TommasoBelluzzo / SystemicRisk

A framework for systemic risk valuation and analysis.

#financial-analysis #network-analysis #risk-analysis #risk-models #systemic-risk #financial-data #financial-institutions #financial-markets #quantitative-analysis #quantitative-finance #quantitative-methods #risk-management #time-series #time-series-analysis #time-series-econometrics

525 commits | **1** branch | **0** packages | **0** releases | **1** contributor | Apache-2.0

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TommasoBelluzzo Update README.md — Latest commit 35e17bf yesterday

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.gitattributes	Create .gitattributes	8 months ago
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CODE_OF_CONDUCT.md	Create CODE_OF_CONDUCT.md	3 years ago
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LICENSE.md	Update LICENSE.md	3 years ago
README.md	Update README.md	yesterday
run.m	Add files via upload	6 days ago

README.md

Systemic Risk

This script calculates and analyses the following risk measures:

- `Cross-Sectional Measures`
  - `CoVaR & Delta CoVaR (Conditional Value-at-Risk)` by Adrian & Brunnermeier (2008)
  - `MES (Marginal Expected Shortfall)` by Acharya et al. (2010)
  - `SRISK (Conditional Capital Shortfall Index)` by Brownlees & Engle (2010)
  - `Idiosyncratic Metrics: Beta, Value-at-Risk & Expected Shortfall`
- `Connectedness Measures` proposed in Billio et al. (2011)
  - `Dynamic Causality Index`
  - `"In & Out" Connections`
  - `"In & Out - Other" Connections`
  - `Network Centralities`
- `Spillover Measures` proposed in Diebold & Yilmaz (2014)
  - `Spillover Index`
  - `Spillovers From & To`
  - `Net Spillovers`
- `Component Measures`
  - `Absorption Ratio` by Kritzman et al. (2010)
  - `Correlation Surprise` by Kinlaw & Turkington (2012)
  - `Turbulence Index` by Kritzman & Li (2010)
  - `Principal Component Analysis`

Some of the aforementioned models have been adjusted and improved according to the methodologies described in the V-Lab Documentation, which represents a great source for systemic risk measurement.

`The project has been published in "MATLAB Digest - Financial Services" of May 2019.`

Requirements

The minimum Matlab version required is `R2014a`. In addition, the following products and toolboxes must be installed in order to properly execute the script:

- Computer Vision System Toolbox
- Curve Fitting Toolbox
- MATLAB Distributed Computing Server
- Optimization Toolbox
- Parallel Computing Toolbox
- Simulink Control Design
- Statistics and Machine Learning Toolbox
- System Identification Toolbox

Usage

1. Create a properly structured database (see the paragraph below).
2. Edit the `run.m` script following your needs.
3. Execute the `run.m` script.

Dataset

Datasets must be built following the structure of default ones included in every release of the framework (see `Datasets` folder). The main one (`Datasets\Example_Large.xlsx`), based on the US financial sector, defines the following entities over a period of time ranging from `2000` to `2014` :

Benchmark: S&P 500

Financial Institutions (20):

- **Group 1: Insurance Companies (5)**
  - American International Group Inc. (AIG)
  - The Allstate Corp. (ALL)
  - Berkshire Hathaway Inc. (BRK)
  - MetLife Inc. (MET)
  - Prudential Financial Inc. (PRU)
- **Group 2: Investment Banks (6)**
  - Bank of America Corp. (BAC)
  - Citigroup Inc. (C)
  - The Goldman Sachs Group Inc. (GS)
  - J.P. Morgan Chase & Co. (JPM)
  - Lehman Brothers Holdings Inc. (LEH)
  - Morgan Stanley (MS)
- **Group 3: Commercial Banks (7)**
  - American Express Co. (AXP)
  - Bank of New York Mellon Corp. (BK)
  - Capital One Financial Corp. (COF)
  - PNC Financial Services Inc. (PNC)
  - State Street Corp. (STT)
  - US Bancorp (USB)
  - Wells Fargo & Co. (WFC)
- **Group 4: Government-sponsored Enterprises (2)**
  - Federal Home Loan Mortgage Corp / Freddie Mac (FMCC)
  - Federal National Mortgage Association / Fannie Mae (FNMA)

State Variables (8):

- **TBILL_DELTA:** the percent change in the 3M treasury bill rate.
- **CREDIT_SPREAD:** the difference between the BAA corporate bond rate and the 10Y treasury bond rate.
- **LIQUIDITY_SPREAD:** the difference between the 3M treasury bill rate and the federal funds rate.
- **TED_SPREAD:** the difference between the 3M USD LIBOR rate and the 3M treasury bill rate.
- **YIELD_SPREAD:** the difference between the 10Y treasury bond rate and the 3M treasury bond rate.
- **DJ_CA:** the DJ US Composite Average log-returns as a proxy of industrial returns.
- **DJ_RESI:** the DJ US Select Real Estate Securities Index log-returns as a proxy of real estate returns.
- **VIX:** the implied volatility index.

Notes

- Financial time series must contain a benchmark index and at least 3 firms. They must have a daily frequency and contain enough observations to run consistent calculations (the minimum required amount is 253, which translates into a full business year plus an additional observation at the beginning of the time series). They must have been previously validated and preprocessed by:
  - discarding illiquid series with too many zeros (unless necessary);

  - detecting and removing outliers;
  - removing rows with NaNs or filling the gaps through interpolation.

- In accordance with all the systemic risk indicators, returns must be expressed on a logarithmic scale. Market capitalizations, total liabilities and separate accounts must be expressed in the same currency and scale. Following the SRISK methodology, it is recommended to roll forward liabilities by at least 3 months in order to simulate the difficulty of renegotiating debt in case of financial distress.

- Data concerning state variables and firm groups are optional, hence their respective sheets must be removed from the dataset if the related computations aren't necessary. Groups are based on key-value pairs where the Name field represents the group names and the Count field represents the number of firms to include in the group. The sum of the Count fields must be equal to the number of firms included in the dataset. For example, the following groups definition:

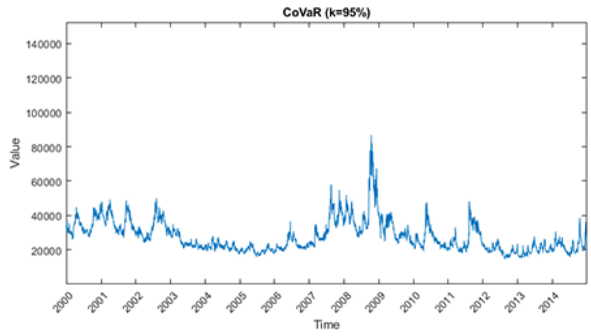
  > Firms in the Returns Sheet: A, B, C, D, E, F, G, H
  > Insurance Companies: 2
  > Investment Banks: 2
  > Commercial Banks: 3
  > Government-sponsored Enterprises: 1

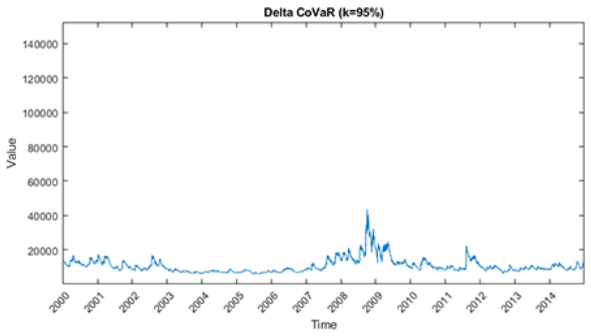
  produces the following outcome:

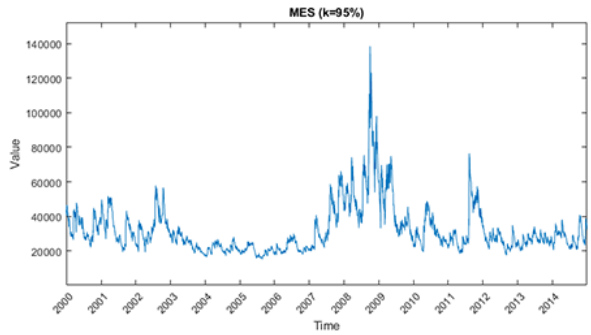
  > "Insurance Companies" contains A and B
  > "Investment Banks" contains C and D
  > "Commercial Banks" contains E, F and G
  > "Government-sponsored Enterprises" contains H

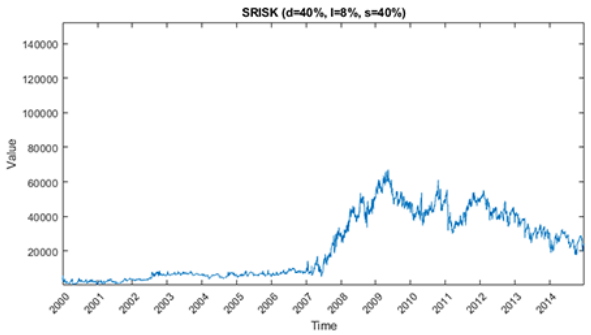
- While stochastic measures are very fast to compute, for huge datasets like `Datasets\Example_Large.xlsx` connectedness and spillover measures may take very long time to finish. The performance of computations may vary from machine to machine, depending on the CPU processing speed and the number of cores available for parallel computing.

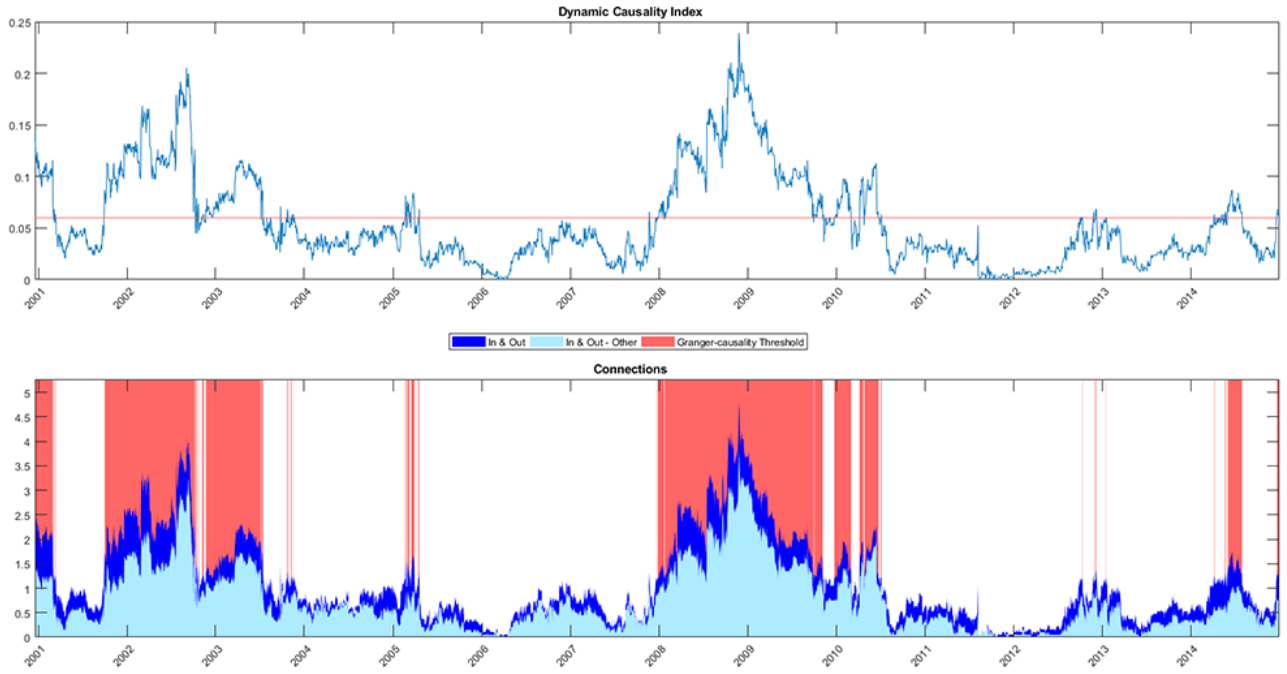
Screenshots

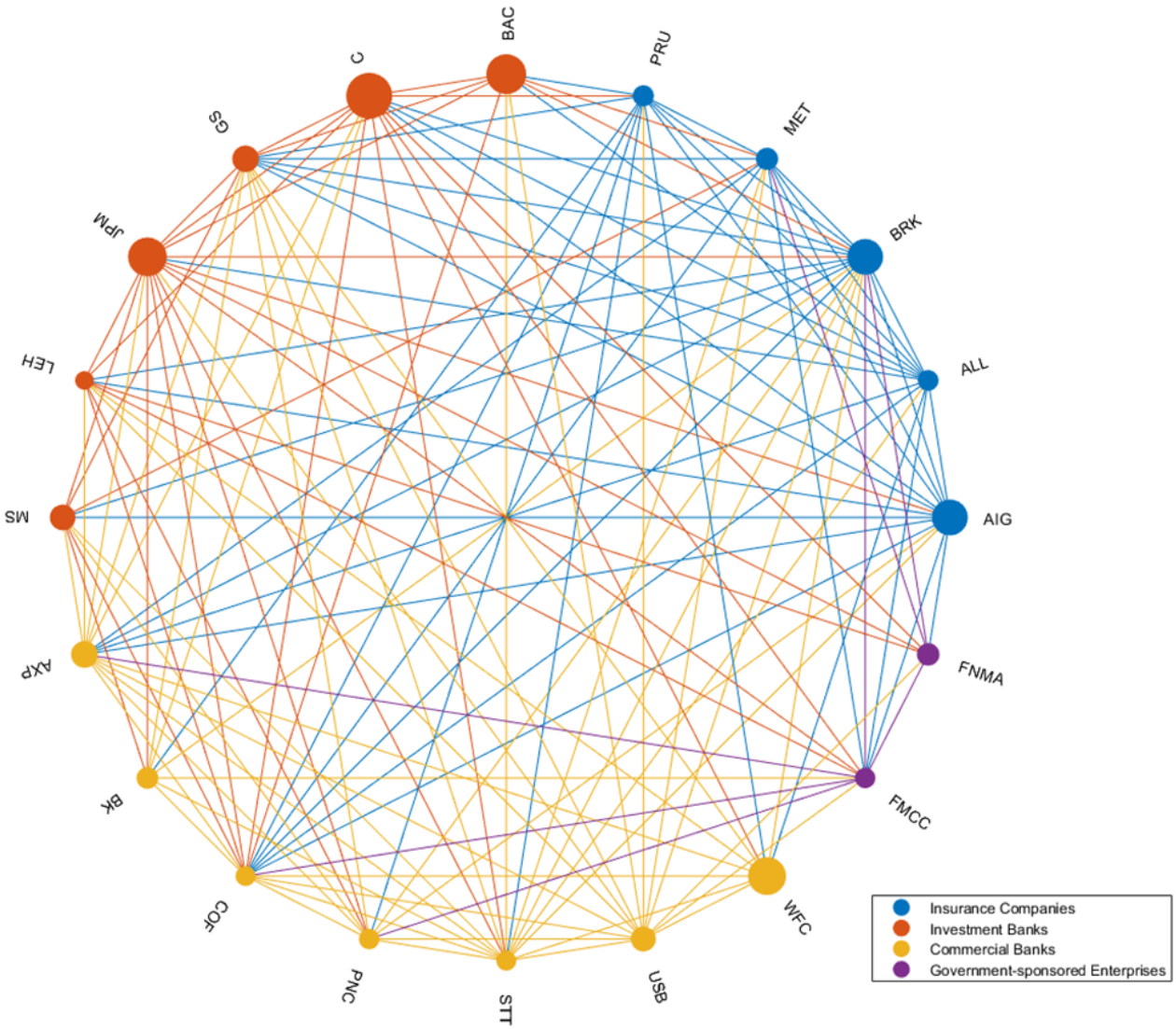


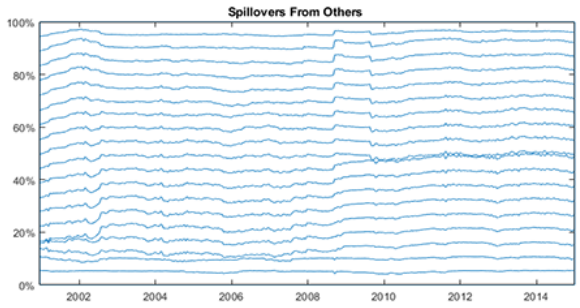


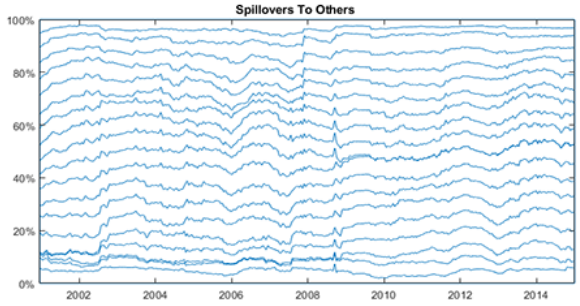


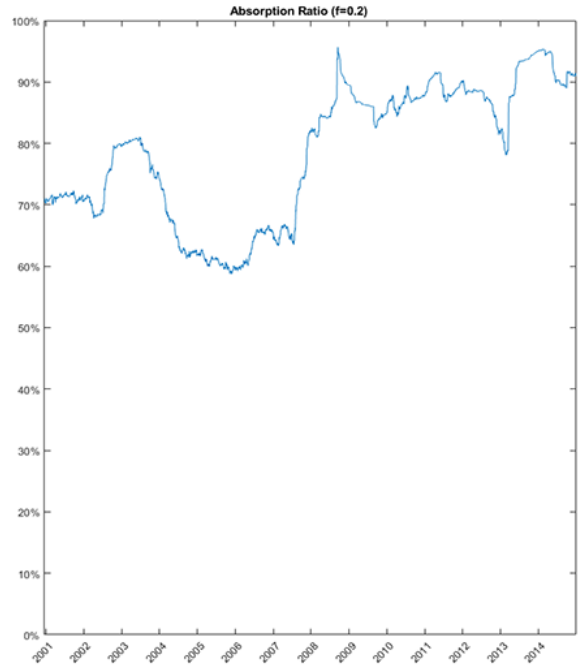


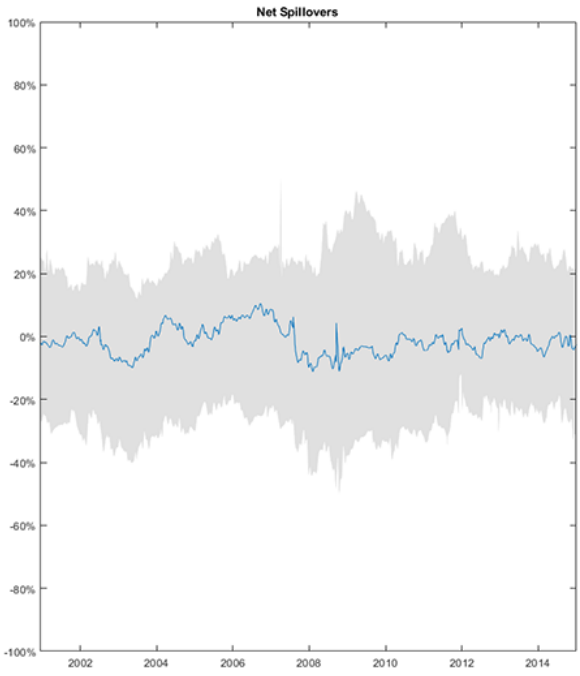

Dynamic Causality Index
In & Out
In & Out - Other
Granger-causality Threshold
Connections

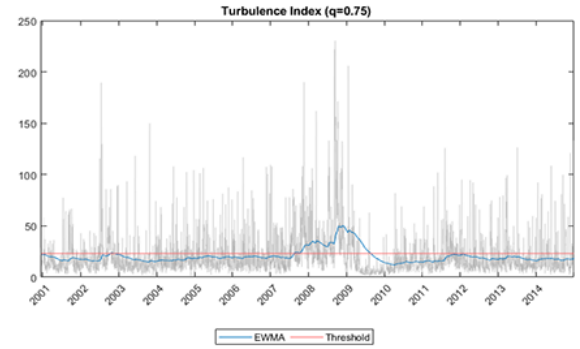

BAC
C
PRU
GS
MET
JPM
BRK
LEH
ALL
MS
AIG
AXP
FNMA
BK
FMCC
COF
WFC
PNC
STT
USB
Insurance Companies
Investment Banks
Commercial Banks
Government-sponsored Enterprises

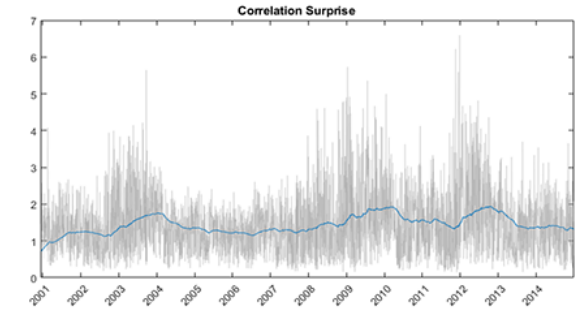

Spillovers From Others
100%
80%
60%
40%
20%
0%
2002
2004
2006
2008
2010
2012
2014


Spillovers To Others
100%
80%
60%
40%
20%
0%
2002
2004
2006
2008
2010
2012
2014


Absorption Ratio (f=0.2)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014


Net Spillovers
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
-80%
-100%
2002
2004
2006
2008
2010
2012
2014


Turbulence Index (q=0.75)
250
200
150
100
50
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
EWMA
Threshold


Correlation Surprise
7
6
5
4
3
2
1
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014