The Time-Spatial dimension of Eurozone Banking Systemic Risk

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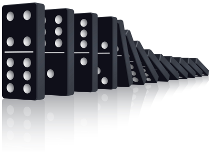
SEE Economic Research

Overview

The Aim

- Since financial variables like CDS spreads show a high level of co-movement, it is likely that development of spreads in $BANK_i$ are affected by developments in spreads in $BANK_j$ depending on the degree of interconnectedness
- We want to highlight the "time-space dynamics" of contagion $\rightarrow$ the dynamic and the evolution of credit risk
- We propose a new bank systemic risk measure to consider the two components of systemic risk: cross-sectional and time dimension
- To this $\rightarrow$ Spatial econometric approach



“Classical Methods” to measure systemic risk

1. Regression Methods: Koopman et al. (2012); Betz et al. (2014)
2. Network: Billio et al. (2012); Battiston et al. (2012, 2017)
3. Conditional Quantiles: Acharya et al. (*MES*, 2012); Adrian & Brunnermeier (*CoVaR*, 2016); Brownlees & Engle (*SRISK*, 2016)
4. Extreme Value Theory $\cong$ *The Black Swan* (Taleb, 2007-2010), Hartmann et al. (2007); Zhou (2010); Ergen (2014); Balla (2014)
5. Composite Index: Financial Stress Index (Oet et al. 2011, Akinci and Olmstead-Rumsey, 2017), CISS (Hollo et al. 2012), Financial stability index (Cihak et al. 2013, Crell et al. 2015)

New Approach: A Spatial Finance Literature

- In recent years, first efforts of introducing spatial econometric techniques into financial systems have been made
- Spatial spillover effects in empirical finance can take the meaning of credit risk propagation (Dell'Erba et al. 2013; Eder and Keiler, 2015; Tonzer, 2015; Blasques et al., 2016),return co-movements over time (Arnold et al, 2013; Kelly et al., 2013; Asgharian et al., 2013, Milcheva and Bing Zhu, 2016), for a network approach to assess interbank liquidity (Denbee et al., 2014) or risk premium propagation among firms ($S - CAPM$, Fernandez, 2011)

The Time-Spatial dimension of Contagion

- We analyze the co-movements across CDS spread using GAS-SAR model (Blansque et al., 2016)
- By incorporating spatial terms into a panel setting we can explain the “time-space dynamics” in the variation in CDS spreads at one bank by the variation in CDS spread at other bank

$$y = \underbrace{\rho_t Wy}_{contagion\ risk} + \underbrace{X_t\beta}_{systematic\ risk} + \underbrace{\varepsilon_t}_{idiosincratic\ risk} \quad (1)$$

- where y_t is the dependent variable, X is $n \times k$ matrix of regressors, β is the vector of coefficients, ρ is the spatial dependency coefficient, ε is the error vector with multivariate density $p_e(\varepsilon_t, \Sigma; \lambda)$ - mean zero, covariance matrix, and λ is the the shape of the distribution - W is the spatial weights matrix

GAS for ρ_t

- Parametrization $\rho_t = h(f_t)$
- f_t follow a dynamic process:

$$f_{t+1} = \omega + \sum_{i=0}^{p-1} a_i s_t + \sum_{j=0}^{q-1} b_i f_t \tag{2}$$

where ω is a scalar coefficient, a_i and b_i are fixed scalar parameters, while $s_{t-1} = S_t \nabla_t$ is the scaled score function

- Model can be estimated straightforwardly by maximum likelihood

Financial Data

- 22 Eurozone banks: Austria(2), Belgium(1), France(3), Germany(2), Greece (2), Ireland(2), Italy(4), Netherlands(1), Portugal(1), Spain(3). Daily log changes in CDS spreads from December 2008 to February 2017 (2110 obs.)
- Banks specific variables:
  - stock index return
- Common control variables:
  - term spread: 10y - 2y government bond yields (term structure)
  - change in volatility index VSTOXX (risk appetite)
  - spread between three-month Euribor and EONIA (credit spread)
- ADF unit root test indicate that all time series are stationary
- All variables are included in the model with a lag of one period

Building a Weight Matrix

- We build a financial distance matrix using the CLAIM matrix, provides by BIS, following Calabrese et al., (2017) approach
- This matrix is an aggregate claim of the entire banking sector in one country to the entire banking sector in another
- To check for the robustness $\rightarrow$ stock correlation weighting matrix, following Fernandez (2011) $\rightarrow$ Spearman correlation matrix
- To avoid endogeneity, we lag the matrices by 1 year $\rightarrow$ W_{2007} (Eder and Keiler, 2015; Blansque et al., 2016)

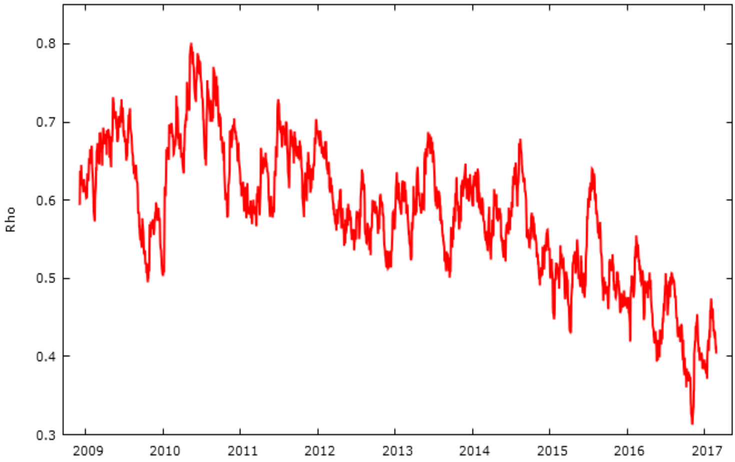
The spatial model results

	Static Model	Time-varying
ρ	0.52 (0.003)	
ω		0.0048 (0.000)
a		0.004 (0.000)
b		0.9918 (0.000)
σ^2	1.0434 (0.017)	1.046 (0.014)
VStoxx (-1)	-0.037 (0.004)	-0.04 (0.014)
Credit Spread (-1)	0.098 (0.011)	0.01 (0.044)
Stock Return (-1)	-0.05 (0.001)	-0.035 (0.000)
Term structure (-1)	-0.001 (0.000)	-0.005 (0.000)
const	-0.0002 (0.0004)	-0.0002 (0.0003)
logLik / T	-52.00	-51.20

Notes: Estimated parameters and their robust (sandwich) standard errors in parentheses, for the static spatial lag model and the time-varying spatial model, based on Student's *t* distributed errors.

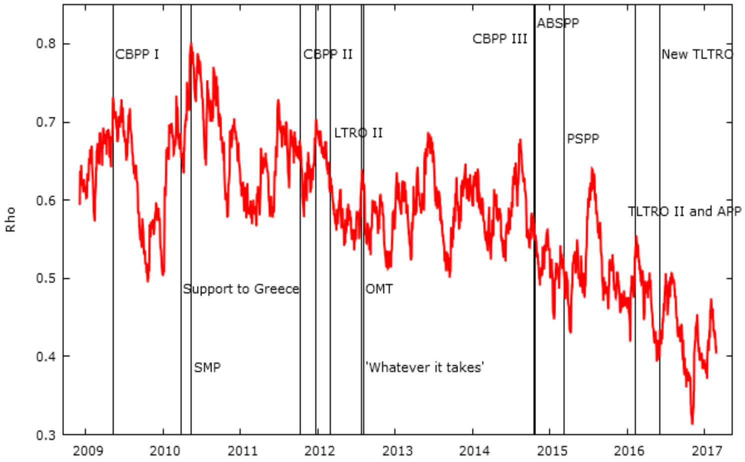
The contagion risk measure

The time-varying $\hat{\rho}_t$



The contagion risk measure

The ρ_t together with politic event and ECB intervention



Spillover effect on the real economy

According ECB: *"the risk that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially"*

$\Longrightarrow$ Granger causality test through VAR model (Brownless and Engle, 2012):

$$y_t = \begin{vmatrix} \Delta \log \rho_t \\ \Delta \log GDP \\ \Delta \log UR \end{vmatrix} \tag{3}$$

where $\Delta\rho_t$ is growth rates of our measure of systemic risk, *GDP* is the Gross Domestic Production[1] and *UR* is the unemployment. All variables are monthly based and are obtained from the ECB Data Warehouse

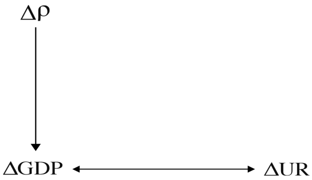
[1] We apply interpolation methodology follow Litterman (1983).

Spillover effect on the real economy

Granger Causality test

	$\Delta\rho$	ΔUR	ΔGDP
$\Delta\rho$		0.711 (0.700)	1.223 (0.542)
ΔUR	2.369 (0.306)		5.528 (0.063)
ΔGDP	9.897 (0.007)	11.63 (0.003)	

Notes: The table reports the results of the Granger causality; χ^2 - statistics of lagged 1 st differenced term; in parentheses () the p-value



The monetary policy impact

To evaluate the impact of ECB monetary policy on the transmission and contagion in European banking system, we apply:

- The "classical" VEC model
- The short and long-term causality, following the methodology proposed by Dufour and Taamouti (2010), and applied by Colletaz et al. (2018)

The Classical VECM

We decided to simulate two policy shock

- Increase in MRO $\rightarrow$ restrictive monetary policy
- Increase in M2 $\rightarrow$ expansionary monetary policy
- We include the inflation rate (HICP) as a measure of the ease of monetary conditions

$$\Delta Y_{t,i} = \alpha_i + \lambda_i \beta_i Y_{t-1} + \sum_{z=1}^{n} \Gamma_{j,i} \Delta Y_{t-j,i} + \varepsilon_{t,i} \tag{4}$$

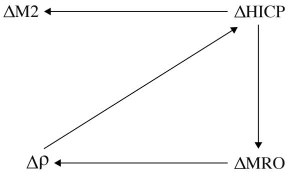
- where $Y_{t,i} \equiv (\rho_t, G_j)$ is a vector of variables $G_j =$ (M2, MRO and HICP), α_i is the linear trend, $\Gamma_{j,i}$ is the matrix that reflects the short-run relationship, while β_i is the cointegration vector. The λ_i represent the error correction coefficient that should have a negative sign with range $-1 < \lambda_i < 0$

The Classical VECM: Results

Granger causality test

	$\Delta\rho$	$\Delta M2$	ΔMRO	$\Delta HICP$	ECT (1)	ECT (2)
$\Delta\rho$		0.083 (0.773)	3.099 (0.078)	2.699 (0.101)	-0.464 (0.000)	-0.018 (0.000)
$\Delta M2$	0.454 (0.500)		1.584 (0.208)	3.229 (0.072)	-0.166 (0.784)	-0.071 (0.008)
ΔMRO	0.8323 (0.3604)	0.215 (0.645)		4.536 (0.033)	0.148 (0.321)	0.001 (0.924)
$\Delta HICP$	4.355 (0.036)	0.283 (0.594)	0.049 (0.824)		-1.526 (0.001)	-0.051 (0.015)

Notes: The table reports the results of the Granger causality; χ^2 - statistics of lagged 1 st differenced term; in parentheses () the p-value



Systemic risk-taking channel

- What are the shadow channels in which turn the monetary policy impact on contagion of banks?
- Has financial stability become a goal of the ECB's policy?
- We employ the long-term causality in different point of view: a variable x not Granger cause y in short run, maybe the long run causality exists by an another (auxiliary) variable z.
- The z variables capture the essence of underestimate risk, the "shadow link"

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- The z variables capture the essence of underestimate risk, the "shadow link"
- The absence of causality at time 1, not exclude the existence of longer causality

Building a (one) monetary policy stance

- We use a unique measure of monetary policy stance, $\rightarrow$ "short shadow rate" (SSR - Lombardi and Zhu, 2014; Pattipeilohy et al. 2017)
- We use a factor analysis to extract the two components from yield curve, following the Pattipeilohy et al. (2017) approach
- Two unobservable components: term premium and the expectations component

$$Z_t^M = \hat{a}_1^M F_{1,t} + \hat{a}_2^M F_{2,t} + \varepsilon_t \tag{5}$$

where Z_t^M is the yield for maturity bucket M, $\hat{a}_1^M$ stand for the loading on factor i, F_{it} represent the score and ε_t is the mean zero error term. We use the weekly yield curve data

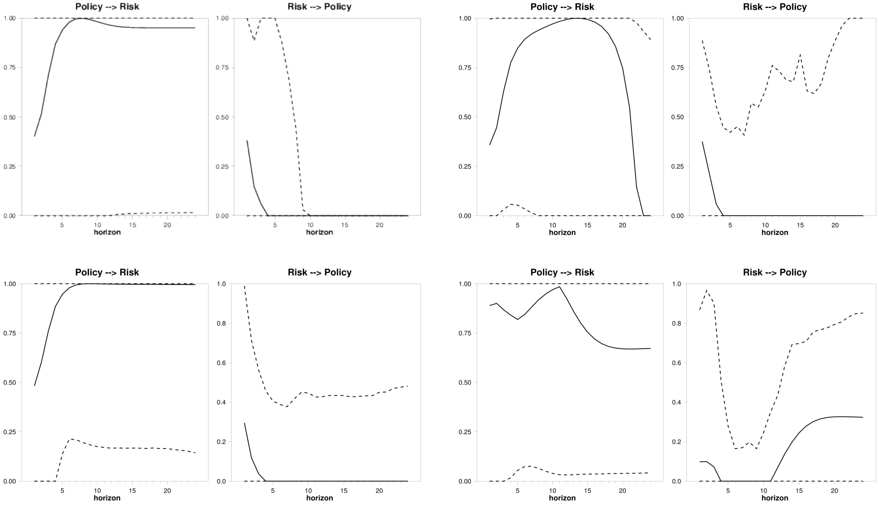
Auxiliary Variables

Following Colletaz et al. (2018) we include different auxiliary variables (z) related to globally financial risk and specific bank risk:

- Global Risk Aversion indicator ($GRAI$) that capture the global risk perception
- The cost of equity for banks (COE)
- The return of equity (ROE)
- The liquidity to asset ratio (LIQ)

All data is taken by ECB and has a monthly frequency

Results



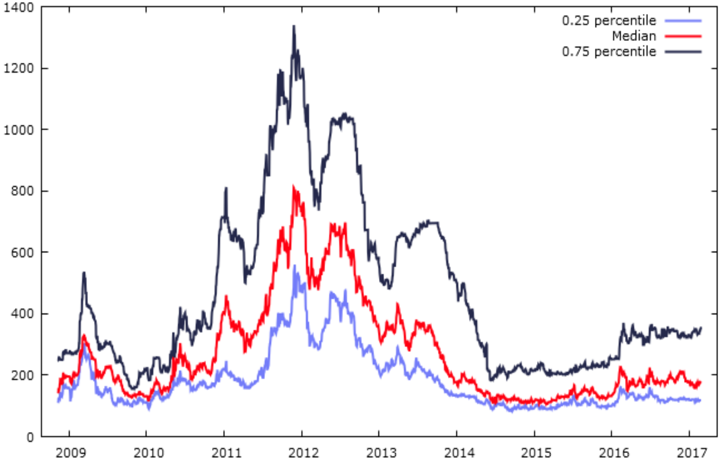
Notes: dashed lines represent the 90% confidence intervals; the values of our measures are comprised between 0 (not significant) and 1, lower bound of the confidence interval is equal to 0 the measure is not significant. z = GRAI, COE, ROE, LIQ.

Conclusions

- European banks CDS spreads are strongly spatially dependent via cross-exposure channel, but the channel's strength may vary over time
- Our measure of systemic risk ($\hat{\rho}_t$) has "an indirect impact on Unemployment through the Industrial Production channel"
- We found that contagion not imply policy intervention $\rightarrow$ financial stability is not yet a monetary policy goal

Thanks

Evolution of CDS 5y spread



GAS for ρ_t

- Parametrization $\rho_t = h(f_t)$
- f_t follow a dynamic process:

$$f_{t+1} = \omega + \sum_{i=0}^{p-1} a_i s_t + \sum_{j=0}^{q-1} b_i f_t \quad (6)$$

  where ω is a scalar coefficient, a_i and b_i are fixed scalar parameters, while $s_{t-1} = S_t \nabla_t$ is the scaled score function

- Model can be estimated straightforwardly by maximum likelihood

Spearman correlation matrix of stock return

	Static Model	Time-varying
ρ	0.7129 (0.000)	
ω		0.030 (0.009)
a		0.029 (0.107)
b		0.966 (0.021)
$\log \sigma^2$	1.036 (0.000)	1.037 (0.000)
logLik	-51.99	-51.98

Notes: Estimated parameters and their robust (sandwich) standard errors in parentheses, for the static spatial lag model and the time-varying spatial model, based on Student's *t* distributed errors.

The long-run causality

- The absence of causality at time 1, not exclude the existence of longer causality
- 2 type of VAR model: the unconstrained and the constrained model
- The unconstrained VAR model:

$$W_t = \sum_{i=1}^{p} \Theta W_{t-i} + \varepsilon_t \tag{7}$$

  where W is the matrix of variables (y, x, z), Θ is the coefficient matrices and the ε_t is iid error term
- The constrained model is divide in two: a) a model where only y and z are included (causality from y to x), and b) a model where only x and z are included (causality from x to z)