8	6.7	3.9	7.1	8.0	4.4	5.4	5.4	2.6	7.5	4.1		0.1	1.0	4.6	6.2	6.2	5.9	5.3	1.8	5.0	5.7
LT	5.8	6.7	1.0	1.2	5.6	7.0	0.0	7.5	5.4	17.3	6.0	1.5	6.0		60.4	7.3	2.8	7.8	7.4	4.6	10.1	9.5	6.7
LV	8.9	6.7	0.0	9.8	6.5	5.8	0.0	9.1	4.4	7.6	10.9	3.6	5.6	71.3		3.8	0.1	6.0	4.3	6.0	18.7	4.1	6.0
NL	5.1	5.3	8.3	1.0	5.1	4.4	0.8	5.0	6.0	2.4	5.5	0.0	4.4	0.0	2.4		9.3	8.2	4.4	5.5	0.0	6.4	5.5
PL	9.8	8.4	0.1	34.8	8.4	8.6	0.1	5.4	8.7	42.6	8.0	11.1	6.4	5.1	9.0	9.6		6.4	8.1	10.3	22.9	6.5	9.4
PT	6.9	1.4	7.5	1.2	5.2	6.3	16.4	6.4	1.6	1.2	0.0	26.4	5.2	0.9	0.0	6.1	5.8		5.2	4.2	1.4	7.9	6.7
SE	5.5	6.2	6.2	0.0	5.5	2.4	5.1	7.5	5.5	2.8	6.5	0.0	5.6	0.0	1.9	4.0	7.9	6.3		5.4	2.2	4.5	5.3
SI	7.9	5.5	4.4	8.7	3.4	6.9	0.0	6.4	5.6	5.6	6.0	5.7	4.5	1.0	0.7	4.6	7.1	4.6	5.3		12.2	6.2	6.2
SK	7.8	4.2	3.7	41.5	4.7	4.7	0.0	9.1	4.7	2.3	6.8	0.3	5.2	2.9	9.7	7.9	0.0	5.4	5.0	0.2		6.3	3.4
UK	4.2	4.5	6.6	0.0	3.2	5.3	12.3	5.4	5.8	0.1	3.6	1.2	4.3	0.0	1.2	5.5	6.7	7.3	3.8	6.0	0.0		3.5
US	5.7	6.7	6.1	1.1	4.4	4.6	6.7	3.5	5.3	1.2	5.3	0.0	5.8	0.0	0.0	5.7	8.4	8.1	5.6	7.3	4.5	4.6	

Note: Error bounds do not need to sum to 100% in columns. The upper bound marks the 90th percentile of the weights’ distribution.

Table 11: Estimated MCS-GVAR weights – Sovereigns versus Banks – Upper bounds

	AT	BE	BG	CZ	DE	DK	ES	FR	GR	HU	IE	IT	JP	LT	LV	NL	PL	PT	SE	SI	SK	UK	US
AT001	4.0	6.8	9.6	5.7	3.2	2.9	1.4	4.6	2.7	1.7	7.8	1.3	6.5	0.7	1.5	3.0	2.5	1.7	5.5	0.2	5.2	2.3	4.4
AT002	8.0	14.9	9.3	3.2	14.1	12.0	4.3	13.5	18.8	9.2	3.3	7.2	7.0	2.5	3.9	7.3	7.8	9.3	7.7	8.6	1.8	11.3	7.5
BE004	6.5	2.5	5.9	8.8	7.0	16.5	3.9	15.4	4.8	3.1	13.1	1.3	5.4	5.6	7.3	3.8	3.7	4.7	3.6	3.8	16.6	3.8	7.2
BE005	4.9	5.8	7.9	6.1	11.2	9.4	1.1	1.3	5.7	5.4	4.5	11.1	6.0	7.0	8.2	1.6	5.0	8.8	7.2	3.5	5.0	4.0	3.8
DE017	0.7	0.0	0.0	2.3	1.0	1.0	9.4	1.3	3.5	0.0	12.0	1.3	3.1	0.1	0.8	0.5	1.5	3.9	0.8	9.9	0.1	12.5	2.3
DE018	0.0	3.2	2.6	0.0	1.4	0.5	0.5	5.0	0.8	3.7	1.8	0.5	1.7	0.0	2.2	2.6	0.0	4.2	2.9	0.0	0.4	0.2	4.1
DE021	1.4	2.3	1.6	8.4	3.3	1.8	0.4	2.7	1.8	1.7	2.7	1.1	4.7	1.3	0.6	2.1	3.6	1.9	1.8	4.3	1.7	3.7	3.4
DE024	0.7	0.2	1.3	3.5	2.0	2.3	4.1	6.2	5.6	1.4	3.5	0.8	3.8	1.1	1.9	3.5	3.3	5.2	3.8	2.5	7.1	7.3	1.9
ES059	5.9	0.6	10.3	1.0	5.6	4.4	8.1	0.8	4.8	8.4	6.9	0.8	2.6	1.6	3.4	5.4	2.4	1.9	10.7	1.7	0.3	2.9	4.4
ES060	0.8	2.1	2.6	6.2	0.6	1.1	19.6	0.5	0.4	3.0	1.0	0.0	0.6	14.8	4.1	1.9	1.5	1.3	0.7	1.6	0.0	2.4	0.7
FR013	17.9	0.0	4.2	0.0	5.6	3.9	0.1	0.9	6.6	3.4	0.0	0.0	3.2	0.0	4.0	12.6	1.0	3.2	0.4	0.3	1.1	8.6	1.5
FR014	2.0	1.2	0.9	2.7	1.0	0.4	13.5	1.3	0.8	1.8	1.2	0.0	1.5	1.8	0.0	1.5	3.3	1.3	1.7	5.8	2.6	0.9	2.5
FR016	5.6	0.0	1.9	0.0	4.4	0.8	0.0	0.5	2.3	0.9	1.0	2.4	2.9	0.0	1.5	1.4	2.8	1.7	0.3	0.6	1.8	0.6	4.4
GB088	0.7	0.3	1.5	10.4	1.4	3.0	1.6	0.3	4.1	1.1	0.0	6.5	1.5	2.1	4.5	2.2	1.0	2.3	0.0	2.9	3.1	3.0	7.3
GB090	1.1	0.5	3.6	0.0	0.6	0.6	3.7	1.1	1.7	0.0	1.2	0.0	2.8	0.0	2.2	4.2	2.5	1.1	0.3	0.1	0.6	12.7	0.3
GB091	8.6	2.5	1.3	1.6	4.8	3.7	0.2	1.6	6.3	1.9	0.9	1.6	3.7	0.0	1.0	4.0	9.9	1.1	2.3	1.7	5.2	0.1	2.5
IE038	5.0	7.6	5.4	4.6	5.0	5.2	4.5	2.7	4.6	5.5	2.4	2.2	3.7	5.0	4.7	3.8	3.5	2.9	3.8	6.0	1.0	3.1	4.8
IT040	0.1	6.8	1.1	3.2	7.1	0.8	0.0	2.0	0.1	3.6	7.0	2.3	0.0	0.2	5.0	2.1	0.0	0.2	0.8	2.2	0.0	1.2	3.3
IT041	0.7	1.8	4.4	1.6	5.6	0.3	6.0	1.0	1.1	1.0	0.2	0.3	1.7	1.2	6.7	6.7	8.4	1.7	8.8	2.8	0.0	0.5	3.4
IT042	4.1	1.2	1.6	2.7	1.8	14.8	0.0	11.4	2.4	3.1	7.2	3.1	6.9	4.4	4.5	2.8	1.7	6.3	3.4	3.0	0.0	2.8	0.0
IT043	4.8	9.2	3.6	4.0	6.9	4.2	4.1	8.4	3.9	5.7	9.3	0.5	5.3	0.9	4.0	2.2	2.2	4.1	3.6	4.4	11.5	3.3	2.9
NL047	1.3	0.2	1.1	6.5	2.4	1.6	0.1	2.6	2.0	0.2	4.3	0.6	3.6	1.1	0.5	2.2	1.6	3.7	2.5	1.5	2.3	0.2	5.9
NL048	1.1	0.9	5.2	5.2	3.6	4.6	0.0	3.6	4.2	7.3	7.7	3.0	8.4	3.9	1.5	2.5	3.6	14.0	8.3	3.7	7.6	7.5	6.8
NL049	1.3	0.4	0.1	2.9	5.0	7.9	1.6	0.6	1.3	0.3	4.0	1.9	2.2	13.0	1.2	0.9	6.3	4.5	0.0	2.2	1.3	0.7	4.3
NL050	3.8	10.5	3.5	5.7	2.9	5.7	3.8	2.6	3.5	8.5	2.3	3.2	4.3	1.8	1.9	8.7	10.2	5.7	2.7	3.8	9.9	3.1	3.5
PT054	2.9	0.9	1.2	5.1	5.6	2.8	3.1	2.8	4.5	7.0	1.8	7.8	2.8	8.4	12.8	1.3	4.4	7.4	4.9	7.4	3.0	4.4	11.1
PT055	1.5	0.1	1.9	3.2	4.4	7.8	2.3	2.2	6.6	1.3	1.5	14.1	4.8	11.2	3.1	7.5	3.4	4.0	5.3	3.1	5.5	3.1	2.6
SE084	10.8	7.0	7.7	14.7	6.4	6.7	3.4	4.6	5.0	1.3	4.6	2.4	6.2	4.8	0.8	7.4	6.3	15.0	6.9	12.6	0.3	4.8	5.9
CH001	0.0	3.7	0.5	2.9	1.8	1.5	1.5	3.1	1.9	13.9	6.4	0.2	2.6	0.0	10.4	0.0	7.4	1.9	15.8	0.6	3.9	0.0	1.6
CH002	2.4	0.2	0.0	2.4	1.7	6.6	1.0	2.4	2.1	1.0	1.5	4.7	2.0	1.0	0.0	3.0	3.5	1.6	1.7	12.5	1.7	1.5	0.4
US001	5.2	0.0	1.3	3.2	2.4	1.6	0.0	2.7	10.9	14.5	1.0	2.6	4.3	4.0	4.3	5.5	2.0	2.2	0.9	4.2	1.1	1.8	4.1
US002	1.4	3.2	2.3	0.8	1.0	2.0	2.2	1.8	1.1	0.7	4.4	1.6	0.7	0.8	7.6	2.2	0.3	1.4	0.8	2.5	1.5	1.2	2.2
US003	0.6	0.6	4.5	7.2	1.2	6.2	5.9	2.0	1.0	0.6	1.1	1.1	1.2	0.7	4.2	0.5	1.2	5.0	0.1	0.1	3.4	7.6	1.3
US004	2.4	9.5	3.5	0.7	1.2	1.7	5.1	0.6	0.6	0.5	3.0	9.9	2.0	1.3	0.0	1.4	2.5	1.7	0.9	0.1	5.3	0.0	4.0
US005	1.7	1.2	1.5	0.0	3.3	1.1	3.7	2.2	4.2	0.6	1.7	5.0	4.0	0.4	0.2	0.8	10.2	4.8	2.6	6.1	2.6	0.0	5.0
US006	0.5	5.8	4.0	10.8	2.0	1.1	6.5	0.0	0.7	2.2	1.6	8.3	0.2	0.2	0.0	1.6	0.0	3.5	8.6	6.3	0.6	0.3	3.5
US008	3.4	8.1	0.3	1.6	3.1	3.6	6.5	0.7	1.0	1.9	1.9	1.4	1.6	10.5	3.4	0.5	4.1	0.7	0.5	2.3	2.6	0.7	1.6
JP001	2.6	0.5	2.6	3.3	1.9	2.9	2.8	11.3	2.3	1.4	1.2	0.6	7.0	0.5	5.2	1.1	2.7	2.9	0.6	4.3	4.0	6.6	1.9
JP002	4.4	1.1	3.9	4.7	5.2	4.4	2.9	2.0	2.6	3.3	2.4	8.8	13.0	6.4	7.6	10.3	3.6	6.3	1.6	1.9	5.3	3.1	5.7
JP003	1.6	7.0	7.1	3.0	7.2	4.2	5.1	2.2	5.2	3.0	5.3	5.5	3.6	1.2	0.0	5.2	2.9	6.7	4.6	7.4	0.7	6.0	4.6
JP004	9.3	0.6	3.3	3.1	1.9	3.6	1.3	4.8	1.7	1.4	2.4	3.2	5.7	0.9	2.5	3.5	3.1	2.3	1.6	3.7	4.5	1.1	2.1

Note: Error bounds do not need to sum to 100% in columns. The upper bound marks the 90th percentile of the weights' distribution.

Table 12: Estimated MCS-GVAR weights – Banks versus Banks – Upper bounds

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT001		77.1	3.6	5.1	5.9	1.3	2.1	8.5	0.5	4.4	2.7	2.3	0.8	0.9	1.1	1.8	2.6	1.0	2.4	2.4	3.4	5.0	3.6	1.8	5.1	1.4	0.0	3.2	3.0	1.9	2.2	0.8	0.0	0.3	3.1	1.0	1.7	0.0	1.4	3.8	0.0
AT002	51.5		4.0	4.2	1.2	2.9	3.3	4.2	0.1	4.9	1.7	6.6	1.8	2.8	1.8	0.6	5.7	3.3	0.5	4.0	6.2	2.0	8.1	4.3	5.5	1.5	0.8	4.8	2.7	0.8	1.2	3.0	1.0	0.0	0.8	2.7	2.2	3.0	3.2	3.2	2.2
BE004	1.5	4.3		4.7	3.0	4.2	2.6	7.1	1.7	10.9	3.5	4.4	3.5	0.9	3.6	2.2	8.1	5.4	2.1	7.1	11.9	2.8	6.3	4.9	7.9	2.3	0.4	5.7	5.5	0.0	4.4	1.6	2.1	1.8	2.1	5.1	0.0	1.0	2.1	15.4	0.0
BE005	2.6	4.0	8.0		0.6	9.9	0.2	2.5	0.1	8.9	2.2	2.7	4.2	1.0	1.6	1.8	2.9	1.9	9.1	1.3	3.9	1.3	11.3	3.7	9.7	0.0	2.5	3.1	11.2	0.3	4.3	0.0	3.2	3.3	0.0	1.7	0.0	2.5	2.8	2.6	4.8
DE017	6.1	0.0	1.2	0.5		23.8	4.8	11.4	0.0	3.1	4.9	1.8	1.0	7.9	9.4	0.0	3.5	6.1	0.0	0.0	2.5	0.2	0.0	0.3	0.0	0.0	2.6	4.2	6.0	12.8	1.0	0.0	0.0	6.9	0.0	0.0	0.9	0.0	0.0	0.7	0.0
DE018	0.0	0.0	0.3	3.5	20.7		0.0	10.2	0.0	3.3	8.2	2.4	0.0	7.0	2.1	0.0	5.4	0.1	9.3	0.1	2.8	2.3	0.9	2.7	0.2	0.0	0.0	4.9	3.3	1.5	0.1	0.0	0.0	3.0	0.0	0.0	1.7	5.1	0.0	3.7	0.0
DE021	7.4	3.6	13.3	5.9	1.4	3.7		26.0	0.4	3.6	3.0	3.4	4.0	0.0	2.7	2.3	3.0	1.1	1.0	2.9	2.4	1.5	2.9	2.4	5.0	1.4	5.2	2.5	1.9	0.6	2.2	0.6	1.4	0.0	0.6	3.7	0.7	4.3	1.2	3.5	2.4
DE024	8.1	0.8	6.0	3.1	4.6	4.0	0.0		2.7	1.0	3.1	0.1	2.4	0.2	0.0	1.3	1.3	0.6	1.0	3.4	2.5	5.0	2.4	3.4	3.1	1.4	1.9	3.8	1.5	0.1	0.1	1.3	0.0	1.3	0.0	1.8	2.1	0.0	0.1	1.7	2.9
ES059	0.0	0.0	1.4	2.8	0.5	0.3	4.6	3.8		20.7	1.0	1.2	0.0	3.1	2.7	0.2	1.5	7.0	0.0	0.0	28.2	1.5	2.2	0.3	4.9	0.0	6.7	3.5	1.4	0.0	1.0	2.9	1.4	0.3	0.1	0.0	0.0	1.1	0.0	3.1	15.3
ES060	6.6	1.3	1.1	4.2	4.6	3.4	0.7	0.2	45.8		5.8	1.4	0.6	0.0	1.6	6.3	0.9	3.7	2.6	11.3	0.0	0.0	0.6	0.3	0.0	17.0	6.1	0.0	1.2	1.7	0.0	0.0	0.0	0.9	2.2	0.0	0.0	0.0	0.0	0.0	0.1
FR013	1.0	0.0	0.0	0.0	6.4	9.7	0.0	6.9	0.0	5.9		11.5	23.3	0.0	3.1	5.9	3.8	0.9	0.0	4.2	3.5	0.1	0.0	5.6	5.4	0.0	2.0	2.2	6.9	1.9	0.0	3.4	0.1	0.0	0.2	0.5	0.0	0.0	0.0	0.2	0.0
FR014	8.5	0.0	8.3	3.6	4.6	4.8	1.9	1.0	0.1	1.9	21.8		32.1	0.0	5.6	3.6	8.5	0.1	5.7	9.0	5.7	0.0	1.6	0.2	5.0	0.0	0.7	4.4	7.4	2.2	1.1	0.8	0.9	0.0	2.0	0.0	0.0	0.0	0.0	3.4	0.0
FR016	0.0	0.0	0.0	0.0	2.8	0.3	0.0	2.0	0.0	2.2	27.9	21.7		0.0	7.7	5.8	0.0	1.5	0.0	5.0	0.1	8.3	0.0	0.1	2.8	0.0	6.8	0.0	10.0	0.0	0.3	0.4	0.0	0.0	0.2	1.5	0.0	0.0	0.0	1.7	0.0
GB088	0.1	0.0	3.8	3.0	10.8	9.3	10.6	1.8	3.5	0.1	0.1	0.0	0.2		30.4	31.7	0.7	2.2	7.2	0.0	0.0	5.8	0.1	29.7	2.4	0.0	0.4	7.4	0.0	0.7	3.4	0.0	10.3	0.0	0.0	0.0	0.0	7.0	0.0	2.1	0.0
GB090	0.0	0.0	0.0	0.0	10.7	2.6	0.0	2.0	2.5	1.2	2.5	1.1	6.3	25.9		11.5	7.4	2.3	1.6	0.0	0.0	9.2	1.7	0.0	0.0	0.0	3.4	0.0	10.4	2.8	0.0	0.0	0.0	0.0	0.2	1.1	0.0	0.0	0.0	1.2	0.0
GB091	1.3	0.0	3.9	3.4	0.0	0.1	3.4	0.7	0.1	6.7	4.4	2.2	5.2	28.7	11.6		0.3	7.2	0.0	2.0	5.1	5.6	0.0	1.2	0.7	0.0	6.1	0.7	1.1	9.7	0.0	0.5	0.0	4.8	0.0	0.0	2.3	2.1	5.2	1.5	0.0
IE038	2.0	1.4	7.1	3.2	1.7	1.6	3.7	3.2	3.0	5.2	2.7	10.8	3.2	2.6	0.1	2.3		1.7	1.3	3.0	3.6	4.3	2.7	4.4	5.8	0.0	2.4	4.2	3.3	1.3	1.3	0.3	3.9	0.6	0.0	1.6	1.2	1.6	0.0	3.4	0.7
IT040	0.0	0.0	0.0	0.0	8.4	0.2	5.5	1.7	8.2	4.3	0.8	0.0	1.9	0.1	2.5	7.0	2.9		22.8	34.9	2.9	6.2	0.0	0.2	0.6	1.7	1.1	2.2	0.6	0.0	0.0	2.8	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0
IT041	3.6	0.0	1.2	4.8	0.0	11.3	6.7	0.0	0.0	3.6	0.4	3.0	0.0	4.7	2.5	0.2	3.1	19.1		23.2	8.1	1.2	0.4	9.2	1.9	0.0	0.0	0.1	5.3	4.6	0.0	3.4	0.0	1.7	0.4	0.0	0.0	0.0	0.0	3.8	0.0
IT042	7.3	0.0	5.5	2.7	0.9	1.3	7.5	4.8	0.0	11.1	3.3	5.6	4.2	0.0	0.0	4.4	0.0	27.7	25.7		4.7	3.1	5.4	0.6	2.2	5.7	3.3	4.6	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.7	3.1	0.0
IT043	0.1	2.3	13.0	7.8	0.0	4.7	5.1	5.9	14.4	2.4	0.0	3.2	1.9	3.2	3.3	0.7	9.5	3.4	4.3	4.0		0.8	8.9	3.3	12.2	1.5	2.3	4.6	5.1	2.9	8.5	0.6	2.5	0.0	2.3	1.1	0.0	0.0	0.1	19.5	0.0
NL047	3.9	0.0	1.2	6.4	0.8	2.5	9.0	12.2	1.8	0.2	0.5	0.0	5.3	3.1	3.7	3.4	0.0	3.1	1.6	1.6	3.2		0.0	19.0	3.2	1.4	0.0	0.0	4.8	0.1	0.0	0.0	1.5	0.0	0.1	1.3	3.6	0.0	0.0	0.9	4.7
NL048	5.1	0.0	4.3	15.4	7.3	1.8	3.4	5.1	3.9	3.2	7.6	2.1	1.0	1.8	0.4	7.0	3.0	3.0	2.6	2.2	5.4	24.6		9.8	6.3	3.9	0.1	8.7	5.0	7.2	6.5	1.8	0.0	0.0	0.0	6.1	3.7	0.0	0.1	3.9	5.7
NL049	0.0	2.5	2.8	1.8	1.0	2.2	3.1	6.5	0.0	3.1	5.2	1.0	0.0	12.9	0.0	1.1	8.5	1.6	5.6	0.0	2.9	15.2	0.0		1.8	0.0	4.7	3.3	1.7	5.1	0.0	2.9	1.1	0.2	0.0	1.2	0.3	0.0	0.0	1.2	0.0
NL050	0.0	9.8	7.5	4.8	3.6	2.3	2.1	5.5	4.6	4.2	1.8	18.3	0.1	2.0	3.5	3.2	10.1	2.1	1.5	2.0	13.2	4.6	1.7	2.8		5.6	0.0	3.0	3.9	7.1	4.7	0.4	1.7	0.0	0.4	8.7	0.0	2.4	0.0	32.2	1.8
PT054	1.3	1.0	1.0	9.9	0.0	2.7	0.0	2.7	0.4	10.8	0.0	2.7	0.0	2.4	0.9	0.4	7.6	3.5	0.5	7.1	1.9	1.1	1.0	1.8	5.4		54.7	4.7	1.7	4.8	0.0	4.5	0.0	0.0	4.9	1.5	0.0	0.2	0.4	3.8	0.0
PT055	0.0	0.1	3.4	3.3	3.1	0.8	0.0	3.1	11.0	3.3	0.6	1.0	3.1	0.0	3.9	4.0	1.2	2.0	0.0	4.0	2.3	0.0	6.4	5.1	4.5	67.0		4.1	1.2	1.0	0.0	0.0	2.0	3.4	1.5	0.0	0.0	0.0	0.0	3.2	0.0
SE084	5.2	3.5	4.5	5.2	1.5	2.0	5.1	5.3	1.5	5.7	4.0	10.7	6.0	0.1	3.8	3.9	5.1	3.0	4.6	4.6	3.5	3.5	9.4	3.5	5.3	0.8	0.8		4.2	1.2	6.3	2.5	0.0	1.0	0.5	2.8	2.0	1.9	1.1	4.5	3.5
CH001	0.0	0.0	1.6	1.3	6.8	4.3	0.8	3.1	0.0	3.4	6.8	4.3	7.5	0.0	10.8	0.4	6.9	1.3	5.3	0.0	2.2	5.6	0.0	4.6	2.5	0.5	0.0	4.6		34.2	0.1	0.0	0.0	4.5	0.8	1.8	0.0	1.3	0.3	1.8	3.2
CH002	0.0	0.0	5.0	2.0	12.0	2.5	4.6	2.8	0.0	3.3	1.3	2.0	0.0	0.0	2.9	7.6	1.3	0.6	5.8	0.0	0.6	0.0	0.0	7.8	7.3	2.7	0.1	2.8	35.0		0.0	0.0	0.0	0.3	0.0	2.8	0.2	8.2	3.6	3.3	0.0
US001	1.8	0.0	1.0	0.9	2.2	1.6	6.0	2.2	5.0	3.2	0.4	4.9	2.5	2.0	1.4	0.7	6.5	0.9	1.3	1.5	3.1	0.8	1.3	1.6	1.3	0.2	0.0	0.5	1.2	0.1		12.9	1.7	3.1	8.0	9.3	6.0	0.6	2.1	1.3	0.0
US002	0.1	1.1	2.1	3.5	0.1	0.6	6.2	1.2	2.3	2.0	2.6	2.6	0.3	0.0	3.2	0.2	3.9	1.5	2.8	0.0	1.5	0.0	3.2	2.7	1.9	0.7	0.0	0.6	0.1	0.3	26.4		20.2	11.7	13.2	4.5	29.1	0.0	0.0	2.5	0.0
US003	0.0	0.1	0.9	0.7	0.2	0.3	1.1	2.7	1.3	1.4	1.5	1.3	0.0	2.7	0.4	0.2	0.0	4.2	0.0	0.0	0.4	1.0	6.8	0.2	0.4	0.0	0.7	4.9	0.0	0.6	0.9	13.3		7.6	11.0	11.1	10.9	0.0	0.0	0.3	0.3
US004	0.0	0.0	0.9	0.5	5.6	0.5	7.6	0.7	0.0	0.6	0.4	0.2	0.2	0.0	0.0	1.2	2.6	0.2	0.5	0.0	3.8	0.4	9.8	0.7	1.0	0.0	2.6	3.1	2.6	0.2	4.2	11.3	11.5		13.6	44.5	3.6	1.0	0.0	2.5	0.0
US005	1.3	0.0	0.9	8.2	0.3	1.1	3.5	2.8	0.0	0.6	0.6	1.0	0.4	0.0	2.3	0.5	6.4	0.3	0.5	3.1	1.3	0.8	8.4	1.3	1.4	0.1	0.0	4.6	0.0	0.0	18.0	14.5	17.2	16.2		0.7	41.9	0.0	0.6	2.0	0.0
US006	0.0	0.0	1.1	1.4	0.3	0.6	0.2	1.1	0.1	3.7	1.1	4.0	1.8	0.0	1.9	0.2	0.8	0.7	0.1	1.6	0.6	2.3	0.0	1.9	6.5	0.1	0.0	1.4	0.5	3.1	15.1	4.3	13.3	40.9	1.3		0.6	11.0	0.0	2.1	0.0
US008	2.3	1.7	4.9	9.8	1.4	3.5	3.3	1.7	1.6	3.5	1.9	11.1	1.2	0.0	2.4	1.5	2.4	0.7	1.3	1.8	4.0	2.1	1.7	1.4	5.1	0.0	0.1	2.7	4.3	2.6	14.1	32.3	18.2	6.5	42.5	1.4		1.2	0.0	2.9	0.0
JP001	0.0	4.0	2.8	2.1	1.0	2.5	4.0	2.8	0.5	1.9	1.3	4.7	1.1	2.8	0.0	2.0	3.3	1.8	0.4	1.1	2.4	0.8	5.8	0.9	2.3	0.6	0.4	2.5	1.4	3.2	0.9	0.0	0.2	1.3	0.2	3.9	2.9		54.2	2.2	32.3
JP002	1.0	2.9	2.3	3.0	3.0	1.3	4.6	3.3	0.0	4.3	3.1	8.7	0.7	1.0	1.2	3.7	5.6	1.0	0.1	5.4	2.3	2.3	6.4	3.0	3.7	0.8	0.5	3.7	3.4	3.7	3.3	0.9	0.6	0.7	3.3	1.7	0.0	43.2		21.2	13.4
JP003	0.0	2.0	18.8	4.4	1.3	1.2	8.2	3.1	3.3	3.6	2.3	9.9	1.0	2.6	0.7	1.7	4.3	3.0	0.5	3.9	17.9	1.3	5.5	2.5	22.2	0.0	0.5	3.8	2.6	5.0	3.2	0.0	2.1	0.1	0.4	3.0	1.0	2.6	23.5		26.2
JP004	0.0	2.2	3.5	2.5	1.2	0.7	1.9	2.2	4.3	2.4	1.2	4.2	1.5	2.4	1.1	0.6	3.4	1.7	0.9	1.5	2.7	2.5	2.7	1.8	2.2	0.3	0.1	2.5	2.3	0.8	1.0	0.9	2.3	0.2	1.1	1.0	0.6	20.0	11.4	19.5	

Note: Error bounds do not need to sum to 100% in columns. The upper bound marks the 90th percentile of the weights' distribution.

Table 13: Estimated MCS-GVAR weights – Banks versus Sovereigns – Upper bounds

	AT001	AT002	BE004	BE005	DE017	DE018	DE021	DE024	ES059	ES060	FR013	FR014	FR016	GB088	GB090	GB091	IE038	IT040	IT041	IT042	IT043	NL047	NL048	NL049	NL050	PT054	PT055	SE084	CH001	CH002	US001	US002	US003	US004	US005	US006	US008	JP001	JP002	JP003	JP004
AT	10.6	4.1	1.7	4.6	7.1	10.4	3.3	9.0	6.6	5.5	26.4	4.0	10.9	5.7	6.7	8.4	6.9	5.1	5.4	4.2	4.2	4.5	6.5	5.5	3.4	5.6	5.3	6.9	10.9	3.2	1.8	3.8	4.2	3.1	6.0	4.1	6.0	2.8	8.2	11.2	8.1
BE	7.7	9.0	5.2	3.7	10.1	7.9	11.1	8.7	5.2	5.4	5.6	9.5	8.0	7.7	6.0	4.1	18.8	7.4	20.8	6.2	11.5	10.9	13.9	7.5	16.6	7.2	12.4	8.3	4.0	5.0	15.8	13.6	6.5	9.0	4.8	5.6	17.1	6.4	3.7	18.4	21.1
BG	15.2	7.3	7.2	10.7	6.9	11.7	4.2	10.8	23.0	9.9	10.2	6.3	9.7	14.5	4.9	6.5	21.8	9.8	4.0	6.4	7.2	13.1	7.0	23.3	11.4	9.8	8.7	11.4	4.1	32.6	11.4	15.7	12.8	3.2	8.7	5.0	7.3	3.9	3.2	14.3	4.8
CZ	7.5	7.2	5.4	16.0	9.0	5.4	19.3	4.0	13.0	10.0	8.3	4.3	16.9	9.2	5.5	6.8	6.9	7.2	7.8	10.4	3.7	10.7	4.1	5.2	10.1	6.9	4.7	25.9	6.0	5.8	6.2	18.0	24.2	4.5	4.9	7.0	9.3	5.3	2.6	11.7	3.8
DE	7.9	10.8	3.8	6.0	5.3	9.3	8.9	10.5	10.6	5.9	6.5	5.4	11.7	5.6	10.5	8.9	8.4	7.4	8.5	5.7	4.5	12.5	11.1	6.4	5.2	3.8	16.4	8.0	4.6	6.2	3.7	4.1	7.2	8.4	16.9	7.0	14.5	4.3	2.3	10.7	10.6
DK	3.1	4.8	4.6	3.9	4.6	6.0	2.5	1.8	2.5	4.2	4.1	1.8	2.1	5.2	3.1	5.7	2.0	4.6	11.6	10.6	4.6	3.6	2.6	7.3	7.5	6.6	1.8	2.2	11.3	1.4	1.7	3.0	5.7	6.0	4.5	3.0	5.6	3.8	3.1	3.3	9.5
ES	17.5	4.6	6.5	4.9	4.6	5.5	8.6	6.7	7.1	21.2	2.3	36.7	17.0	12.9	4.2	7.2	3.6	5.2	6.7	12.4	4.5	4.5	6.9	5.0	2.2	12.0	3.1	5.1	3.4	3.2	6.4	10.5	5.1	6.2	5.4	4.0	5.0	12.6	10.7	4.4	4.6
FR	6.1	6.6	0.0	2.0	2.6	2.3	2.9	4.6	0.1	3.9	1.3	2.6	3.4	3.3	14.3	5.6	3.1	6.3	0.8	13.4	15.5	2.2	2.1	2.2	1.7	2.4	20.1	3.0	6.4	1.5	1.5	6.3	3.9	2.2	6.3	3.6	2.8	22.7	2.7	1.6	2.9
GR	2.7	5.2	3.5	3.2	4.1	4.0	2.3	1.9	1.6	3.4	5.2	3.8	3.2	6.9	3.7	3.9	2.1	7.2	3.6	4.3	1.6	1.8	2.2	2.2	3.7	6.4	1.3	3.1	3.3	2.1	4.3	6.2	3.3	2.5	1.6	1.8	2.4	3.1	1.6	1.3	5.1
HU	24.7	10.3	3.3	5.8	8.6	13.1	6.1	2.5	5.9	4.0	5.4	9.0	8.3	3.3	5.1	5.2	1.7	8.9	7.0	4.4	12.9	8.0	20.1	6.8	1.1	9.7	6.2	4.7	30.8	4.0	53.1	4.2	12.9	12.6	8.9	4.3	8.9	20.2	5.0	5.9	6.7
IE	7.4	8.3	1.0	5.7	11.1	3.2	10.1	3.7	6.6	2.5	3.6	3.7	2.7	3.5	11.8	7.5	1.5	4.3	15.0	5.7	24.7	12.3	4.6	2.7	2.3	3.3	11.4	5.5	2.0	9.3	9.6	2.4	4.1	5.7	4.9	4.8	4.6	5.8	5.7	14.7	6.3
IT	4.0	6.5	19.1	13.6	6.6	4.9	4.1	15.5	5.3	11.5	7.6	16.8	2.8	7.8	15.9	7.1	3.2	3.7	5.8	2.6	4.3	8.8	11.8	8.4	4.4	3.5	10.3	3.2	8.5	0.3	2.6	3.1	9.4	26.0	2.3	25.7	3.0	7.6	12.0	9.3	3.6
JP	4.6	8.6	3.3	4.1	4.4	7.4	3.9	10.0	5.7	4.0	4.0	4.7	4.1	11.4	4.4	9.3	10.5	5.7	17.2	17.4	4.3	3.9	9.7	5.2	9.0	3.3	3.8	4.4	2.6	5.8	4.7	4.3	5.4	15.4	8.8	7.5	11.4	4.1	13.2	8.4	15.5
LT	5.1	7.7	3.4	9.3	6.1	15.1	23.2	10.2	23.1	33.8	5.6	13.5	6.7	8.5	21.8	9.8	16.9	8.0	5.1	10.9	3.6	11.9	8.1	30.1	5.7	6.5	10.5	9.1	7.4	14.4	11.0	1.6	7.7	1.6	10.0	14.2	17.2	9.3	18.0	13.7	6.7
LV	11.8	4.0	5.4	11.8	7.6	11.6	3.7	10.1	3.3	8.6	13.0	14.5	13.7	7.6	2.5	7.3	6.7	8.1	9.7	9.4	6.3	7.0	5.6	5.6	11.4	27.7	3.8	16.4	16.4	7.0	5.0	17.9	4.7	10.9	4.2	15.9	11.5	7.2	20.1	3.1	12.1
NL	3.9	3.1	4.7	4.3	4.5	3.4	2.9	2.7	3.6	4.5	15.4	3.4	8.7	6.1	2.4	5.2	5.2	7.3	2.1	2.8	2.0	14.1	5.1	4.4	11.4	5.5	1.5	3.3	3.9	3.1	1.2	4.1	7.4	5.8	3.6	2.5	2.8	4.7	8.0	1.4	3.3
PL	4.6	18.0	3.2	26.3	5.2	8.9	12.7	10.5	3.9	5.4	6.7	6.1	2.6	6.6	14.3	25.8	0.9	9.6	13.4	5.1	12.6	4.4	3.5	5.9	12.4	4.8	6.2	15.3	5.0	18.7	3.3	5.4	5.2	5.3	12.9	3.6	2.8	6.7	6.2	4.2	7.4
PT	5.5	6.3	6.5	6.8	8.2	6.6	3.5	5.0	10.1	4.6	6.8	5.5	4.5	8.0	4.0	5.6	1.5	13.2	6.2	15.6	3.9	5.0	7.1	6.5	9.2	14.2	23.1	5.5	3.6	12.7	4.5	7.0	15.8	11.0	18.9	13.9	16.1	4.5	1.5	7.2	4.3
SE	7.8	4.6	6.9	4.1	5.4	4.4	8.4	3.3	6.3	4.3	2.1	5.1	6.7	3.9	6.4	4.1	5.5	3.3	3.0	6.3	6.8	4.3	4.9	9.3	2.5	3.3	2.3	2.5	0.0	3.8	2.9	11.2	8.3	2.0	8.5	19.2	3.0	4.9	22.4	3.3	7.0
SI	4.8	9.5	1.5	2.1	16.1	6.1	4.1	6.1	4.1	5.4	2.8	3.2	2.6	5.4	3.2	5.7	2.4	9.5	1.9	3.9	11.4	3.1	3.5	4.4	3.6	5.5	1.6	11.4	0.7	11.7	4.1	3.6	4.4	15.7	9.2	21.2	3.5	6.2	2.3	1.8	5.7
SK	4.7	4.0	35.8	11.7	8.5	4.0	14.9	27.3	5.1	4.2	5.6	5.3	5.3	5.8	2.8	3.0	15.9	9.9	5.3	4.0	14.8	14.3	15.9	4.9	2.7	3.2	9.1	4.3	14.8	2.8	2.3	5.8	0.1	4.4	2.7	3.6	4.9	3.3	2.8	12.4	8.3
UK	3.4	5.5	16.8	4.6	13.8	5.4	2.1	2.1	1.5	4.3	9.2	4.6	4.1	6.6	0.6	5.9	1.7	5.6	4.6	5.2	1.2	5.5	5.3	8.2	3.3	6.3	3.3	8.2	6.7	9.3	2.9	13.4	10.3	2.9	4.4	5.3	3.6	8.6	5.2	3.0	7.7
US	5.8	9.7	7.8	2.8	9.0	5.4	5.6	3.6	6.9	2.8	3.4	4.5	4.6	4.4	9.1	7.8	0.6	6.4	6.0	4.5	5.1	3.9	4.6	6.8	3.1	11.5	1.7	4.3	2.3	3.0	5.3	3.3	4.9	5.2	8.9	4.0	7.3	7.4	2.9	3.4	2.3

Note: Error bounds do not need to sum to 100% in columns. The upper bound marks the 90th percentile of the weights' distribution.

Table 14: Impact and vulnerability ranking based on 5-day cumulative responses

Rank	Impact		Vulnerabililty	
	Sovereigns	Banks	Sovereigns	Banks
1	US	Goldman Sachs (US)	GR	Credit Agricole (FR)
2	ES	Citigroup (US)	IE	KBC Group (BE)
3	FR	Intesa Sanpaolo (IT)	ES	Bank of Ireland (IE)
4	PT	Lloyds Banking Group (GB)	FR	Bayerische Landesbank (DE)
5	BE	Banco Espirito Santo (PT)	PT	Rabobank (NL)
6	DE	Commerzbank AG (DE)	NL	Intesa Sanpaolo (IT)
7	IE	Banco Santander (ES)	HU	Lloyds Banking Group (GB)
8	GR	ABN Amro (NL)	SK	Banco Bilbao Vizcaya Argenteria (ES)
9	IT	Unicredit (IT)	LV	Dexia Group (BE)
10	AT	UBS AG (CH)	US	Banca Monte Dei Paschi Di Siena (IT)

Note: The ranking is based on a systematic shock simulation (using Generalized Impulse Responses) based on the MCS-GVAR model. See text for details.

Table 15: Impact and vulnerability ranking based 10-day cumulative responses

Rank	Impact		Vulnerabililty	
	Sovereigns	Banks	Sovereigns	Banks
1	US	Citigroup (US)	DK	Credit Agricole (FR)
2	SI	Goldman Sachs (US)	NL	KBC Group (BE)
3	ES	Intesa Sanpaolo (IT)	PT	Bank of Ireland (IE)
4	FR	Royal Bank of Scotland Group (GB)	GR	Bayerische Landesbank (DE)
5	DE	Banco Bilbao Vizcaya Argenteria (ES)	IE	Rabobank (NL)
6	IE	Commerzbank AG (DE)	ES	Banco Bilbao Vizcaya Argenteria (ES)
7	IT	Banca Monte Dei Paschi Di Siena (IT)	FR	Lloyds Banking Group (GB)
8	GR	Banco Santander (ES)	DE	Intesa Sanpaolo (IT)
9	CZ	Deutsche Bank AG (DE)	BE	ABN Amro (NL)
10	SK	Lloyds Banking Group (GB)	HU	Commerzbank AG (DE)

Note: The ranking is based on a systematic shock simulation (using Generalized Impulse Responses) based on the MCS-GVAR model. See text for details.

Table 16: Impact and vulnerability ranking based on maximum cumulative responses

Rank	Impact		Vulnerabililty	
	Sovereigns	Banks	Sovereigns	Banks
1	US	Credit Agricole (FR)	GR	Goldman Sachs (US)
2	IE	KBC Group (BE)	ES	Bank of America (US)
3	FR	Bank of Ireland (IE)	FR	Citigroup (US)
4	PT	Banco Bilbao Vizcaya Argenteria (ES)	CZ	Intesa Sanpaolo (IT)
5	BE	Lloyds Banking Group (GB)	SK	Banco Bilbao Vizcaya Argenteria (ES)
6	DE	Intesa Sanpaolo (IT)	SI	Lloyds Banking Group (GB)
7	NL	ABN Amro (NL)	HU	Commerzbank AG (DE)
8	UK	Commerzbank AG (DE)	PL	Banco Santander (ES)
9	GR	American Express (US)	LV	Banca Monte Dei Paschi Di Siena (IT)
10	AT	Dexia Group (BE)	US	ABN Amro (NL)

Note: The ranking is based on a systematic shock simulation (using Generalized Impulse Responses) based on the MCS-GVAR model. See text for details.