Systemic Risk and Bank Business Models[1]

Maarten van Oordt[1] and Chen Zhou[1,2,3]

[1]De Nederlandsche Bank (DNB)

[2]Erasmus University Rotterdam

[3]Tinbergen Institute

Conference on Effective Macroprudential Instruments
Centre for Finance, Credit and Macroeconomics
University of Nottingham, 14 November 2014

[1] *Views expressed do not necessarily reflect official positions of DNB.*

Introduction

- Policy debate
  - Interaction between micro- and macro-prudential policies
    - Focus micro-prudential objective: Risk of individual institution
    - Focus macro-prudential objective: Systemic risk
  - Is micro-prudential policy also useful for limiting systemic risk?
  - New indicators for macro-prudential policy
- How are characteristics of bank business models related to systemic risk?
  - Different from existing literature on which characteristics
  - Focus on two dimensions
    - Individual riskiness
    - Link with the system

Our approach in a nutshell

- A measure of systemic risk
  - The sensitivity of banks to systemic shocks
  - Theoretical and empirical decomposition into two subcomponents
    - Bank tail risk ("Individual riskiness"; IR)
    - Link with system ("Systemic linkage"; SL)
- Panel regression
  - Estimate systemic risk measure and its subcomponents
  - Regress on
    - Fundamental bank characteristics:
      Asset decomposition, income sources, funding structure.
- Results
  - Often opposite relations on IR and SL
  - Traditional banking activities relate to high IR low SL

Related literature

- Measuring systemic risk
  - CoVaR of Adrian and Brunnermeier (2011)
  - Volatility Contribution of Lehar (2005)
  - Distress Insurance Premium of Huang et al. (2010, 2012)
  - Marginal Expected Shortfall of Acharya et al. (2009, 2012)
  - Shapley Value of Drehmann and Tarashev (2013)
- Identifying bank characteristics related to systemic risk
  - López-Espinosa et al. (2012): size, short-term wholesale funding:
  - Brunnermeier et al. (2012): size, leverage, non-interest income
  - Vallascas and Keasey (2012): size, capital, non-interest income and growth
  - Anginer et al. (2013): bank competition
  - Girardi and Ergün (2013): size, leverage
  - López-Espinosa et al. (2013): loan growth

Systemic risk: Conceptualization

- Differentiate definitions on systemic risk
  - shock to "the real economy" v.s. "the financial system"
  - "time dimension" v.s. "cross-sectional dimension"
  - "origin of a crisis" v.s. "suffer in a crisis"
- The systemic risk of a financial institution: the sensitivity to severe shocks in the financial system
- Two dimensions of systemic risk
  - Individual bank (tail) risk
    - systemic: shocks in the financial system
    - other shocks
  - Link between bank tail risk and systemic risk
    - Bank tail risk: overall riskiness
    - Systemic linkage: the "fraction of tail risk" because of large shocks in the financial system

Systemic risk measure: β^T

- The sensitivity of banks to severe shocks in the financial system
- Model
  - Mathematically

$$R_i = \beta_i^T R_s + \varepsilon_i \quad \text{for} \quad R_s < -VaR_s(\bar{p}).$$

  - Similarities with a single factor model
    - Data: stock market returns (publicly available)
    - Measure: coefficient in a linear relation
  - Differences from a single factor model
    - Replace "market return" by banking sector index
    - Partial linear relation: only in the tail

The β^T as a measure of systemic risk

$$R_i = \beta_i^T R_s + \varepsilon_i \quad \text{for} \quad R_s < -VaR_s(\bar{p}).$$

- Why β^T is a measure of systemic risk
  - Reflects the definition
  - Focuses on tail events only
- Connected to existing systemic risk measure
  - Marginal Expected Shortfall (MES) in Acharya et al. (2009,2012)

$$MES_i(p) := -\mathbb{E}[R_i | R_s \leq -VaR_s(p)] = -\beta_i^T \mathbb{E}[R_s | R_s \leq -VaR_s(p)] = \beta_i^T ES_s(p)$$

  - The dispersion in the MES across institutions is solely attributed to the cross-sectional differences in β^T

Estimating β^T: Extreme Value Theory

- Handling tail events: Extreme Value Theory
- Assumptions
  - Heavy-tails in R_i and R_s (tail indices ζ_i and ζ_s): $\Pr(R_i < -x) \sim A_i x^{-\zeta_i}$ as $x \to \infty$
  - Other mild conditions: $\zeta_s < 2\zeta_i$ and $\beta_i^T \geq 0$
- Derivation (Van Oordt and Zhou, 2011)

$$\beta_i^T = \lim_{p \to 0} \tau_i(p)^{1/\zeta_s} \frac{VaR_i(p)}{VaR_s(p)}$$

  - $VaR_i(p)$ and $VaR_s(p)$: Value-at-Risks (VaRs) of R_i and R_s
  - $\tau_i(p)$ is a measure of tail dependence between R_i and R_s

$$\tau_i := \lim_{p \to 0} \tau_i(p) = \lim_{p \to 0} \Pr(R_i < -VaR_i(p) | R_s < -VaR_s(p))$$

    - See e.g. Hartmann et al. (2007) and De Jonghe (2010).

Estimating β^T: Extreme Value Analysis

- Estimating β^T
  - Estimate each component

$$\hat{\beta}_i^T := \widehat{\tau_i(k/n)}^{1/\hat{\zeta}_s} \frac{\widehat{VaR}_i(k/n)}{\widehat{VaR}_s(k/n)}$$

    - All estimated using the k largest losses
- Ingredients in the β^T
  - Cross-sectionally no differences in $\hat{\zeta}_s$ and $\widehat{VaR}_s(k/n)$
  - Firm specific
    - $\widehat{\tau_i(k/n)}$: a tail dependence measure
    - $\widehat{VaR}_i(k/n)$: a tail risk measure

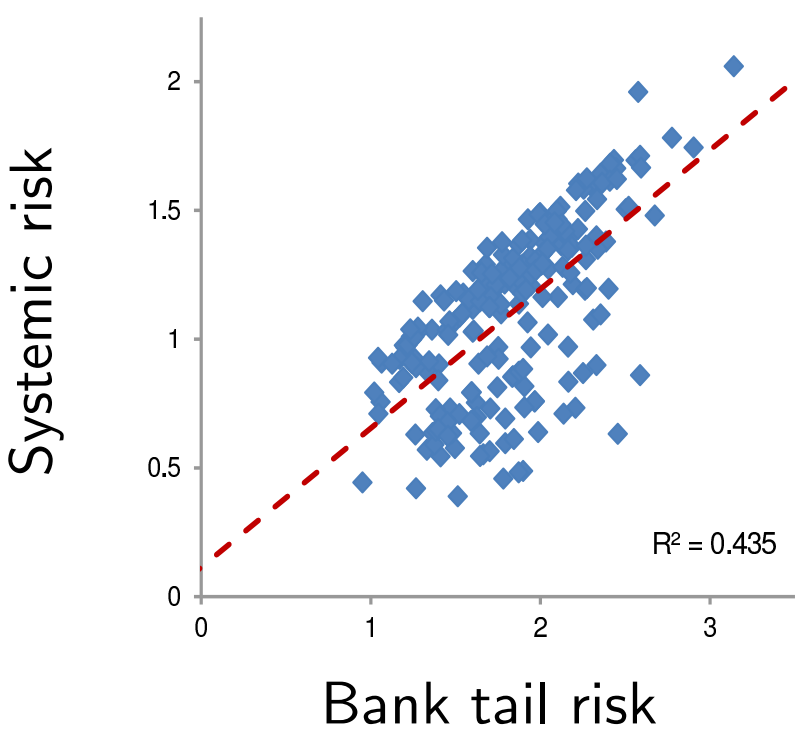
Decomposing β^T

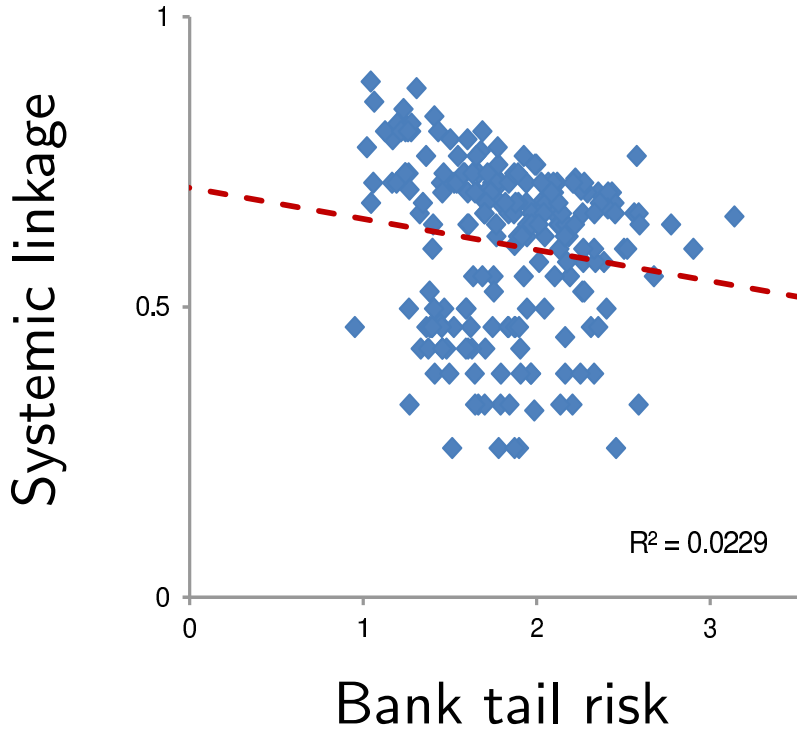
- Decomposition of systemic risk

$$\log \hat{\beta}_i^T = \frac{1}{\hat{\zeta}_s} \log \widehat{\tau_i(k/n)} + \log \frac{\widehat{VaR}_i(k/n)}{\widehat{VaR}_s(k/n)} =: SL_i + IR_i$$

- Two dimensions
  - Systemic linkage SL_i: tail dependence
  - Bank tail risk IR_i: VaR
- Matching the conceptual subcomponents of systemic risk

Bank tail risk and systemic risk

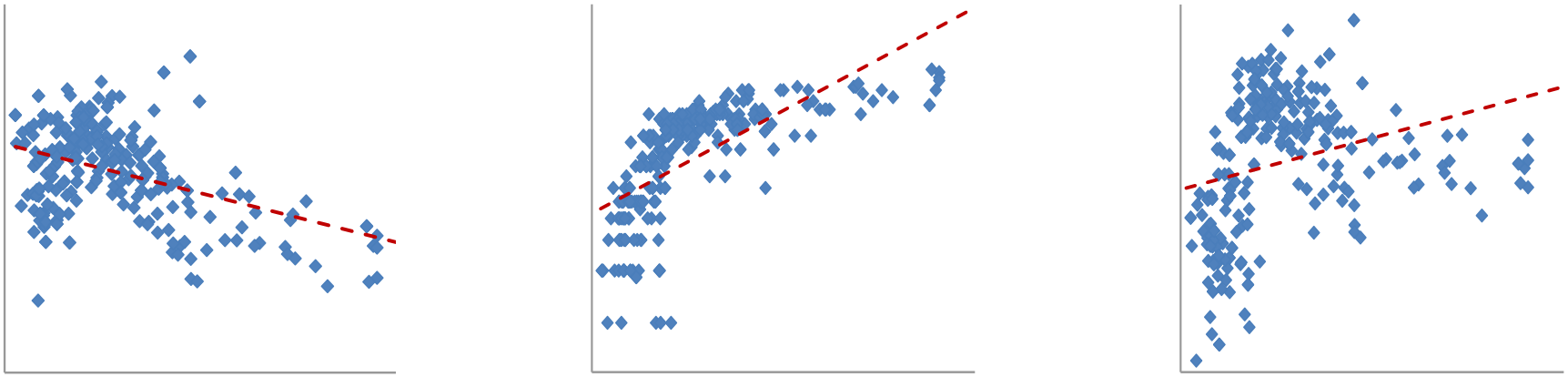




Left: Considerable amount of unexplained variation in systemic risk
Right: Relation between the two subcomponents is very weak

An example: the relation to size

Bank tail risk + Systemic linkage = Systemic risk



- Size has opposite relations with IR (-) and SL (+)
- The positive relation to SL dominates at the SR level

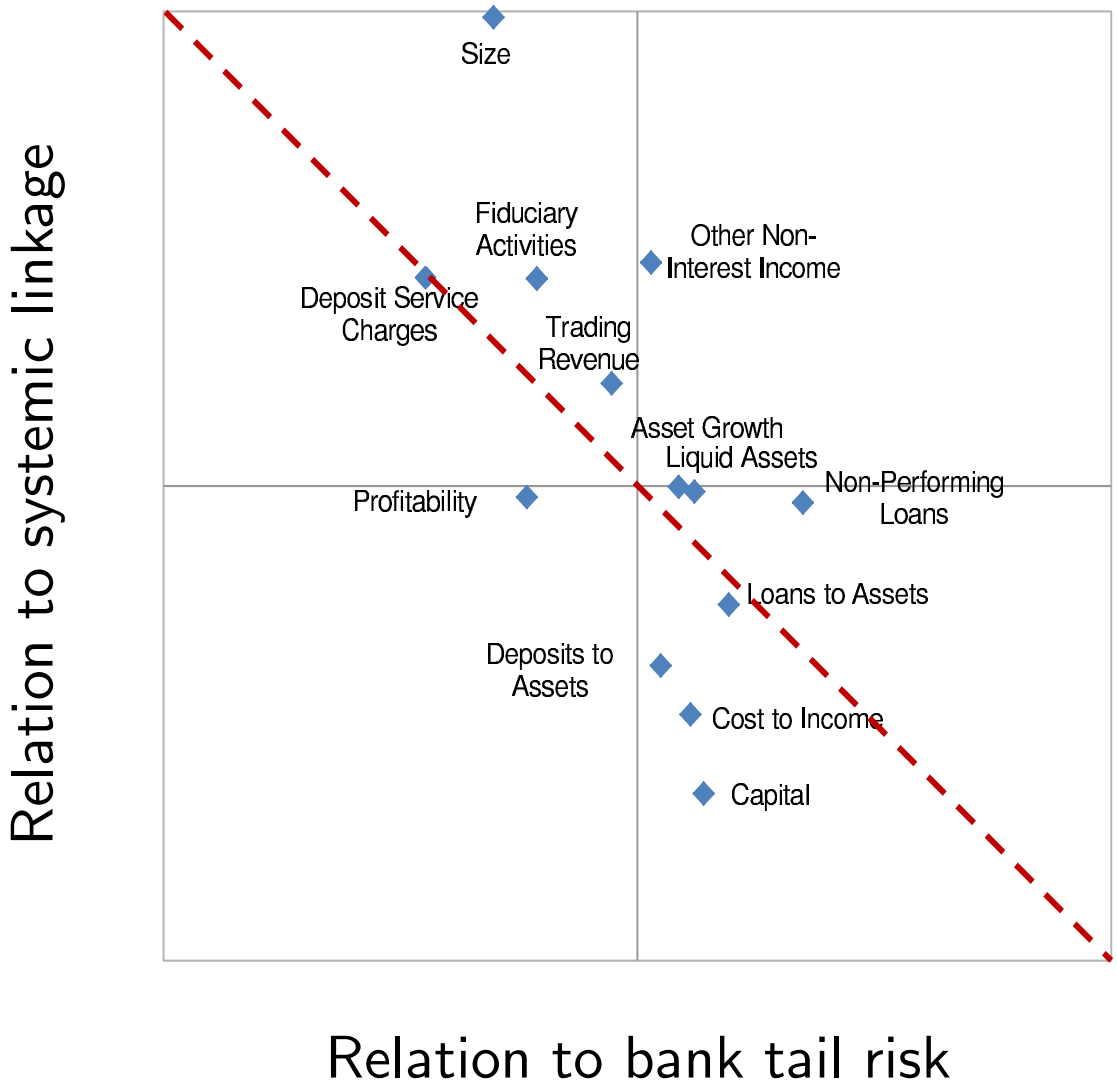
Regression analysis

- Data
  - US Bank Holding Companies in 1991-2011
  - Dependent variables: $\log \beta^T$, *SL* and *IR*
    - Daily equity returns in four-year moving window
    - Quarterly rolling window
    - Coefficients for *SL* and *IR* will add up to those for $\log \beta^T$
  - Bank business model indicators (preceding estimation horizon)
    - Fundamental: size, CAMEL ratios and growth
    - Income sources: non-interest income and its subcomponents
    - Loan decomposition
    - Funding structure
- Methodology
  - Panel regressions across 11,597 bank-quarter observations
  - Time fixed effects, clustering at bank and time level

Results: Regression

	(1)	(2)	(3)
VARIABLES	$\log \hat{\beta}^T_{i,t}$	$SL_{i,t}$	$IR_{i,t}$
Bank Size	0.079***	0.114***	-0.035***
Tier 1 Risk-Based Cap. Ratio	-0.018***	-0.023***	0.005**
Non-Performing Loans Ratio	2.690***	-0.304	2.994***
Cost to Income Ratio	-0.342***	-0.446***	0.104**
Return on Equity	-0.372***	-0.035	-0.337***
Liquid Assets	0.136***	-0.016	0.151***
Loans to Total Assets	-0.048	-0.209***	0.161***
Deposits to Total Assets	-0.319***	-0.367***	0.048
Growth in Total Assets	0.163***	-0.005	0.169***
Fiduciary Activities Income Share	0.357***	0.694***	-0.336***
Srvc Charges on Dep Accnts Shr	-0.023	1.280***	-1.303***
Trading Revenue Share	0.856***	1.139***	-0.283
Other Non-Interest Income Share	0.478***	0.450***	0.028
Constant	0.509***	0.198***	0.311***
R-sq	0.375	0.532	0.434

Results: Scatter plot of standardized coefficients



Summary of results:

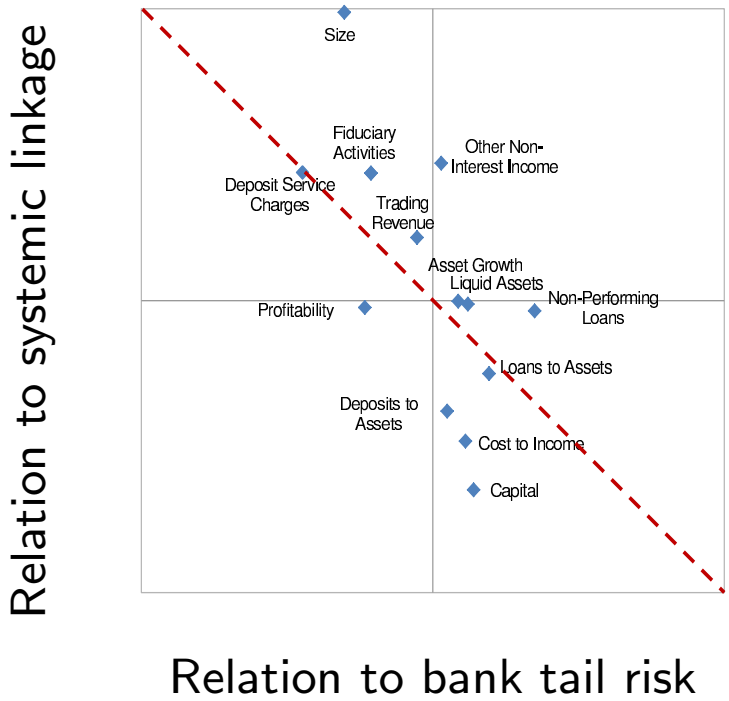
- Banks with a stronger capital buffer, engaging less in activities generating non interest income, having smaller size, or, managing a less risky loan book are associated with lower systemic risk.
- Some bank characteristics have a similar relation to bank risk and systemic risk; others differ in their relation to bank risk and systemic risk, or are related to only one risk type.

Policy implications:

- Micro- and macroprudential policies focusing respectively on individual and systemic risk may differ in scope.
- A single policy measure may have opposite effects on individual and systemic risk.
- The decomposition of systemic risk explains why such opposite effects are possible.
- In the case of opposite effects on individual risk and systemic risk, policy measures require a careful balancing between the micro- and macroprudential objectives of regulation.

Thank you

- Thank you for your time!



- Don't hesitate to contact me at m.r.c.van.oordt@dnb.nl.