

# *Celta CoES: Size, interconnectedness and Black Swans in the financial system*

Javier Ojea Ferreiro<sup>3</sup>

Supervised by: Alfonso Novales Cinca<sup>4</sup>

Complutense University of Madrid

May 8<sup>th</sup>, 2017

---

<sup>3</sup> [jojea@ucm.es](mailto:jojea@ucm.es)

<sup>4</sup> [anovales@ccee.ucm.es](mailto:anovales@ccee.ucm.es)

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# What is and why should we care systemic risk?

- Risk of experiencing events where financial failures likely to translate into adverse effects on welfare in the economy ([ECB10]).
- Relevance in recent crisis
  - ◇ 2008 Financial crisis: BNP Paribas.
  - ◇ 2010-2012 European Sovereign Debt crisis: Monte di Paschi, Anglo Irish Bank,...

BUSINESS NEWS AUGUST 9, 2007 / 8:44 AM / 11 YEARS AGO

## BNP freezes \$2.2 bln of funds over subprime

Sudip Kar-Gupta, Yann Le Guernigou

5 MIN READ



PARIS (Reuters) - France's biggest listed bank, BNP Paribas (BNPP.PA), froze 1.6 billion euros (\$2.2 billion) worth of funds on Thursday, citing the U.S. subprime mortgage sector woes that have rattled financial markets worldwide.



# What is and why should we care systemic risk?

- Risk of experiencing events where financial failures likely to translate into adverse effects on welfare in the economy ([ECB10]).
- Relevance in recent crisis
  - ◇ 2008 Financial crisis: BNP Paribas.
  - ◇ 2010-2012 European Sovereign Debt crisis: Monte di Paschi, Anglo Irish Bank,...

The screenshot shows a mobile interface for the Financial Times. At the top, there is a hamburger menu icon, the text 'FINANCIAL TIMES', and the 'myFT' logo. Below this is a 'Markets' section with a '+ Add to myFT' button. The main headline is 'ECB injects €95bn to help markets'. The byline reads 'Gillian Tett in London, Richard Milne in Frankfurt and Krishna Guha in Washington'. The date is 'AUGUST 10, 2007'. The article text states: 'The European Central Bank scrambled to head off a potential financial crisis on Thursday by pumping an emergency €94.8bn (\$131bn) into the region's banking system after liquidity in the interbank market started to dry up, threatening banks' access to short-term funds.' A second paragraph begins: 'The cash injection was the biggest in the ECB's history, exceeding the €69bn provided the day after the terrorist attacks of September 11 2001. The ECB also made an unprecedented one-day pledge to meet 100 per cent of all funding requests from financial institutions.'

# What is and why should we care systemic risk?

- Risk of experiencing events where financial failures likely to translate into adverse effects on welfare in the economy ([ECB10]).
- Relevance in recent crisis
  - ◇ 2008 Financial crisis: BNP Paribas.
  - ◇ 2010-2012 European Sovereign Debt crisis: Monte di Paschi, Anglo Irish Bank,...

The screenshot shows a Guardian article titled "Irish toxic loans are half as big as economy, bank bailout reveals". The article is by Henry McDonald and Elena Moya, dated Tuesday, 30 March 2010 at 21:41 BST. The article text states that Ireland's taxpayers will hand over €8.5bn (£7.6bn) to buy the toxic loans of the country's crisis-ridden banks, and that the Irish state will become the majority shareholder in the republic's largest bank, Allied Irish Banks.

Support The Guardian

The Guardian

News Opinion Sport Culture Lifestyle

Business ▶ Economics Banking Money Markets Project Syndicate B2B

## Irish toxic loans are half as big as economy, bank bailout reveals

Ireland creates 'bad bank' to rescue stricken lenders and in effect nationalises second bank as it clears up after property crash

Henry McDonald and Elena Moya

Tue 30 Mar 2010 21:41 BST

f t e < 2

This article is over 8 years old

Ireland's taxpayers will hand over €8.5bn (£7.6bn) to buy the toxic loans of the country's crisis-ridden banks, it was announced today.

The Irish state will also become the majority shareholder in the republic's largest bank, the Allied Irish Banks, as the Dublin government attempts to clear up the mess from years of reckless lending that has capsized the country's economy. This is the second major bank the government has in effect nationalised since the financial crisis began.

# What is and why should we care systemic risk?

- Risk of experiencing events where financial failures likely to translate into adverse effects on welfare in the economy ([ECB10]).
- Relevance in recent crisis
  - ◇ 2008 Financial crisis: BNP Paribas.
  - ◇ 2010-2012 European Sovereign Debt crisis: Monte di Paschi, Anglo Irish Bank,...

PRESS RELEASE

## ECB deemed Veneto Banca and Banca Popolare di Vicenza failing or likely to fail

23 June 2017

- > Decision a result of lack of capital
- > SRB concluded that conditions for a resolution action were not fulfilled
- > Banks to be wound up under Italian insolvency procedures

On 23 June, the European Central Bank (ECB) determined that Veneto Banca S.p.A. and Banca Popolare di Vicenza S.p.A. were failing or likely to fail as the two banks repeatedly breached supervisory capital requirements. The determination was made in accordance with Articles 18(1a) and 18(4a) of the Single Resolution Mechanism Regulation.

The ECB had given the banks time to present capital plans, but the banks had been unable to offer credible solutions going forward.

Consequently, the ECB deemed that both banks were failing or likely to fail and duly informed the Single Resolution Board (SRB), which concluded that the conditions for a resolution action in relation to the two banks had not been met. The banks will be wound up under Italian insolvency procedures.

# What is and why should we care systemic risk?

- Risk of experiencing events where financial failures likely to translate into adverse effects on welfare in the economy ([ECB10]).
- Relevance in recent crisis
  - ◇ 2008 Financial crisis: BNP Paribas.
  - ◇ 2010-2012 European Sovereign Debt crisis: Monte di Paschi, Anglo Irish Bank,...

The screenshot shows the Reuters website interface. At the top, there is a search bar and a menu icon. Below the navigation bar, there are several topic filters: "Detained in Myanmar", "Energy & Environment", "Brexit", and "North Korea". The main content area is titled "BUSINESS NEWS" and includes a timestamp "JULY 4, 2017 / 3:44 PM / 10 MONTHS AGO". The headline of the article is "EU clears Italy's \$6 billion state bailout for Monte dei Paschi". Below the headline, it says "Reuters Staff" and there are social media sharing icons for Twitter and Facebook. The article text begins with "BRUSSELS/MILAN/ROME (Reuters) - The European Union has approved a 5.4 billion euro (\$6.1 billion) state bailout of Italy's fourth-largest lender, Monte dei Paschi di Siena (BMP.SI), taking the total amount of Italian taxpayer funds deployed to rescue banks over the past week to more than 20 billion euros."

# What do we need?

- Identifying *SIFIs* is a key step in the macro-prudential supervision ([Tri09], [Con17]).
- Need of high-frequency systemic risk measures due to the acceleration of the financial turmoil phases.
- Features of *SIFIs* ([LRT14], [Ber10], [RW12], [Ber09], [IBF10])
  - ◇ Too Big To Fail (*TBTF*)
  - ◇ Too Connected To Fail (*TCTF*)
  - ◇ **Can complex characteristics of the probability distribution function affect to systemic risk?**



# The role of higher moments in systemic risk

- ES-based systemic risk measures overlook some stylish facts about financial returns
  - ◇ Leptokurtic
  - ◇ Skewness
  - ◇ Joint tail dependence
- Black Swan events ([Tal07])
  - ◇ Low probability of occurrence.
  - ◇ Huge effects.
  - ◇ "Unpredictable": *hasard* (tractable randomness, knightian risk) and *fortuit* (accidental and unforeseen, knightian uncertainty).
- Ludic fallacy (model risk): confuse model with reality.
- Double bubble: underestimate probability and consequences.

# What do we have so far?

- **MES**: mean behaviour of firm  $i$  given an aggregate shock in the financial system.
- **CES**: Absolute contribution of firm  $i$  to the returns of the financial system in case of crisis.
- **SRISK**: Capital need of firm  $i$  conditioned to a long crisis period.
- $\Delta \text{CoVaR}_{m|i}$ : Change in the ES of the financial system when firm  $i$  suffers a crisis.

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# Marginal Expected Shortfall

MES [AER12]

$$MES_{i,t}(\alpha) = \frac{\partial ES_{i,t}(\alpha)}{\partial \omega_{i,t-1}}$$

- Measure of exposure of firms to the market in case of crisis ( $\beta_{i,crisis}$ ).
- It is a market risk measure more than a systemic risk measure. ([BCHP13] [BCHP17])
- Systemic and systematic risk are mixed ([GK14], [LR17], [KMSV17])

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - **SRISK**
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# SRISK

## SRISK [BE16]

$$SRISK_{i,t} = [\text{Required capitalisation} - \text{Expected capitalisation}]^+,$$

- Inputs: market and accountant data
  - ◇ **Common exposure:** LRMES.
  - ◇ **Size:** Market capitalization.
  - ◇ **Leverage:** Total debt.
  - ◇ Capital requirement ratio. Europe  $k = 5.5\%$  ([EJR15]).
- Accountant data
  - ◇ Discrepancy problems.
  - ◇ Scarce and only available at a low frequency.
  - ◇ Misleading information for non-banking sectors ([SRS16]).
  - ◇ *SRISK* highly correlated with the leverage ratio ([SHK16]).

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - **CES**
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions



# Component Expected Shortfall

*CES* [BD15]

$$CES_{i,t}(\alpha) = \omega_{i,t-1}MES_{i,t}(\alpha)$$

- Add a size factor to the *MES* (*TBTF*).
- $ES_{m,t}(\alpha) = \sum_{i=1}^N CES_{i,t}(\alpha)$ .
- Measure of contribution but not dependence. Lack of a benchmark value in normal times.

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta$  CoES<sub>m|i</sub>
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

## Delta Conditional Expected Shortfall

$$\Delta \text{CoES}_{m|i} \text{ [AB16], [GE13]}$$

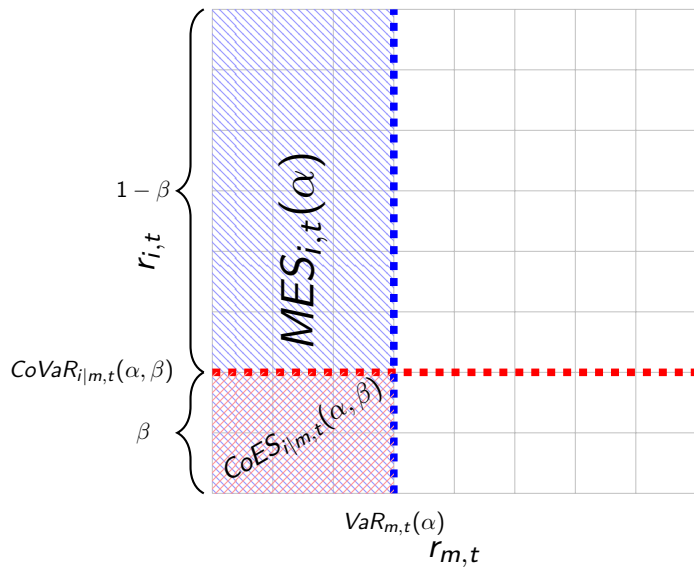
$$\Delta \text{CoES}_{m|i,t}(\beta) = \text{CoES}_{m|i,t}(\alpha_s, \beta) - \text{CoES}_{m|i,t}(\alpha_n, \beta)$$

- Measure of contagion from the firm  $i$  to the financial system ( $TCTF$ ).
- $\Delta \text{CoES}_{i|m,t}(\beta)$  measures the contagion from the financial system to firm  $i$ .
- It is not aggregated unlike  $CES$ ,  $SRISK$ .
- Size is not directly considered.

# Overview

- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# Component Delta Conditional Expected Shortfall



# Component Delta Conditional Expected Shortfall

*Celta CoES*<sub>*i,t*</sub>

$$\text{Celta CoES}_{i,t}(\beta) = \omega_{i,t-1} \Delta \text{CoES}_{i|m,t}(\beta)$$

- Size: *TBTF* ( $\omega_{i,t-1}$ ).
- Interconnectedness: *TCTF* ( $\Delta \text{CoES}_{i|m,t}(\alpha)$ ) [here](#).
- Considers complex distribution features.
- Obtained from the Expected Shortfall of the financial system.
- Can be aggregated as *CES*, *SRISK*.

# Component Delta Conditional Expected Shortfall

Relationship  $ES_{m,t}(\alpha)$ -Celta  $CoES_{i,t}$

$$\Delta ES_{m,t} = \sum_{i=1}^N \left( \underbrace{\omega_{i,t-1} \Delta CoES_{i|m,t}(\beta)}_{\text{Celta } CoES_{i,t}(\beta)} + \omega_{i,t-1} \Delta CoRes_{i|m,t}(\beta) \right)$$

- $\Delta ES_{m,t}$ : Change in the Expected Shortfall of the financial system when a crisis arises.
- $\Delta CoRes_{i|m,t}(\beta)$ : Ability of the institution to adapt and resist from an hazard change in the financial market.

# Overview

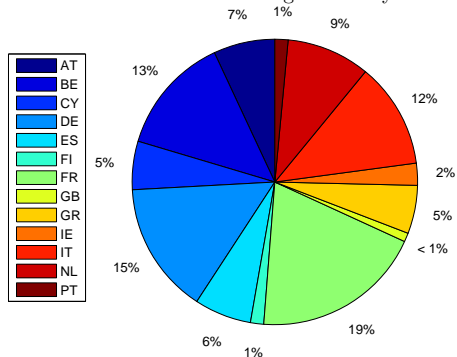
- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 **Data**
- 5 Results
- 6 Conclusions



# European database

- Source: Datastream
- Period: September 2006 to the September 2016.
- Frequency: weekly basis.
- N: 201
  - ◇ 23.88% Banks.
  - ◇ 37.31% Real Estate oriented firms.
  - ◇ 9.45% Insurance firms.
  - ◇ 29.36% Financial services oriented firms.

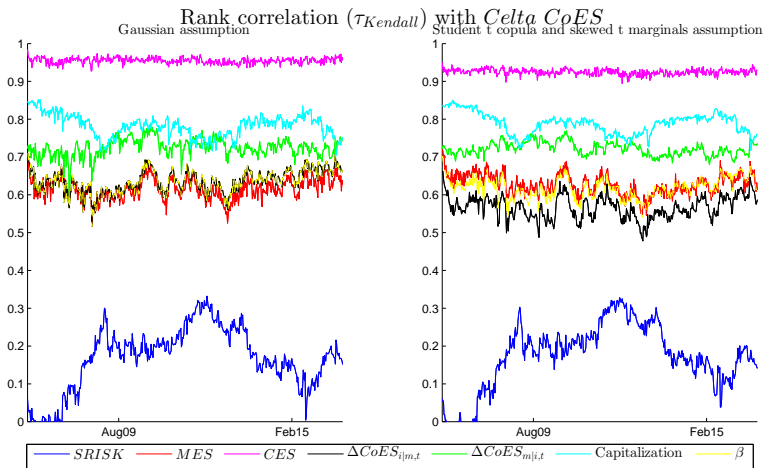
Financial institutions gathered by country



# Overview

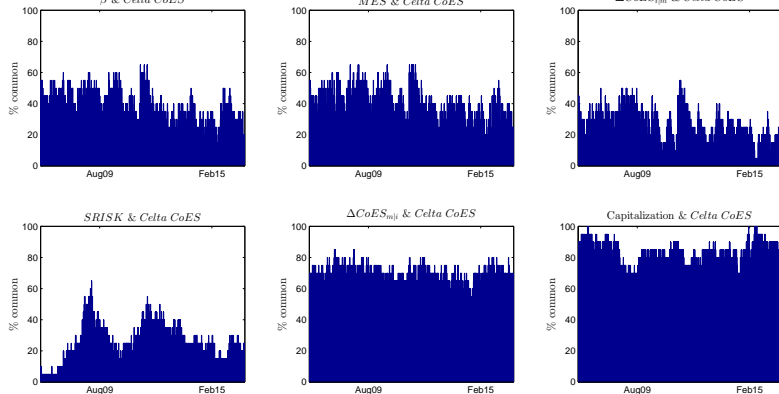
- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results**
- 6 Conclusions

# Rank Correlation

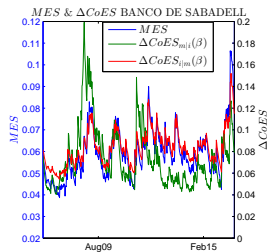
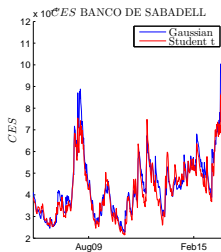
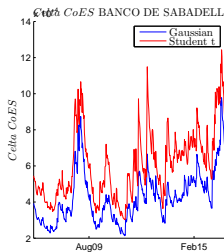
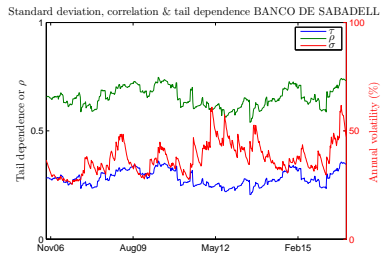
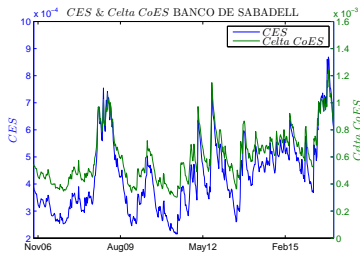


# Common *SIFI* in Top 20

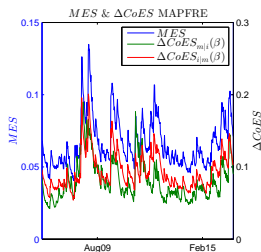
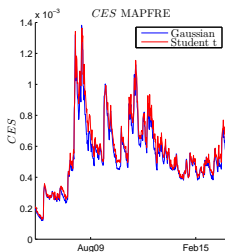
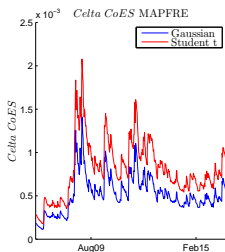
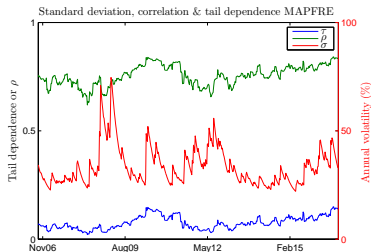
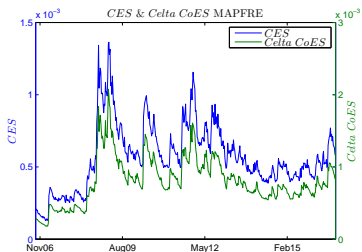
Top 20 SIFIs common with *Celta CoES*: Student t copula with skewed t marginal assumption



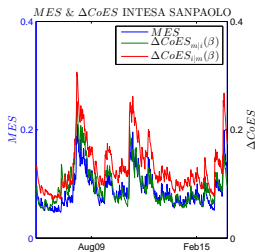
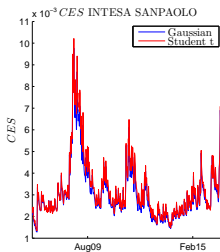
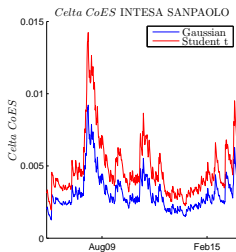
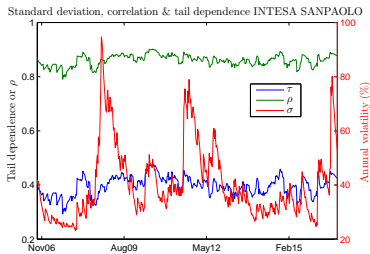
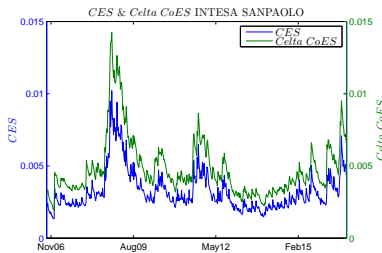
# Celta CoES and CES



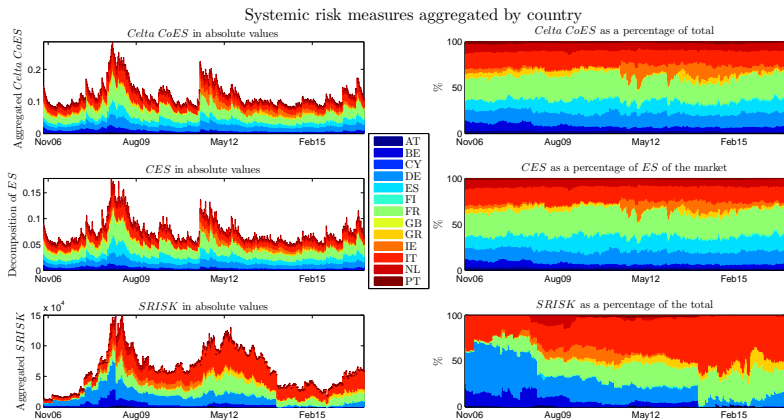
## Celta CoES and CES



## Celta CoES and CES



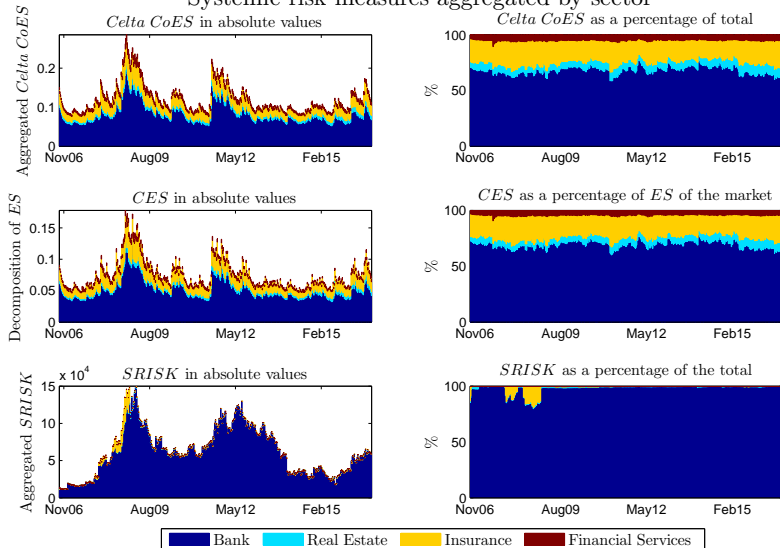
# Aggregated risk measures





# Aggregated risk measures

## Systemic risk measures aggregated by sector



# Overview


- 1 Motivation
- 2 Literature review
  - MES
  - SRISK
  - CES
  - $\Delta \text{CoES}_{m|i}$
- 3 Celta CoES
- 4 Data
- 5 Results
- 6 Conclusions

# Conclusions






- I build a market-based systemic risk measures that gathers *TBTF* and *TCTF*.
- The measure reflects stylish facts concerning financial returns, not weighted enough in the remaining measures.
- *Celta CoES* presents high rank correlation with size and interconnectedness proxies. Similarities in cross-section with *CES* are mainly given by the size factor.
- Concerning the *SRISK-Celta CoES* similarities, they coincide with the financial crisis while *Celta CoES* does not undervalue non-banking sectors.

Thank you for your attention.  
Suggestions, comments, ideas,...





# References I

-  T. Adrian and M. K. Brunnermeier, *CoVaR*, *The American Economic Review* **106** (2016), no. 7, 1705–1741.
-  V. Acharya, R. Engle, and M. Richardson, *Capital shortfall: A new Approach to Ranking and Regulating Systematic Risks*, *American Economic Review* **102** (2012), no. 3, 59–64.
-  S. Benoit, G. Colletaz, C. Hurlin, and C. Pérignon, *A Theoretical and Empirical Comparison of Systemic Risk Measures*, Working Papers halshs-00746272, HAL, June 2013.
-  S. Benoit, J.-E. Colliard, C. Hurlin, and C. Pérignon, *Where the risks lie: A survey on systemic risk*, *Review of Finance* **21** (2017), no. 1, 109–152.




## References II

-  G.-D. Banulescu and E.-I. Dumitrescu, *Which are the sifis? a component expected shortfall approach to systemic risk*, *Journal of Banking & Finance* **50** (2015), 575–588.
-  C. Brownlees and R. F. Engle, *Srisk: A conditional capital shortfall measure of systemic risk*, *The Review of Financial Studies* **30** (2016), no. 1, 48–79.
-  B. Bernanke, *Financial Reform to Address Systemic Risk*, 2009, Speech delivered at the Council on Foreign Relations.
-  B.S. Bernanke, *Causes of the Recent Financial and Economic Crisis*, 2010, Statement of the FED Chairman before the Financial Crisis Inquiry Commission.
-  V. Constâncio, *Macroprudential stress-tests and tools for the non-bank sector*, 2017, ESRB Annual Conference.

## References III

-  ECB, *New quantitative measures of systemic risk*, Tech. report, Financial Stability Review, 12 2010.
-  R. Engle, E. Jondeau, and M. Rockinger, *Systemic risk in Europe*, *Review of Finance* **19** (2015), no. 1, 145–190.
-  G. Girardi and A. T. Ergün, *Systemic risk measurement: Multivariate GARCH estimation of CoVaR*, *Journal of Banking and Finance* **37** (2013), no. 8, 3169–3180.
-  L. Guntay and P. Kupiec, *Taking the risk out of systemic risk measurement*, Tech. report, American Enterprise Institute (AEI) Research Paper, 01 2014.

## References IV

-  International Monetary Fund, Bank for International Settlements, and Financial Stability Board, *Guidance to assess the systemic importance of financial institutions, markets and instruments: Initial considerations: Report to the g-20 finance ministers and central bank governors*, Staff of the International Monetary Fund and the Bank for International Settlements, and the Secretariat of the Financial Stability Board (2010).
-  J. Kleinow, F. Moreira, S. Strobl, and S. Vähämaa, *Measuring systemic risk: A comparison of alternative market-based approaches*, Finance Research Letters **21** (2017), 40 – 46.
-  G. Löffler and P. Raupach, *Pitfalls in the use of systemic risk measures*, Journal of Financial and Quantitative Analysis (2017).



## References V

-  L. Laeven, L. Ratnovski, and H. Tong, *Bank Size and Systemic Risk*, IMF Staff Discussion Notes 14/4, International Monetary Fund, May 2014.
-  A. Rose and T. Wieladek, *Too big to fail: some empirical evidence on the causes and consequences of public banking interventions in the United Kingdom*, Bank of England working papers 460, Bank of England, August 2012.
-  C. Salleo, T. Homar, and H. Kick, *Making sense of the EU wide stress test: a comparison with the SRISK approach*, Working Paper Series 1920, European Central Bank, June 2016.
-  H. S. Scott, K. Ricci, and A. Sarfatti, *SRISK as a Measure of Systemic Risk for Insurers: Oversimplified and Inappropriate*, Tech. report, Harvard Law School Working Paper, 2016.

## References VI



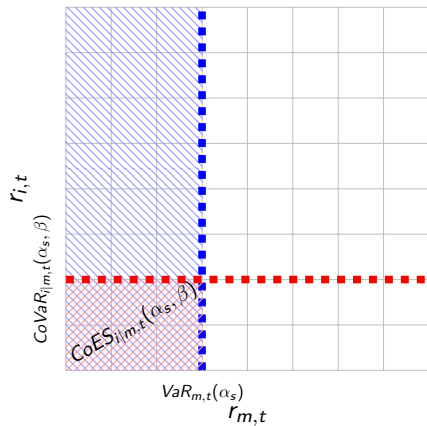
Nassim Nicholas Taleb, *The black swan: The impact of the highly improbable*, vol. 2, Random house, 2007.



J.-C. Trichet, *Clare Distinguished Lecture in Economics and Public Policy*, 2009, Speech at University of Cambridge organised by the Clare College.

$$\Delta CoES_{i|m,t}(\beta)$$

(Minuend)



(Substrahend)

