Aggregate and firm-level measures of systemic risk from a structural model of default

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We define one type of systemic risk as:

- Joint distress of SIFIs
- Potential is high when there is tight coupling of firm credit fundamentals
- “A shock is more likely to propagate quickly and broadly when sources of risk are tightly coupled” (Kritzman et al., 2010)

We focus on credit risk but view systemic risk as distinct

- Our measure highlights states of the world in which there is higher potential for a severe systemic event, but does not necessarily imply one will take place
Overview

► Aggregate measure (Credit Absorption Ratio):
  • We interpret this as a potential for a severe systemic event
  • Simple to calculate from publicly available data
  • Appears to provide some forward looking indication of systemic events
  • Can be estimated at regional (US, EU) or Global level

► Firm - level measure (mean absolute loading):
  • We interpret this as susceptibility of a firm to a systemic event *should one occur*
  • Forward looking – typically moves earlier than some other measures
  • NOT a measure as each bank’s contributions to the risk of overall banking system
  • Can be scaled by CAR to transform to absolute measure of systemic risk
Motivation

➢ Credit Absorption Ratio (CAR)
   • Extension of the Absorption Ratio (Kritzman et al. 2010)
   • Time series of implied asset returns based on version of Merton’s (1973) structural model of default
   • Credit focus (only financial firms are considered)

➢ Economic intuition
   • A financial institution defaults when its asset value falls below the face value of its debt
   • Over short horizon movements in assets cause changes in default probabilities
   • Asset value movements are typically explained by a broad number of industry/geographic factors
   • When this broad set of factors collapses into a much smaller set, the default probabilities become tightly coupled through common dependence
Original Absorption Ratio (Kritzman, et al. 2010)

- Percentage of the total variance explained by several principal components

\[ AR = \frac{\sum_{j=1}^{k} \lambda_j}{\sum_{j=1}^{m} \lambda_j}, \]

where

- \( AR \) \( \equiv \) absorption ratio
- \( m \) \( \equiv \) number of indices
- \( k \) \( \equiv \) number of eigenvectors used to calculate the AR
- \( \lambda_j \) \( \equiv \) variance of the \( j^{th} \) principal component (the \( j^{th} \) eigenvalue)

- The \( k \) is fixed at approximately at \( m/5 \), which in the empirical example corresponds to the \( k = 10 \) principal components
Credit Absorption Ratio

➢ The CAR utilizes Merton’s structural model of default:

• Market value of assets follows geometric Brownian motion where \( \mu_A \) is the drift of the assets and \( \sigma_A \) is the asset volatility.

\[
dA = \mu_A A dt + \sigma_A A dz,
\]

• Default occurs when value of assets falls below the face value of debt.

• Asset values are implied from equity prices and balance sheet information

➢ We perform PCA on the implied asset returns of financial firms, rather than on broad market indices

➢ \( CAR_t \) is defined as the percentage of the total variance explained by the first principal component at time \( t \)

\[
CAR_t = \frac{\lambda_{1t}}{\sum_{j=1}^{m} \lambda_{jt}},
\]
Case Study – EU CAR

EU CAR vs Euro Area Non-Financial Lending Growth

% variance explained

yoy growth

2005 2006 2007 2008 2009 2010 2011 2012 2013

CAR (left axis) EU lending growth (right axis)
Case Study – US CAR

US CAR vs C&I Lending Growth

% variance explained

yoy growth

2005 2006 2007 2008 2009 2010 2011 2012 2013

CAR (left axis)  US C&I loans (right axis)
Firm Specific Measure

➢ We can also use PCA framework to measure the *susceptibility* of each bank to a systemic event

➢ We average the (absolute) loadings of firm $i$ on the first PC over the 12 months ending at time $t$ ($\lambda_{it}$):

\[
\tilde{\gamma}_{it} = \frac{1}{12} \sum_{\tau=t-11}^{t} |\gamma_{i\tau}|
\]

➢ This measures the time $t$ exposure of firm $i$ to a systemic event *should one occur*

➢ This is a *conditional* measure

➢ An *absolute* measure may also be derived, though in the examples we show, the analysis was broadly similar in both cases
Case Study – Dexia

Benelux capital infusion
Renew of Benelux state guarantees
Split into "good" and "bad" bank
Case Study – Freddie Mac

- Put under FHFA management
- Foreclosure suspension lifted
- Bailout limit doubled
- Unlimited funds announced
- Takes short position in subprime
Caveats

➢ There is a number of aspects of our work that suggest caution in interpreting our results:

  • *Time period examined:* Our data only cover the last decade
  
  • *Restatements of historical data:* Rare but sometimes occur as financial data are corrected
  
  • *Revision of asset value model by vendor:* may impact availability of the first portion of data series
  
  • *Focus on credit may (or may not) miss other risks:* E.g., impact of liquidity and how quickly it is incorporated is not known
  
  • Number of principal components used for CAR estimates (we provide analysis of $k=1..10$)

➢ We hope to explore some of these in future work
Conclusion

➢ Combination of original AR with economically motivated structural model of default gave rise to CAR

➢ Credit Absorption Ratio (CAR)
  • Measures coupling of the financial system
  • Increases when risk and correlation increase
  • Loadings on the CAR measure susceptibility of financial institutions to a systemic event
  • Economically motivated

➢ Empirically
  • *Ex ante* CAR appears to rise prior to the periods of financial distress
  • *Ex ante* loadings on CAR appear to rise prior to the distress of individual banks
Related Literature


