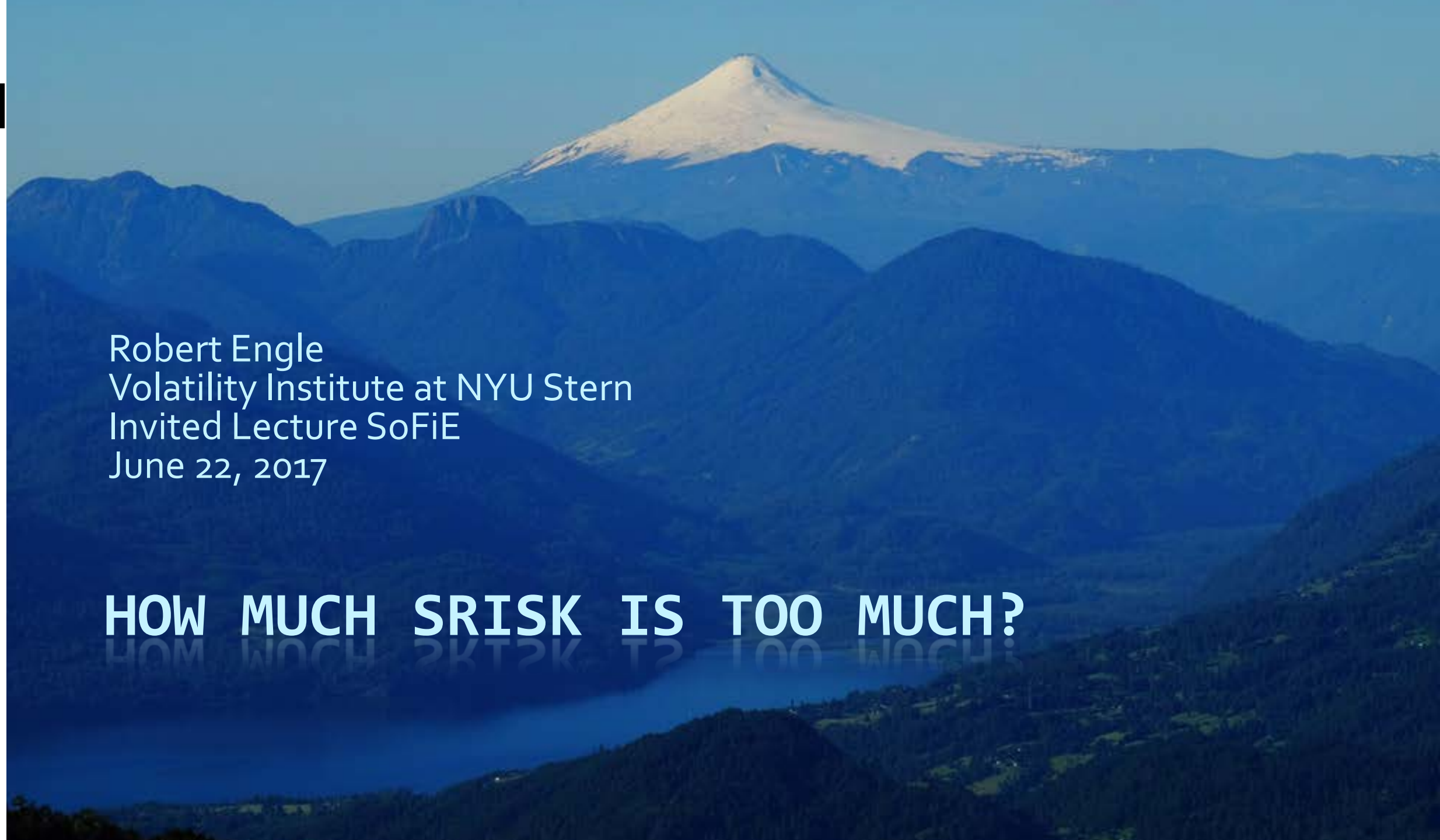


Robert Engle
Volatility Institute at NYU Stern
Invited Lecture SoFiE
June 22, 2017

# HOW MUCH SRISK IS TOO MUCH?

# RISKS OF A FINANCIAL CRISIS

- When the banking sector is undercapitalized, it is vulnerable to external shocks. We measure this by regulatory stress tests and by market measures such as SRISK.

- However, when banks are undercapitalized, the recapitalization may be exactly what causes a financial crisis. Today we will explore this Macro-Financial Linkeage.

# EXCESSIVE CREDIT GROWTH

- It is widely believed that excessive credit growth is the fundamental cause of financial crises.
- See for example Reinhart and Rogoff(2009) "This Time Is Different" or Borio(2012)"the financial cycle", Adrian and Shin(2011)"Leverage"
- But credit growth is typically procyclical as increased credit is a natural component of growth.
- Schularick and Taylor argue that a financial crisis is a "credit boom gone bust." How can we see this in data?

# EXCESSIVE CREDIT MEANS HIGH CAPITAL SHORTFALL

- Credit is excessive if it funds low net present value investments and therefore has market value less than its face or book value.
- A large fraction of aggregate credit is held as assets by the financial sector as a whole and by banks in particular. This may be private credit or sovereign credit.
- If the market value of this credit falls below the book value, then the institutions may be forced to support the investments with capital reserves.
- A large financial sector capital shortfall conditional on bad times, is therefore a risk based measure of excessive credit.

# DEFINITION of SRISK

- *How much capital would a financial institution need to raise in order to function normally if we have another financial crisis?*
- Principle investigators: Viral Acharya, Matt Richardson and me at the Volatility Institute at NYU's Stern School. Collaboration with HEC Lausanne and the Institute for Global Finance at University of New South Wales. Contributions by Christian Brownlees, Rob Capellini, Diane Perriet, Emil Siriwardane.
- References: Acharya, Pedersen, Phillipon, Richardson "Measuring Systemic Risk (2010); Acharya, Engle, Richardson "Capital Shortfall, A New Approach to Ranking and Regulating Systemic Risks, AEAPP (2012), Brownlees and Engle, "Volatilities, Correlations and Tails for Systemic Risk Measurement",2010

# SRISK

$$SRISK_{i,t} = Median_t\left(Capital\ \ Shortfall_i \,|\, Crisis\right)$$
$$= Median_t\left(k\left(Debt_{t+n} + Equity_{t+n}\right) - Equity_{t+n} \,|\, Crisis_{t+n}\right)$$
$$= kDebt_{t+n} - (1-k)\, Median_t\left(Equity_{t+n} \,|\, Crisis_{t+n}\right)$$

- ***And equity in a crisis is expected to fall by beta*market decline***

$$\log\left(Equity_{t+n} / Equity_t\right) = \beta_t \log\left(WEquity_{t+n} / WEquity_t\right) + u_{t+n}$$
$$Median_t\left(Equity_{t+n} \,\middle|\, \frac{WEquity_{t+n}}{WEquity_t} = 1-\theta\right) = Equity_t \exp\left(\beta_t \log(1-\theta)\right)$$

# ESTIMATE BETA WITH DCB

- The beta of a stock is commonly estimated by regressing return on one or more market factors. This assumes that beta is constant.
- Such a beta is a correlation with the market times the ratio of the standard deviation of the firm over the market.
- DCB (Dynamic Conditional Beta) estimates these inputs and adjusts for noise and for asynchronous returns.
- Beta is different every day and is forecast from day t-1.

# IS BETA CONSTANT?

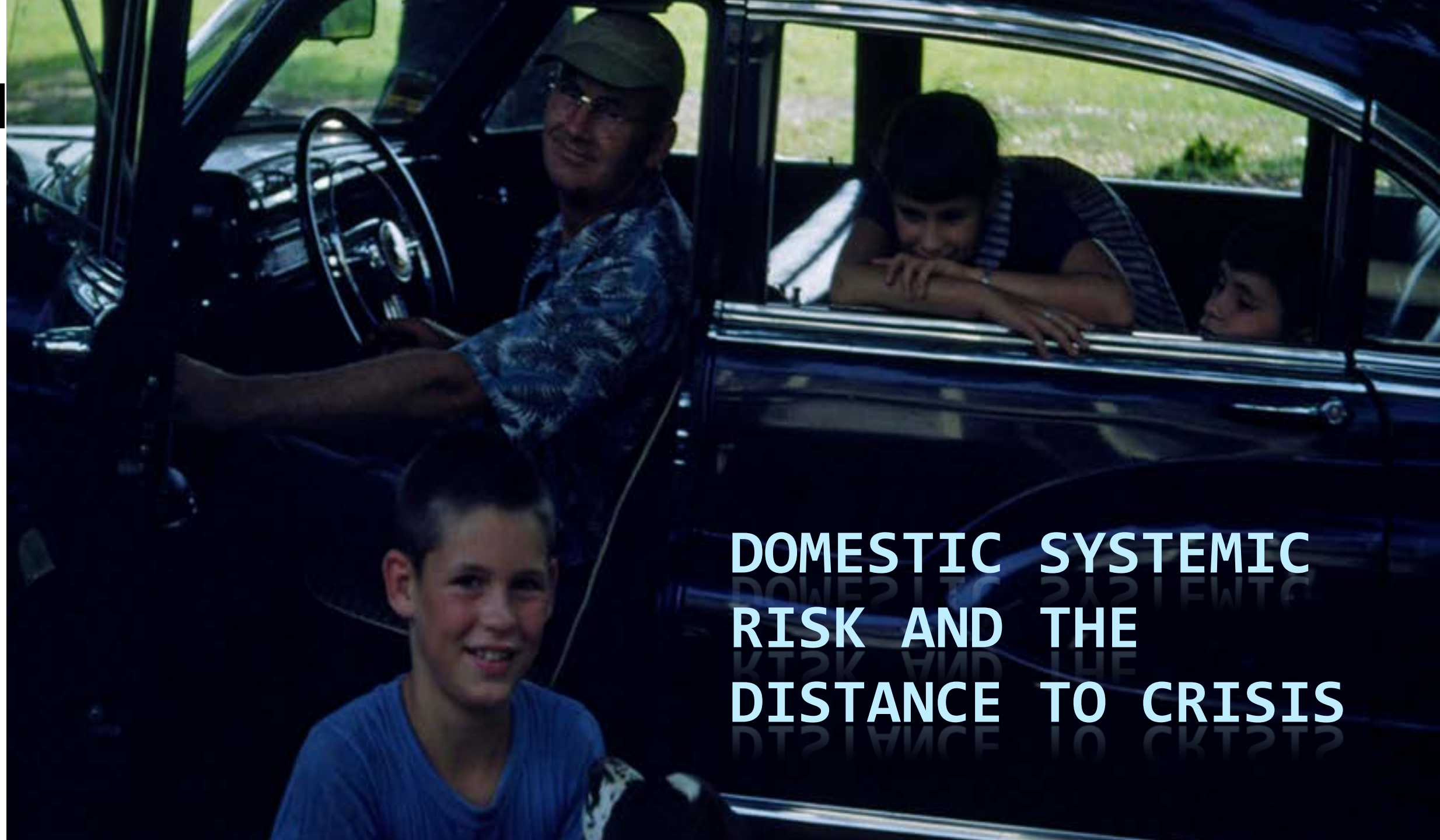
- Estimation of Dynamic Conditional Beta involves
  - GJR GARCH model of the volatility of market returns
  - GJR GARCH model of the volatility of firm returns
  - DCC estimation of the correlation between these

$$\beta_t^j = \rho_t^{j,m} \sqrt{\frac{h_t^j}{h_t^m}}$$

- Test beta=0 with artificially nested model

$$r_t^j = \phi r_t^m + \theta\left(\beta_t^j r_t^m\right) + \sqrt{h_t}\,\varepsilon_t^f$$

- Use $\hat{\phi} + \hat{\theta}\beta_t^j$ as the estimate of beta



# DOMESTIC SYSTEMIC RISK AND THE DISTANCE TO CRISIS

# D-SRISK or DOMESTIC SRISK

- A crisis is now defined as a collapse of the domestic stock market index. For example, assume that the domestic index falls 45% over the next six months and that we ignore the fall in the global index.
- As a result, we cannot compare D-SRISK across countries.
- We can do the analysis in local currency and without adjusting for time zones.
- We still use DCB to estimate beta.
- We can ask how big a decline in the domestic market would lead to aggregate D-SRISK of some value.

# D-SRISK

- As in Engle Jondeau and Rockinger, we think that both the national market return and the global return could influence firm returns.
- As these are generally highly collinear we measure SRISK only with respect to the global market, and D-SRISK only with respect to the domestic index.
- Implicitly, we allow the impact of the other index to be a residual effect.
- It is highly unlikely that a country can have a financial crisis without the domestic market collapsing.


PLEASE
CLOSE
GATE

# HOW HIGH IS HIGH?

- Can we identify a level of SRISK_Crisis that typically leads to a crisis?
- What fall in the domestic stock index would produce this level of capital shortfall?
- Find the stress that is sufficient to create a crisis by making D-SRISK=SRISK_Crisis
- We call this stress  the "distance to crisis."

# MANAGING SRISK

- If SRISK is a large fraction of GDP, regulators will be particularly anxious to reduce taxpayer exposure.
- If SRISK is a large fraction of Market Cap, then firms will be unwilling to sell new shares of stock as it will further depress equity prices.
- If SRISK is a large fraction of Total Assets, then asset sales will be costly and will likely lead to a fire sale spiral.

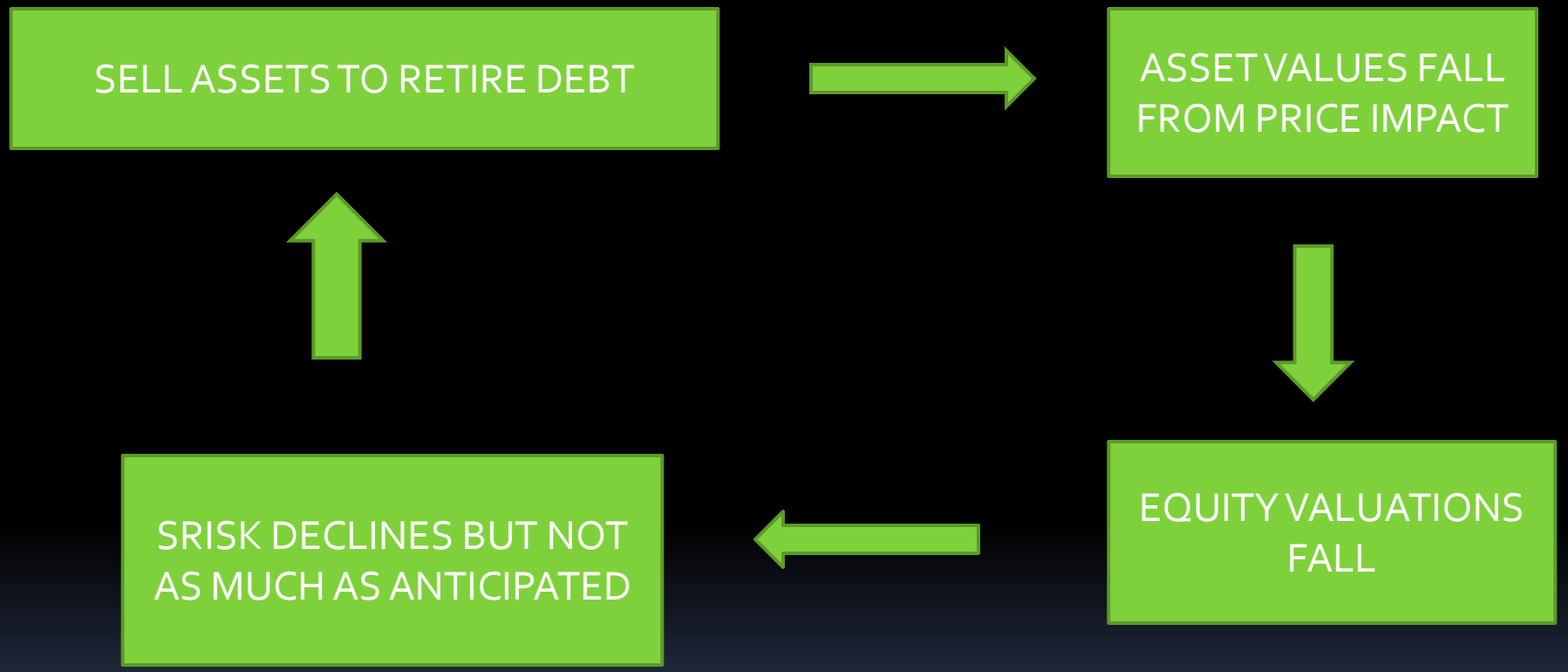
# ENDOGENOUS FINANIAL CYCLES

- Firms with high SRISK will begin to delever – and *cause* the macro shock
  - Either because risk managers insist
  - Or because regulators insist
- They may either sell stock or sell assets and retire debt. Most commonly they sell assets.
- This starts the leverage spiral. Lets see how it works.
- This is builds on Cont and Schaanning, Greenwood et al, and Cont and Wagalath among others.

# MODELING THIS SPIRAL

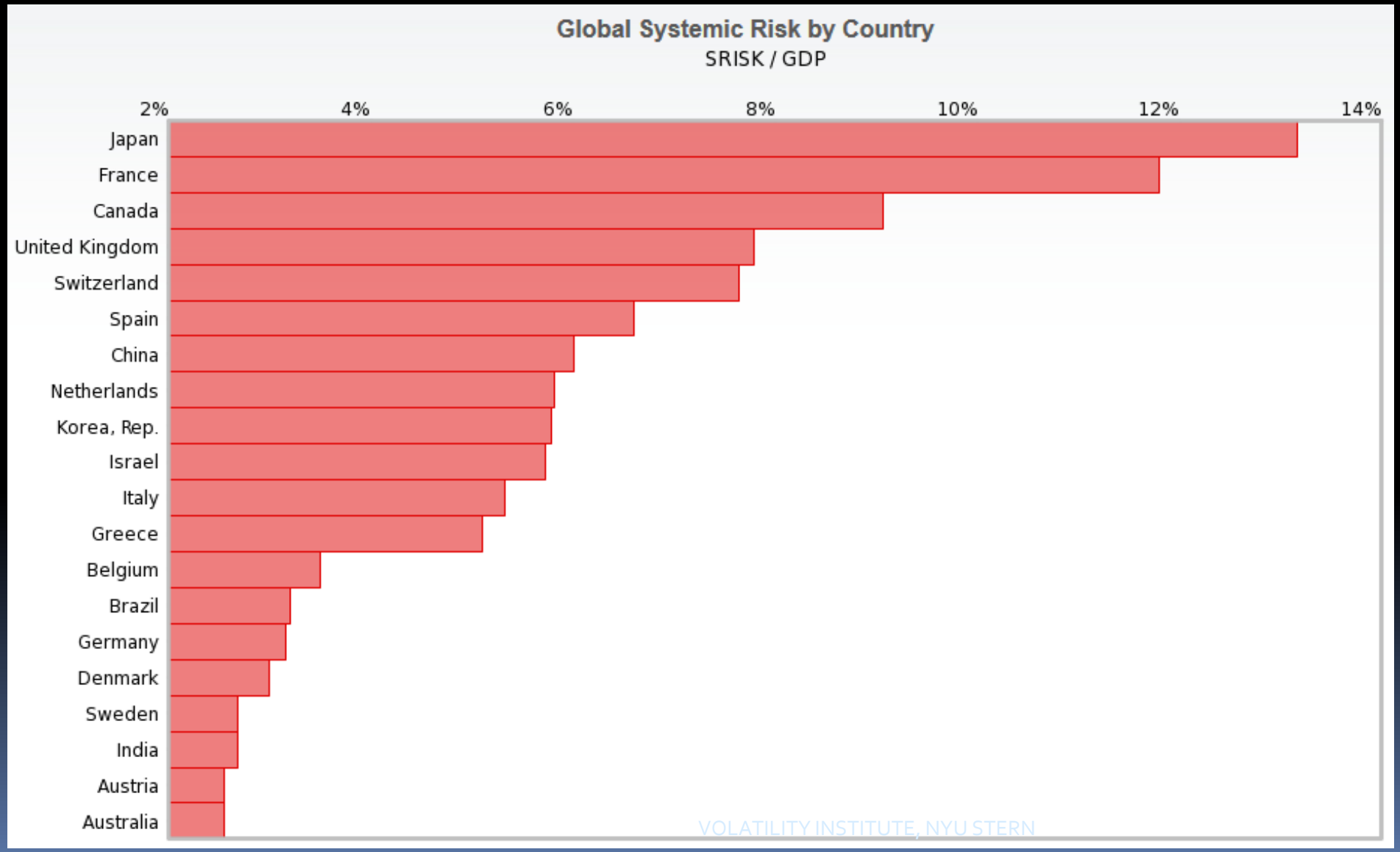
- If a firm has SRISK>0, it would have to sell SRISK/k in assets to bring SRISK=0.
- If there are many firms with positive SRISK, then they must all sell so (Total SRISK)/k will hit the market.
- If this is large relative to normal loan transactions, then the price impact will reduce the value of the assets sold as well as the assets that remain on firm books requiring even more sales.
- *The market value of equity will likely decline before the asset sales are completed as investors are forward looking*.

# DELEVERAGING SPIRAL

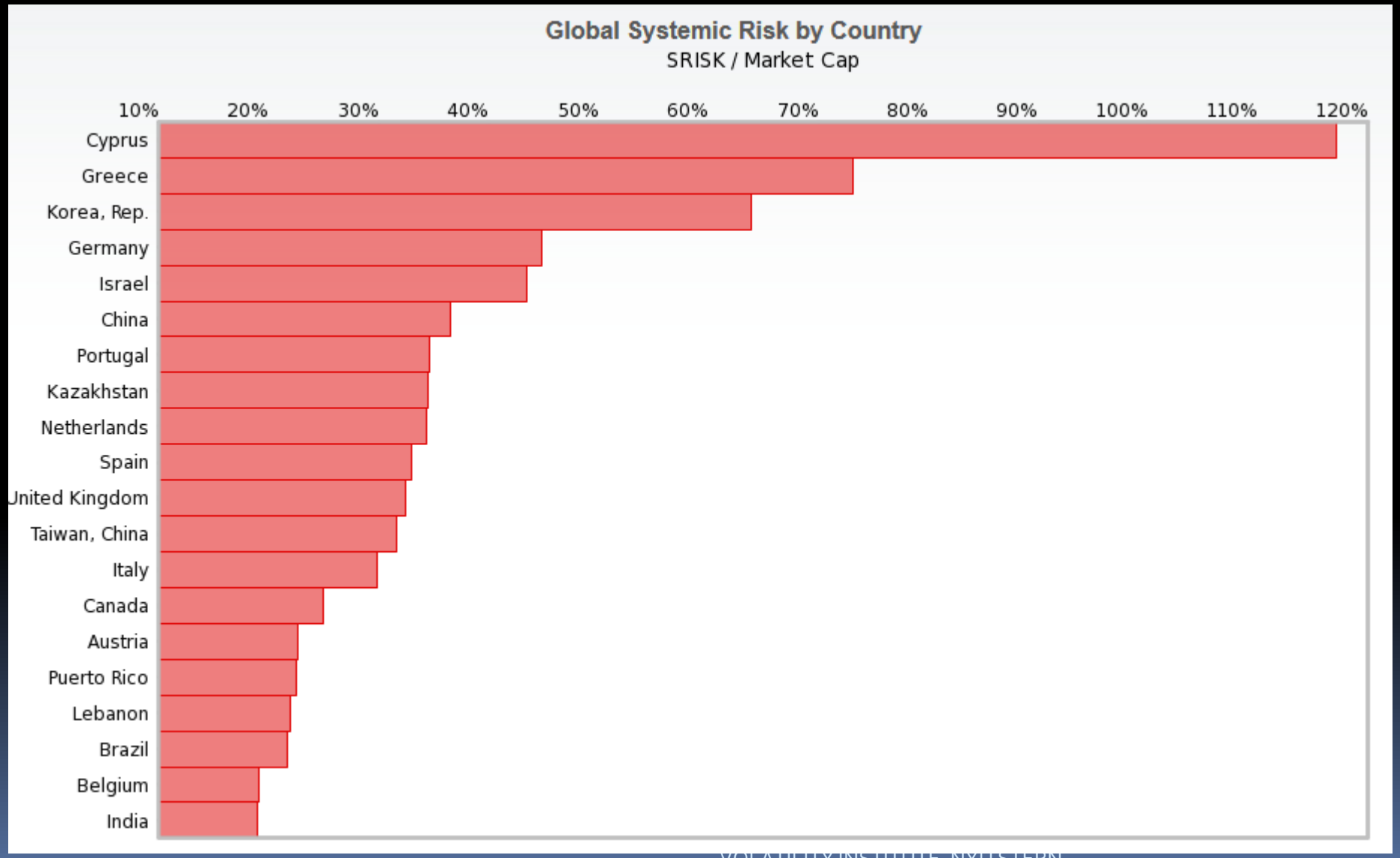



SPIRAL REDUCES CREDIT TO REAL ECONOMY AND CAUSES DECLINES IN DOMESTIC MARKET AND GDP

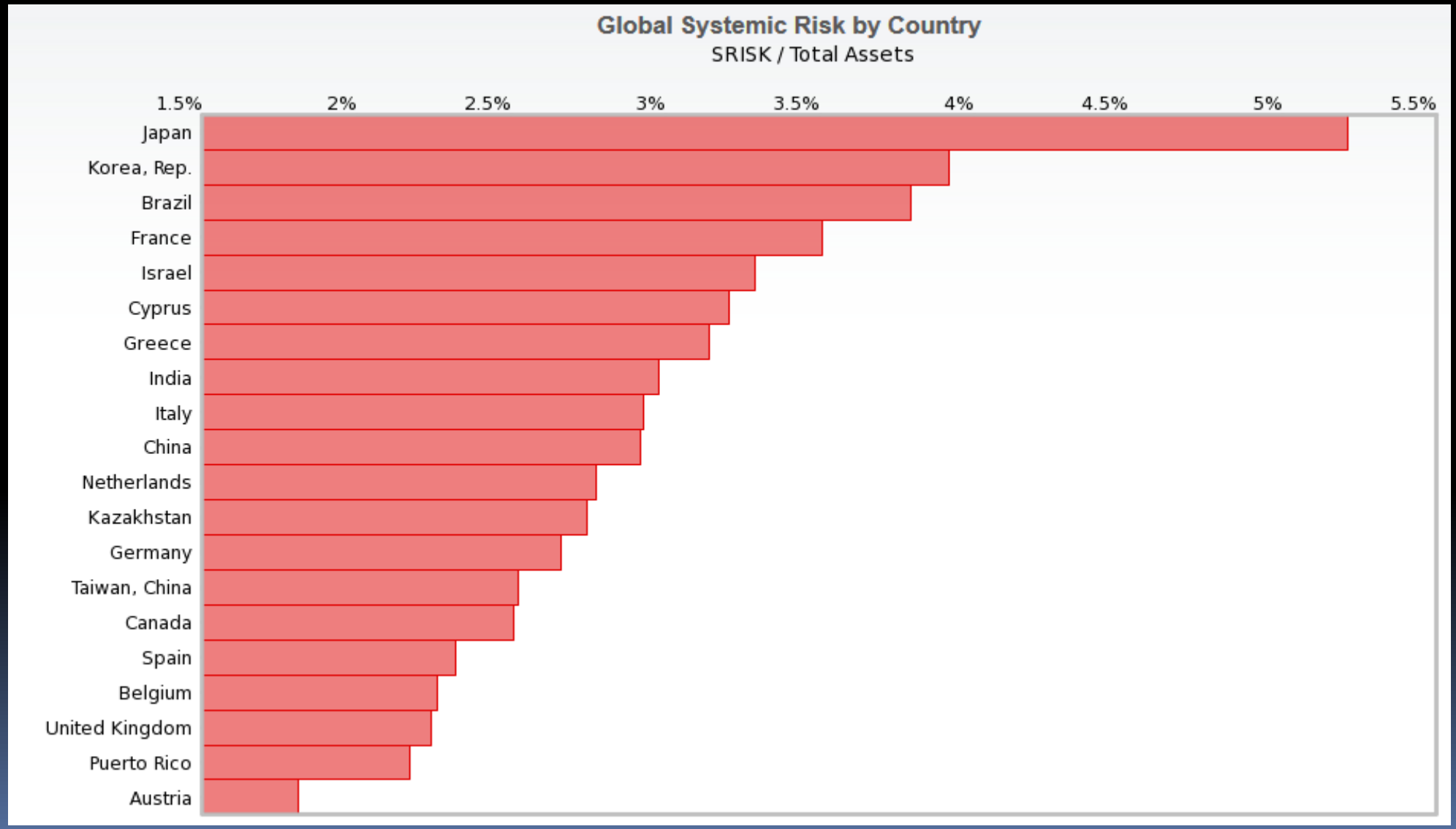
# SRISK/GDP from VLAB.STERN.NYU.EDU

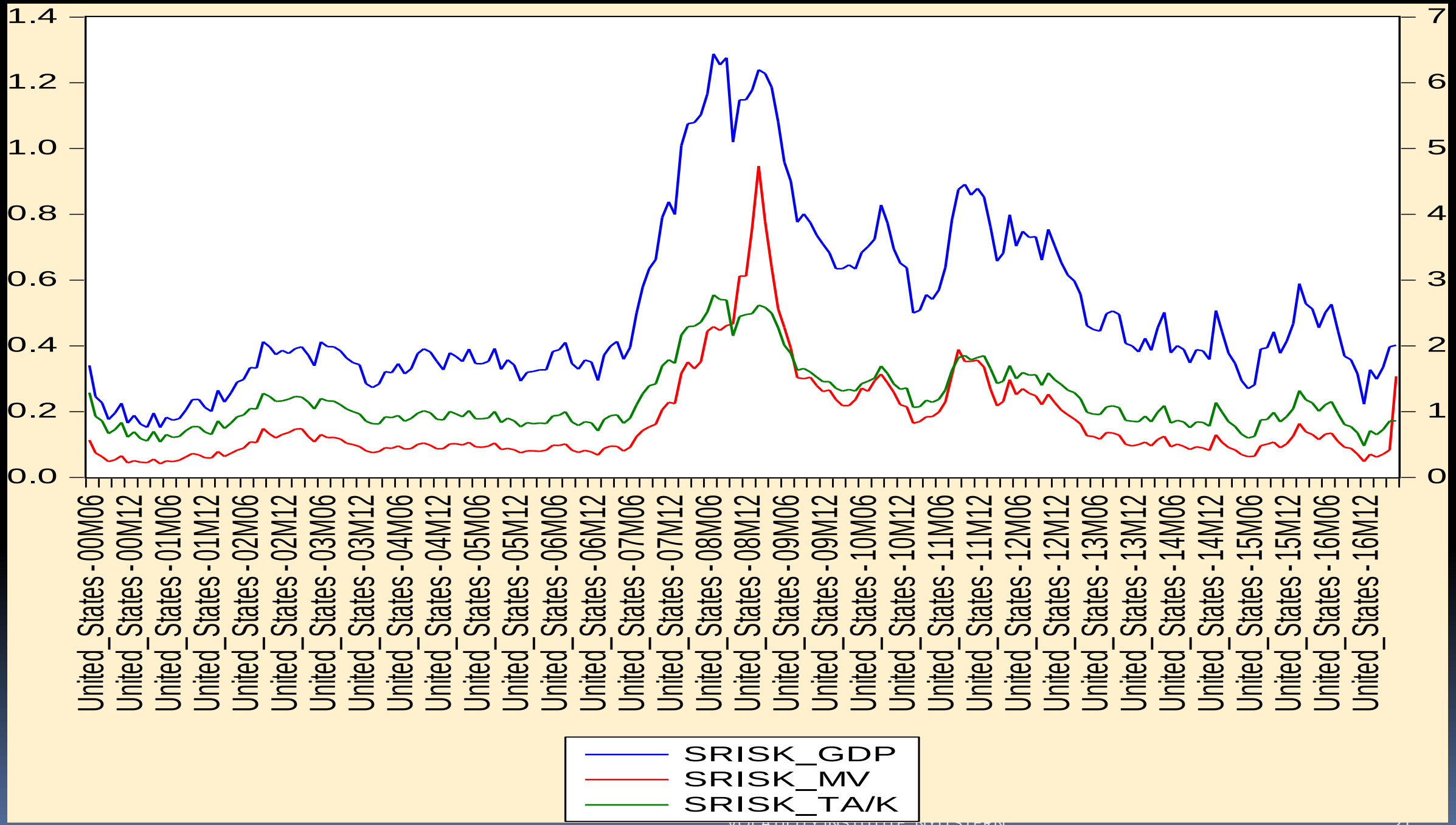


# SRISK/MARKET CAP MAY 2017



# SRISK/ASSETS MAY 2017

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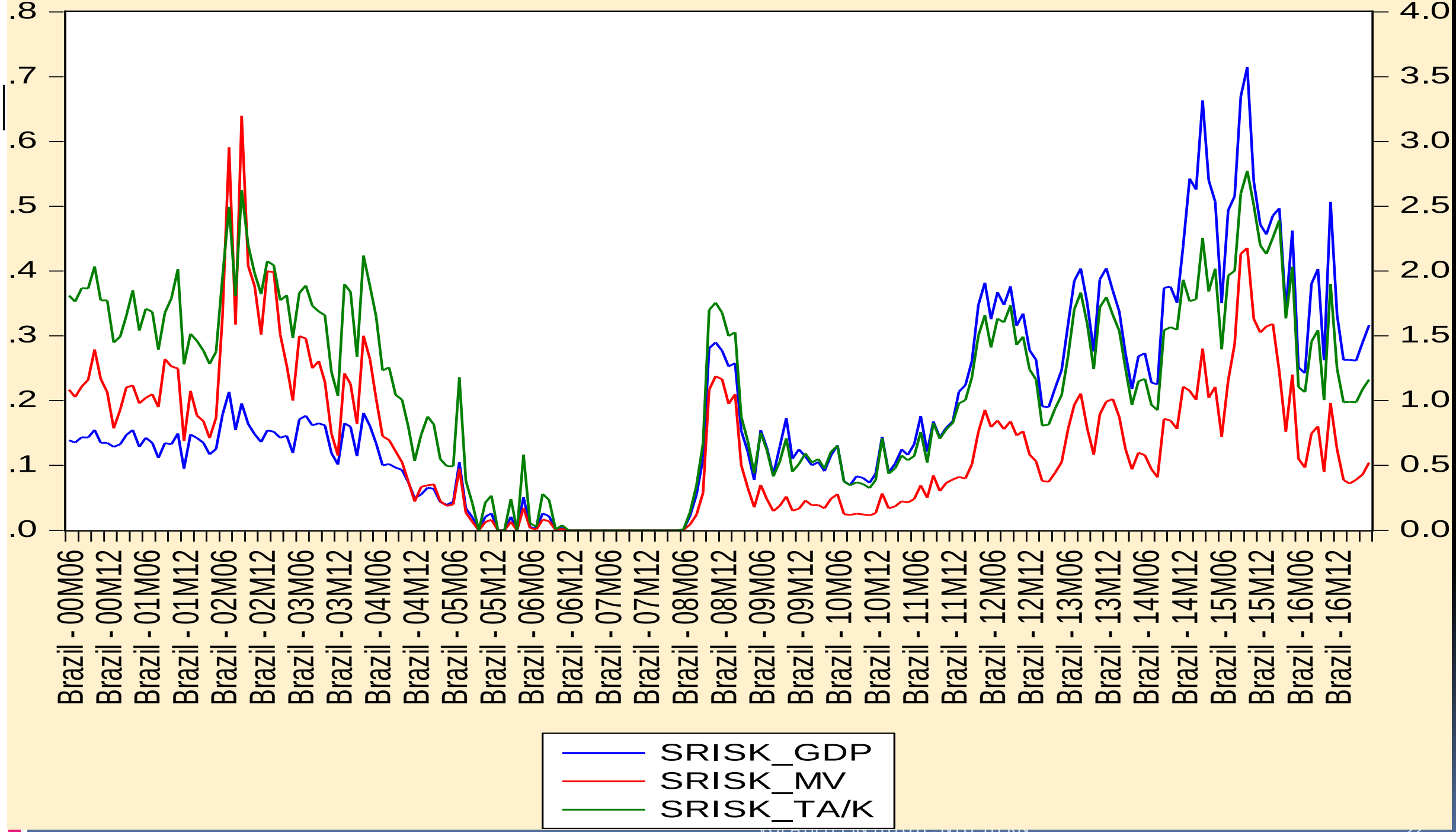
SRISK_GDP
SRISK_MV
SRISK_TA/K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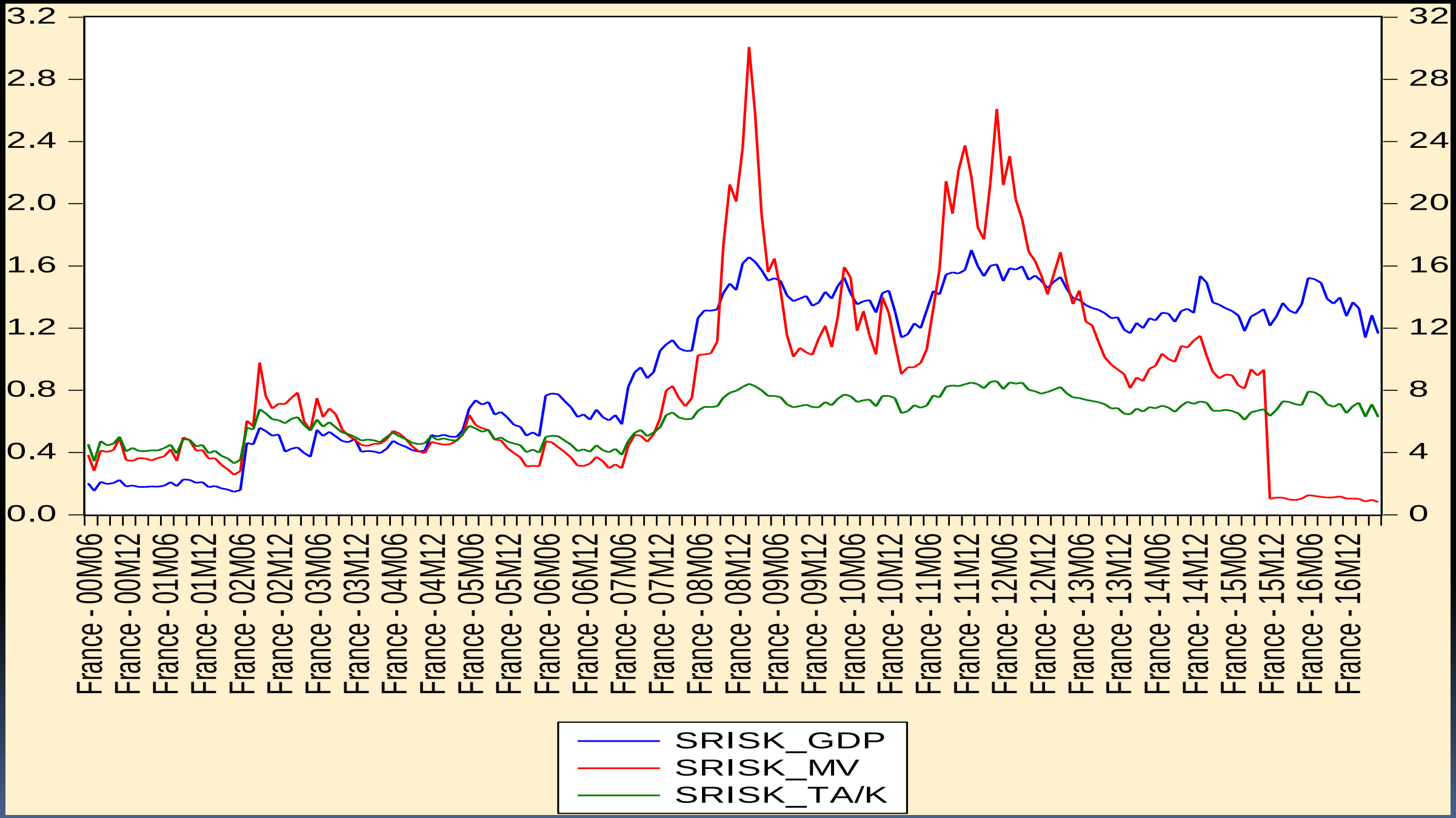
SRISK_TA/K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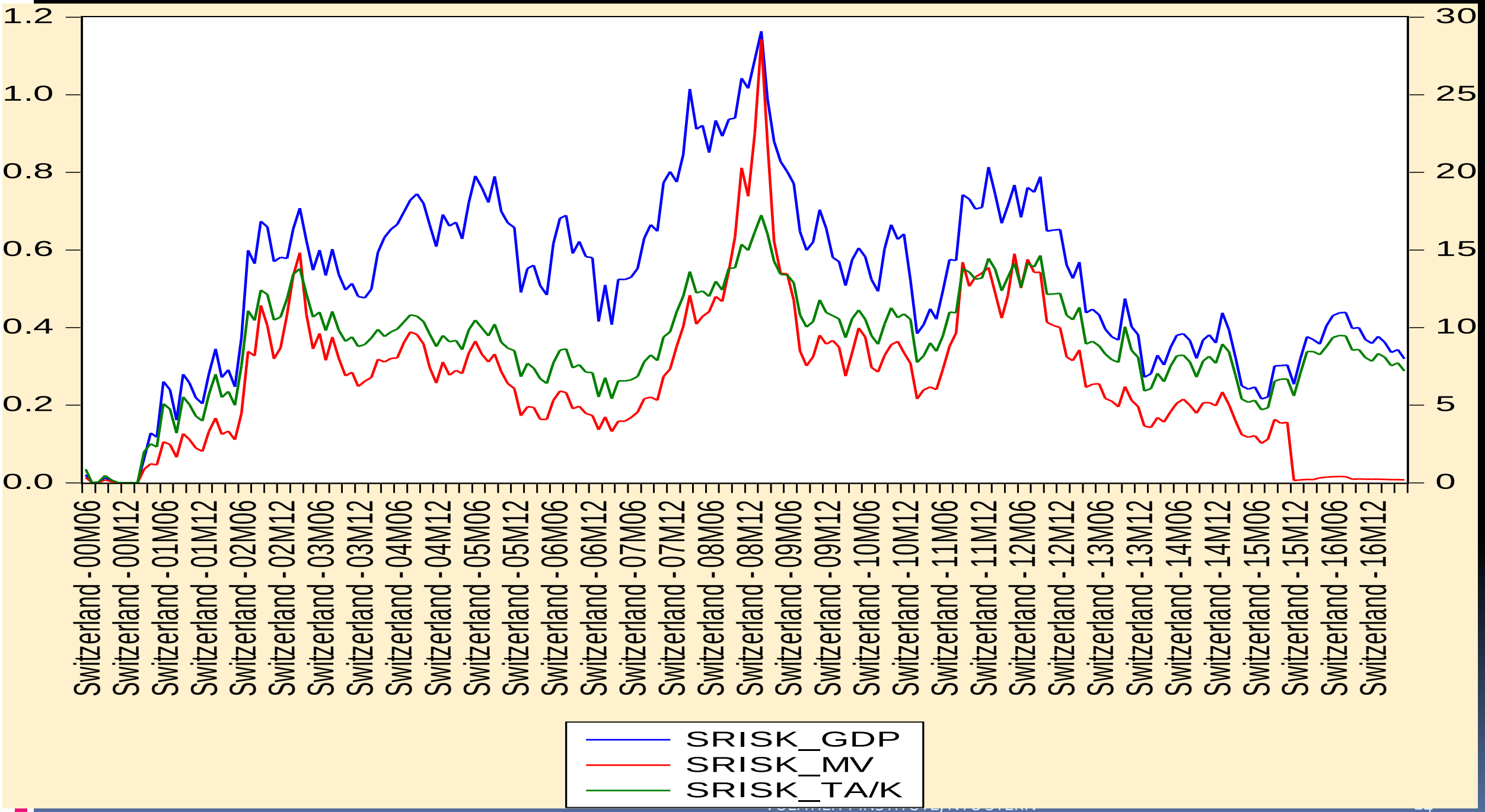
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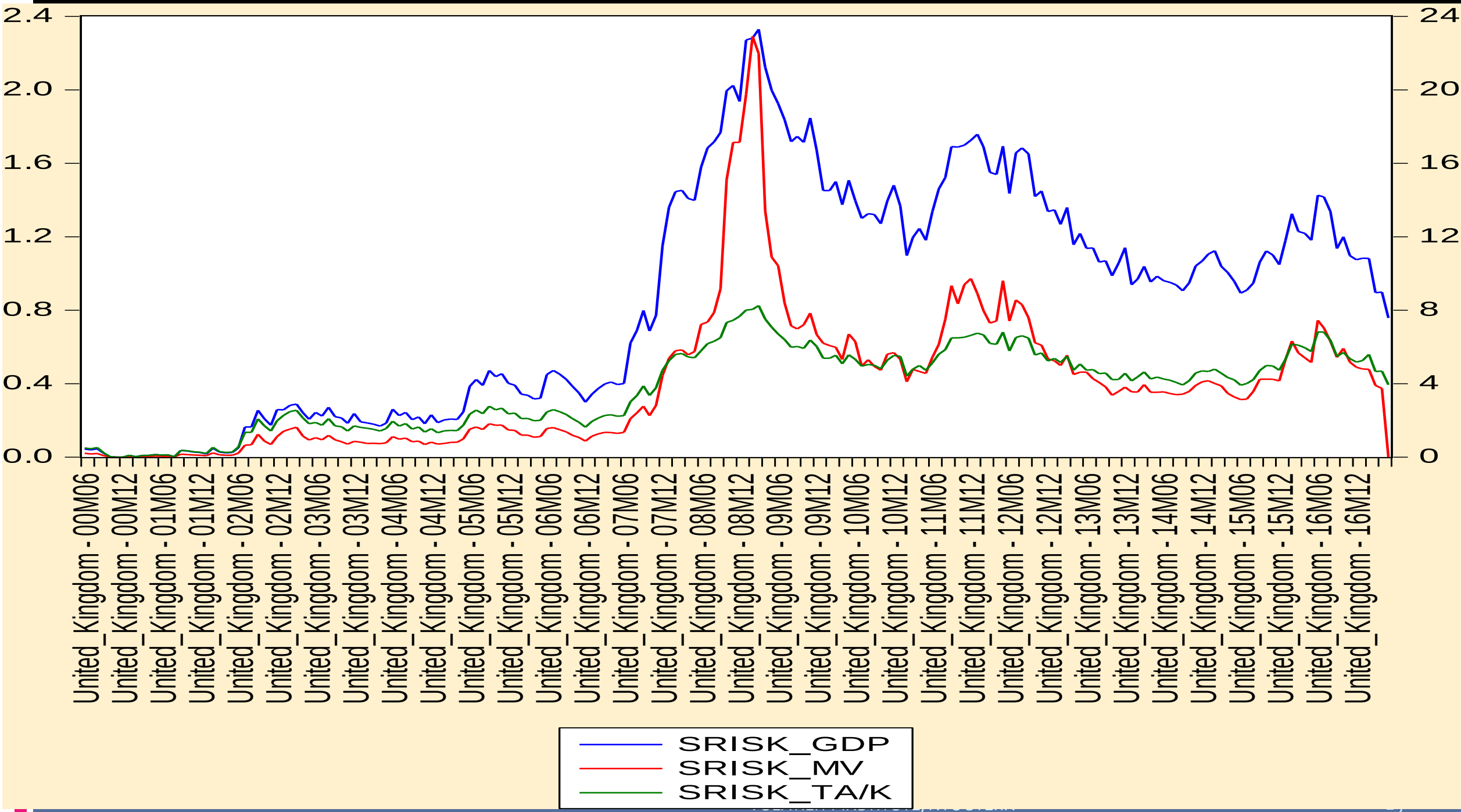
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SRISK_GDP
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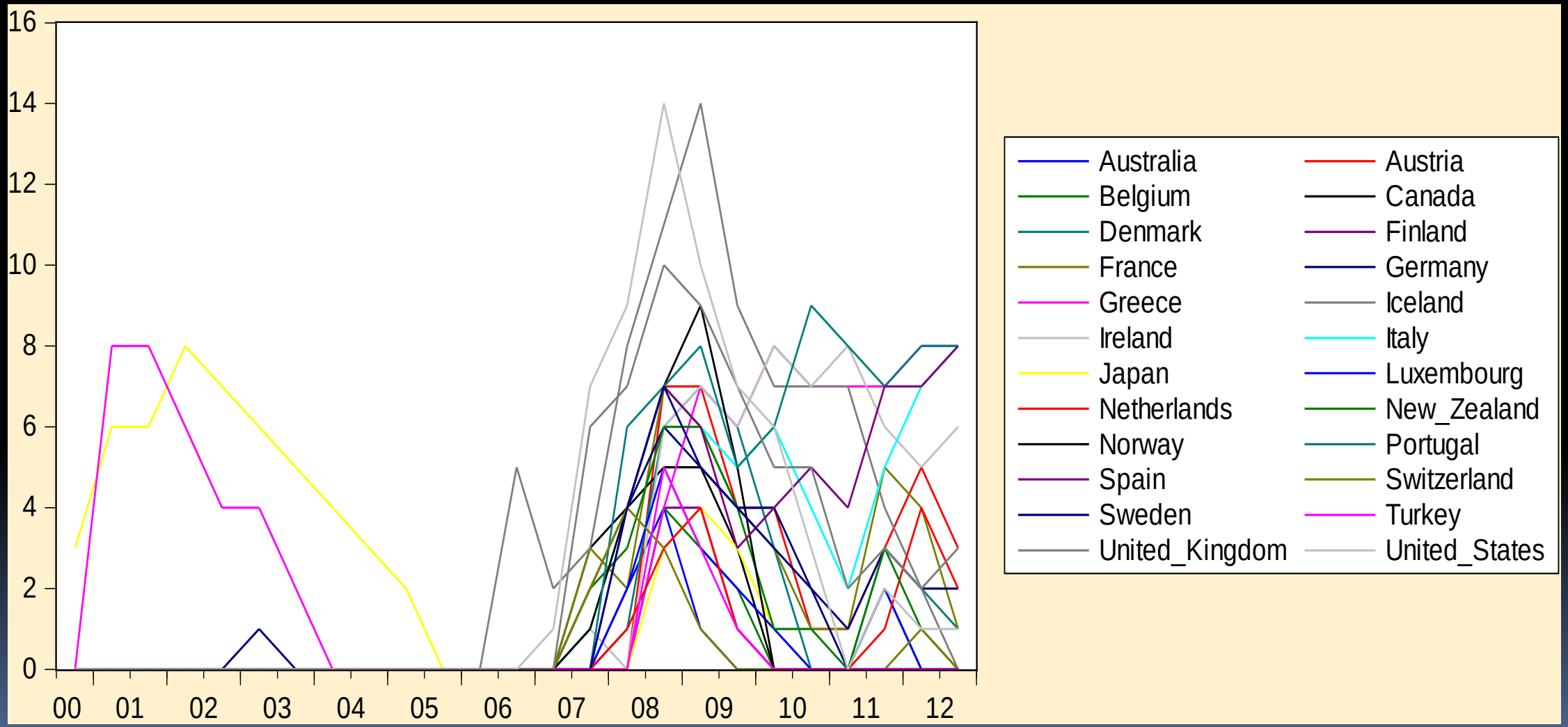
SRISK_TA/K

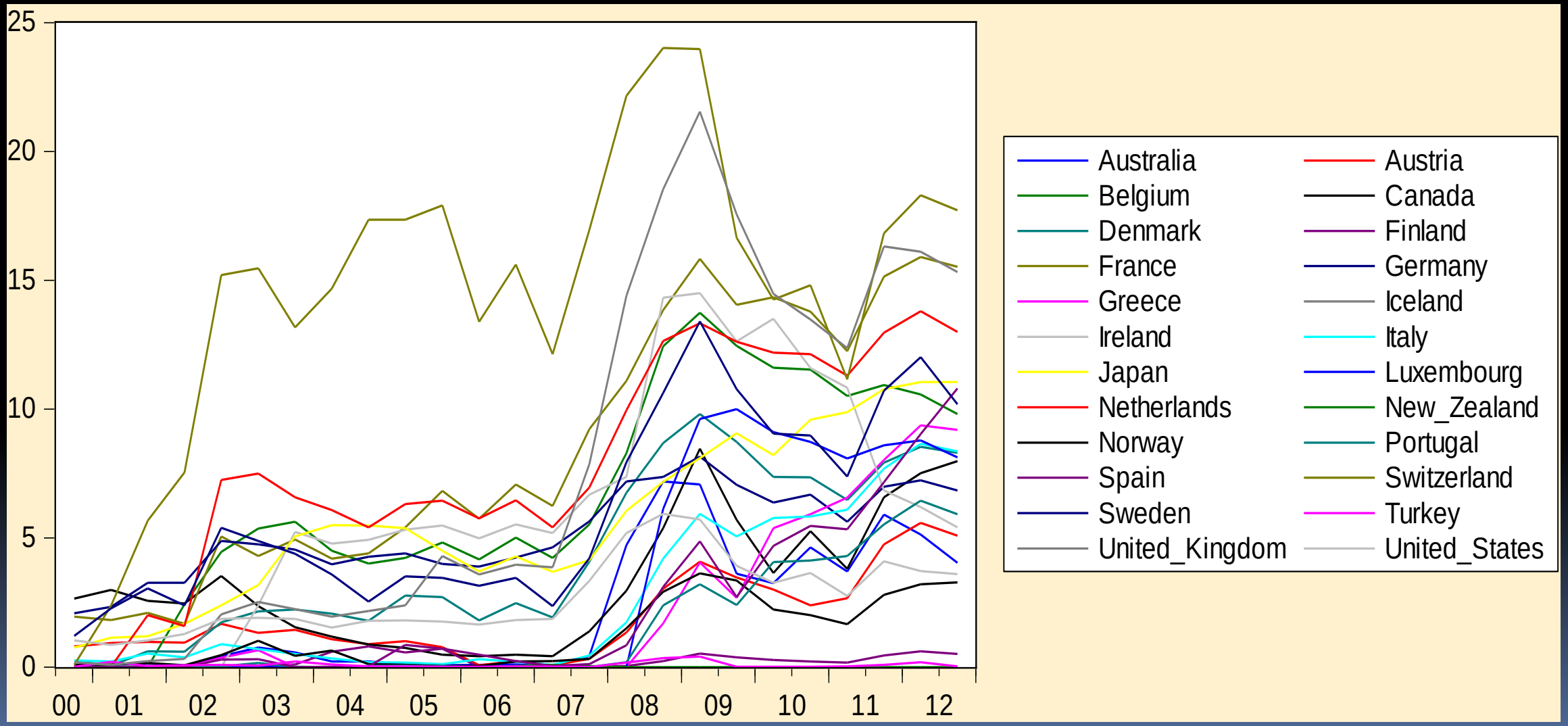
# ROMER AND ROMER(2016) CRISIS INDICATOR

- For 24 industrial countries a semi-annual indicator of crisis intensity extracted from OECD Reports 2000-2012.
- Computing each of the measures for this period, see which indicator is most correlated with crisis intensity.
- Include country and time fixed effects.

# CRISIS INDICATOR



# SRISK/GDP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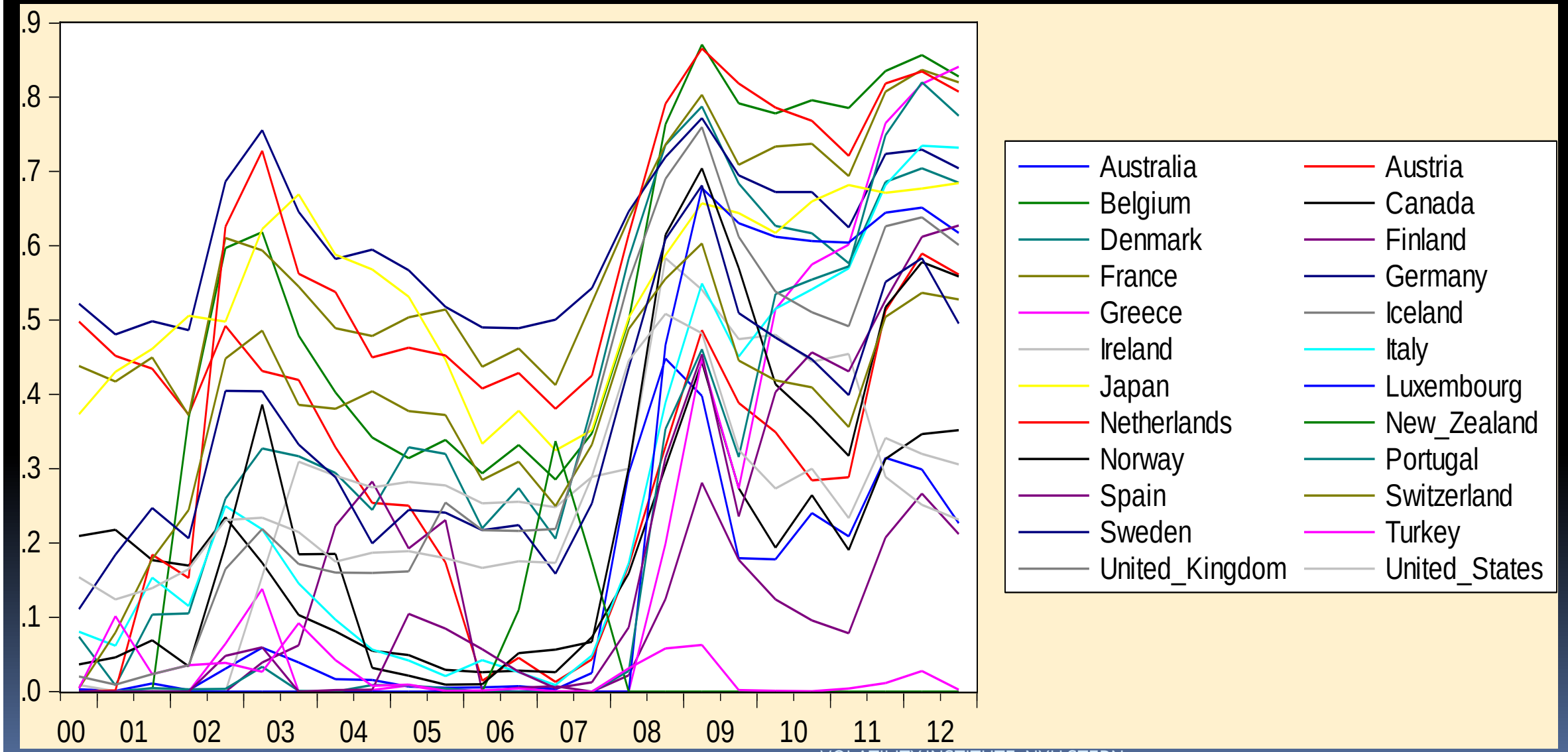
# SRISK/TA/K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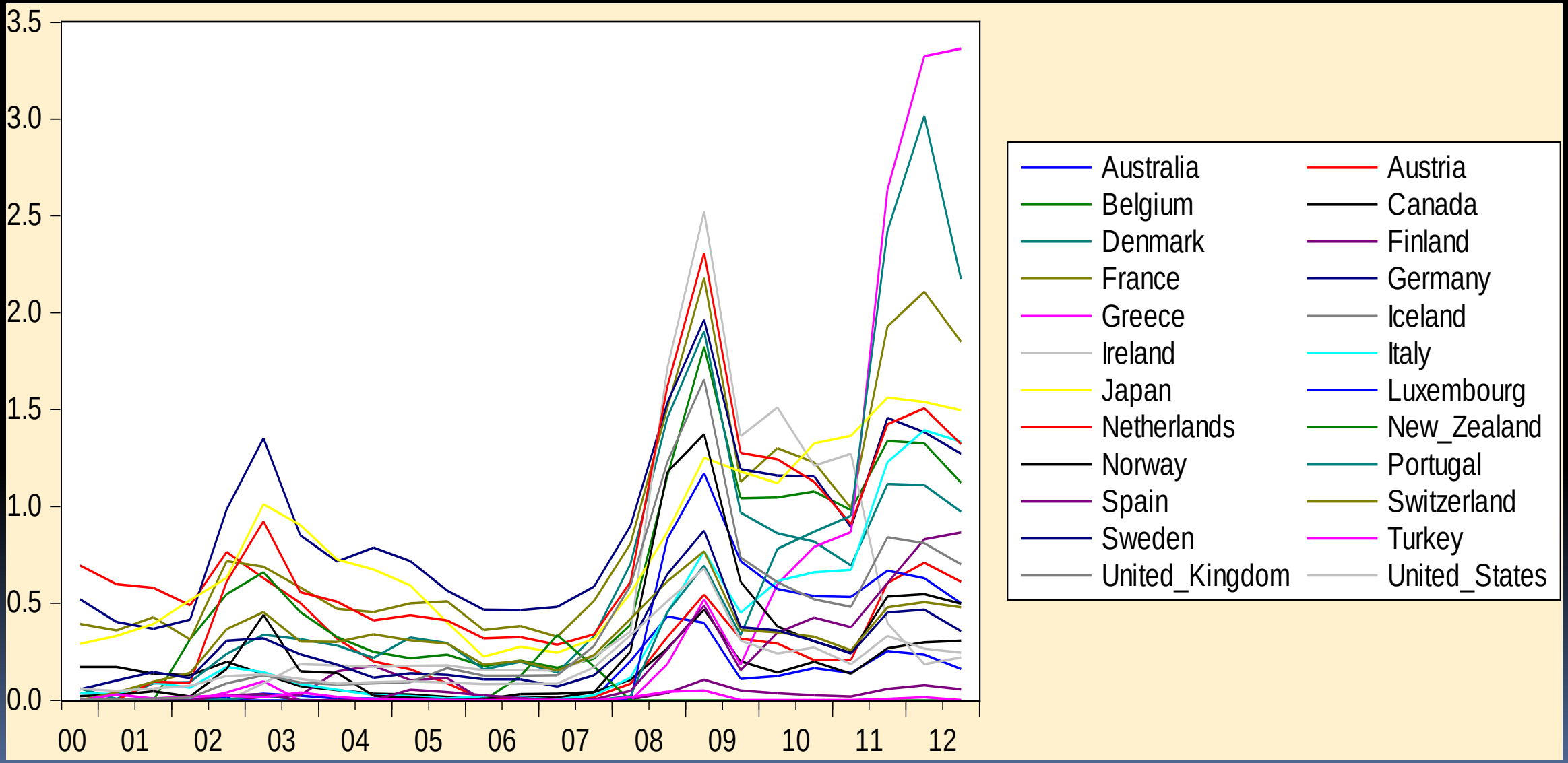
# SRISK/MV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Switzerland
Sweden
Turkey
United_Kingdom
United_States

- Dependent Variable: CRISIS
- Method: Panel Least Squares
- Date: 05/31/17 Time: 12:14
- Sample: 2000S2 2012S2
- Periods included: 25
- Cross-sections included: 23
- Total panel (unbalanced) observations: 564

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.018001 | 0.193786 | -0.092890 | 0.9260 |
| SRISK_TAK | 4.362860 | 0.871091 | 5.008503 | 0.0000 |
| SRISK_GDP | -0.080404 | 0.042989 | -1.870365 | 0.0620 |
| SRISK_MV | 1.267579 | 0.296627 | 4.273308 | 0.0000 |

- Effects Specification
- Cross-section fixed (dummy variables)
- Period fixed (dummy variables)
- R-squared 0.626034 Mean dependent var 1.471631

# PREDICTIVE REGRESSION

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.125941 | 0.129094 | 0.975579 | 0.3298 |
| CRISIS(-1) | 0.797442 | 0.030242 | 26.36874 | 0.0000 |
| SRISK_TAK(-1) | 1.230027 | 0.607853 | 2.023559 | 0.0436 |
| SRISK_GDP(-1) | -0.061690 | 0.029471 | -2.093225 | 0.0368 |
| SRISK_MV(-1) | 0.385229 | 0.218191 | 1.765560 | 0.0781 |

Effects Specification

- Cross-section fixed (dummy variables)
- Period fixed (dummy variables)
- R2 = .8404

# TOBIT WITH COUNTRY FIXED EFFECTS

- Dependent Variable: CRISIS
- Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

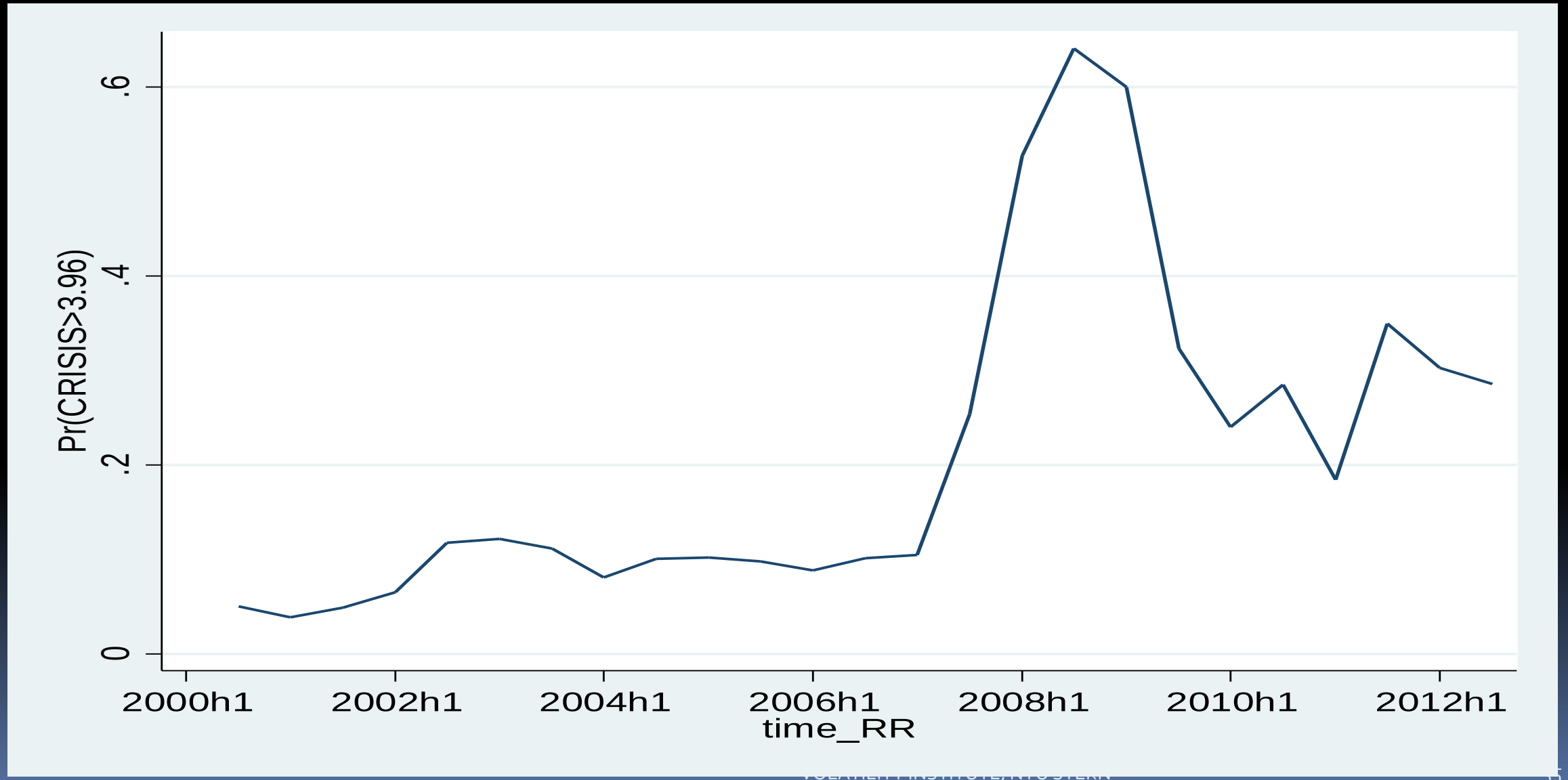
| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| SRISK_TAK | 15.79534 | 1.492883 | 10.58043 | 0.0000 |
| TA_GDP | 0.021540 | 0.004567 | 4.716260 | 0.0000 |
| Country Fixed Effects | | | | |
| Error Distribution | | | | |
| SCALE:C(26) | 3.464019 | 0.197155 | 17.57006 | 0.0000 |

| | | | |
|---|---|---|---|
| Mean dependent var | 1.471631 | S.D. dependent var | 2.526079 |
| S.E. of regression | 1.771309 | Akaike info criterion | 2.281378 |
| Sum squared resid | 1691.132 | Schwarz criterion | 2.481221 |
| Log likelihood | -617.3487 | Hannan-Quinn criter. | 2.359388 |
| Avg. log likelihood | -1.094590 | | |
| Left censored obs | 376 | | |
| Uncensored obs | 188 | Total obs | 564 |

# PROBABILITY OF CRISIS

- With a certain value of SRISK and a certain country with its characteristics, what is the probability that we are currently in a crisis?
- Look at the prediction from the Tobit model. The 90% point of the crisis prediction is 3.96 which is very close to Romer and Romer's notion of a minor crisis level which starts at 4.
- Compute P(Crisisfit>3.96) and call it probability of crisis

# UNITED STATES PROBABILITY OF CRISIS

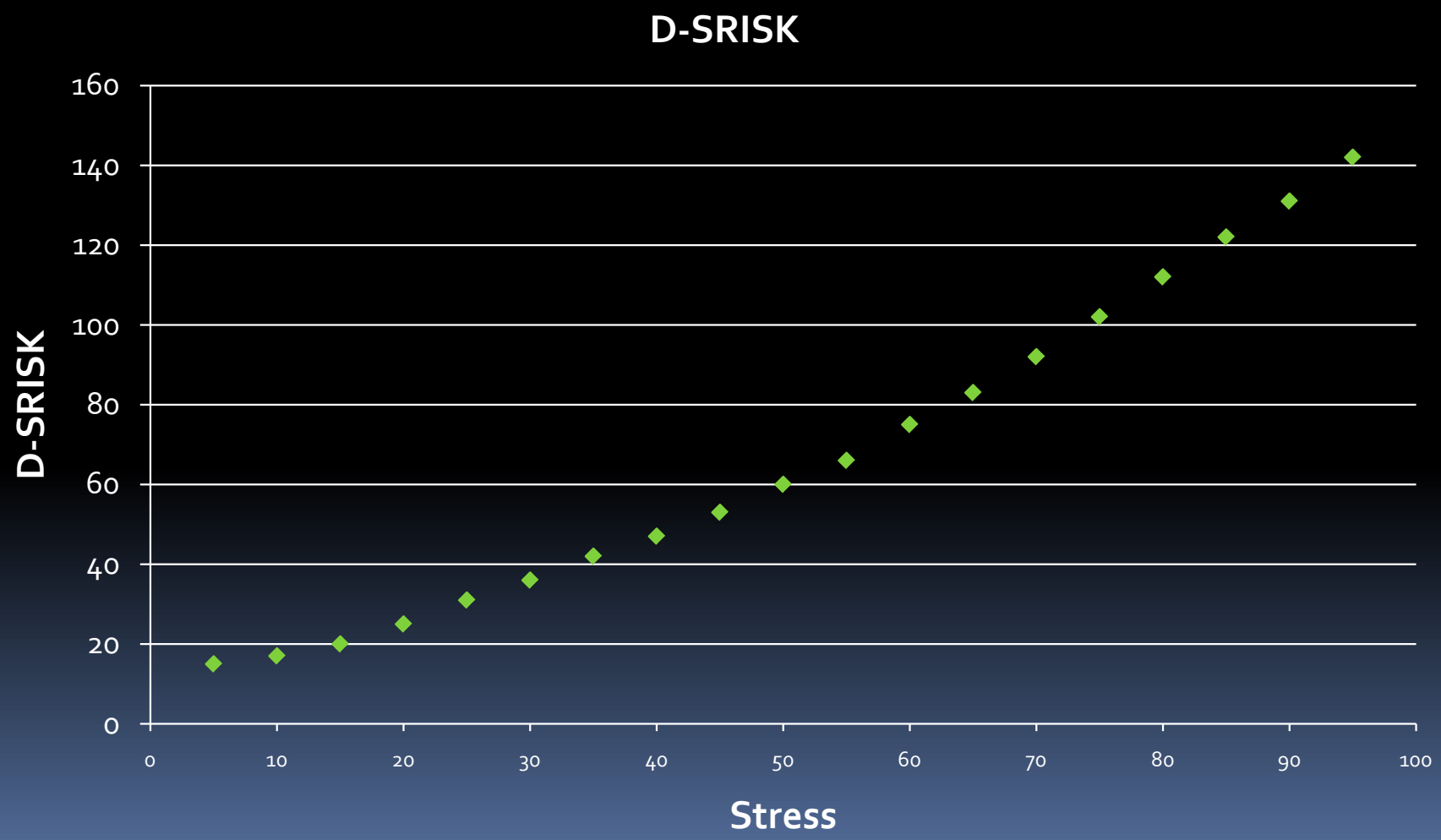


# DISTANCE TO CRISIS

- For illustration, I will use the best indicator, SRISK/TA/K
- The 90% of this indicator is *.54=Assets to be sold/Total Assets*.

- When D-SRISK (calculated at a 40% stress) is this high, the distance to crisis is 40%.
- When less stress matches this indicator, the distance to crisis is less than 40% which means that a crisis is more likely.
- These can be computed from DMES on V-LAB.

# D-SRISK and market STRESS SWITZERLAND



# DISTANCE TO CRISIS

- *WHAT DECLINE IN DOMESTIC EQUITY INDEX WOULD GIVE D-SRISK/K THAT IS 54% OF TOTAL FINANCIAL ASSETS?*

  - Switzerland Distance to Crisis  is 75%
  - US Distance to Crisis is 86%
  - France Distance to Crisis is 28%
  - Japan Distance to Crisis is 22%

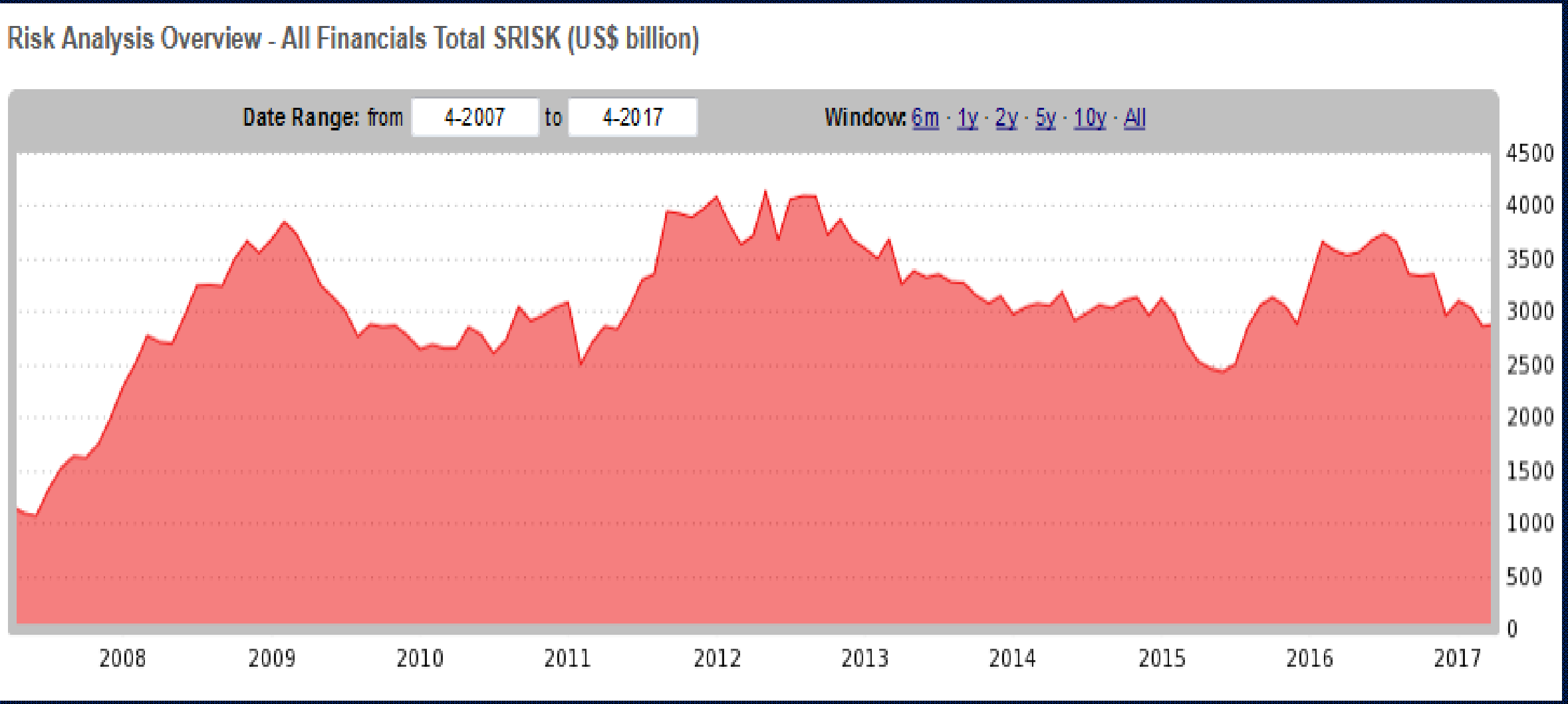
# DISTANCE TO CRISIS FROM TOBIT

- If SRISK is higher, then the probability of crisis will be higher.
- If it is sufficiently high that the probability of crisis is say 90%, then we can call this SRISK _CRISIS
- We can similarly then compute the distance to crisis.

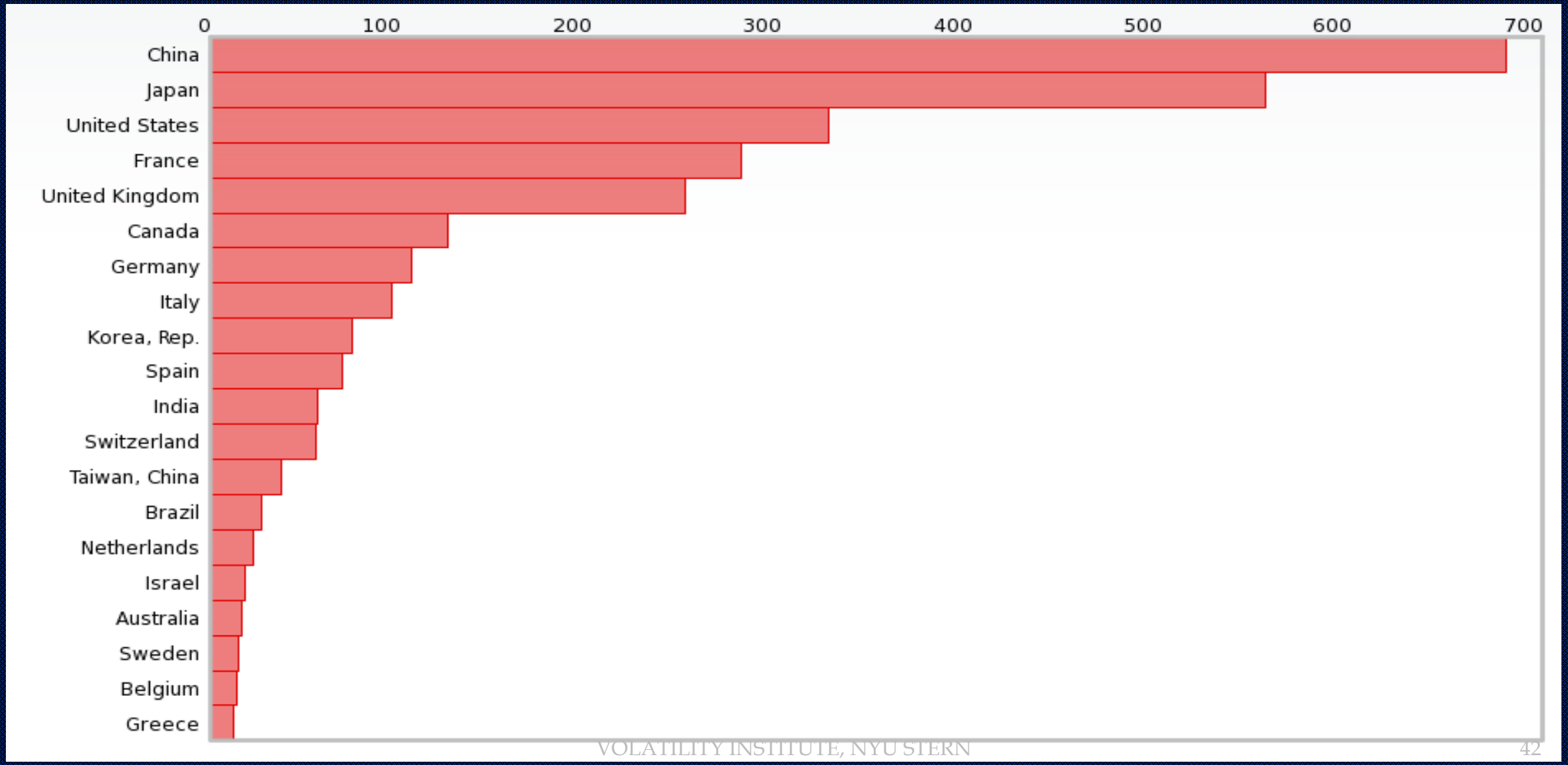
- Our intention is to compute these measures and report them on VLAB in an ongoing and up to date fashion.  Stay tuned.


WHERE IS THE SRISK?

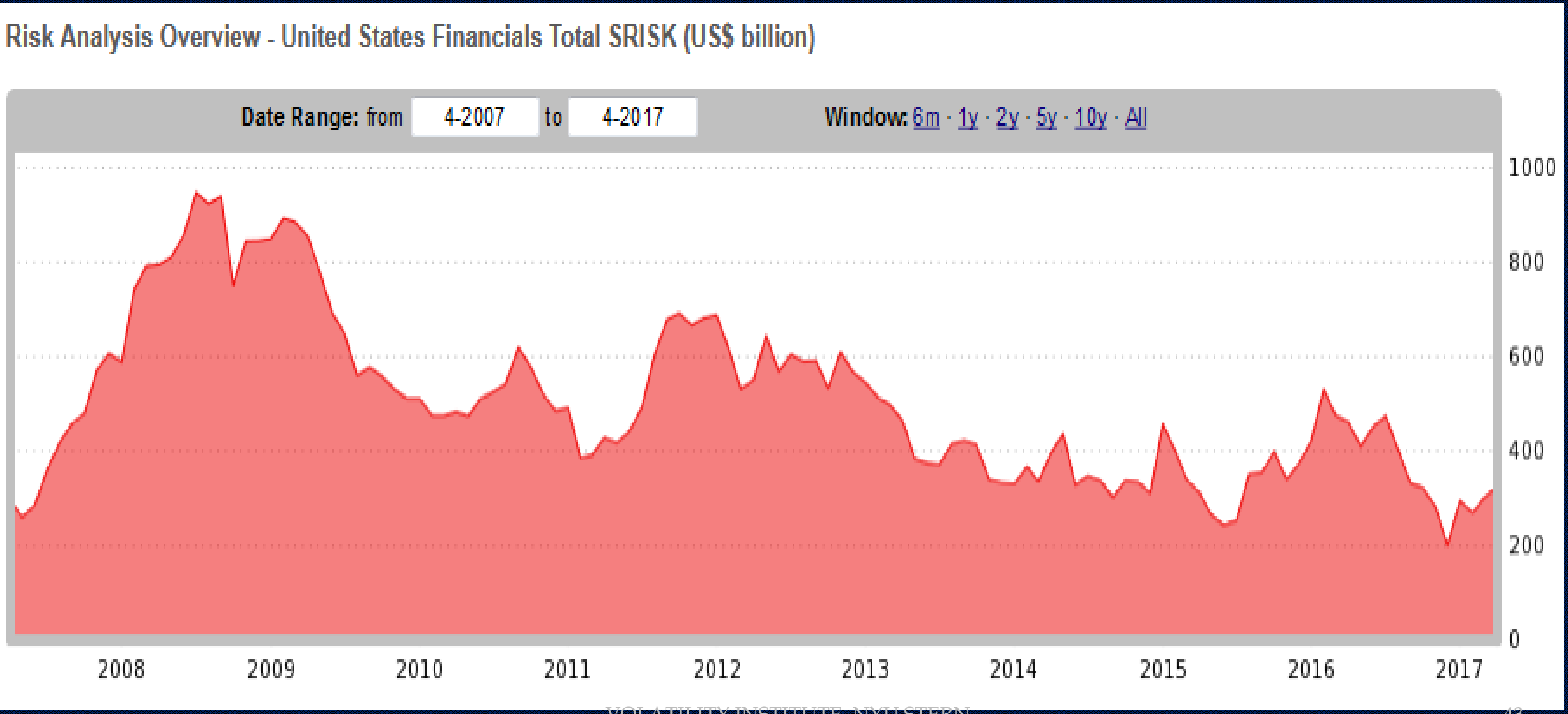
# WORLD SRISK – LAST 10 YEARS



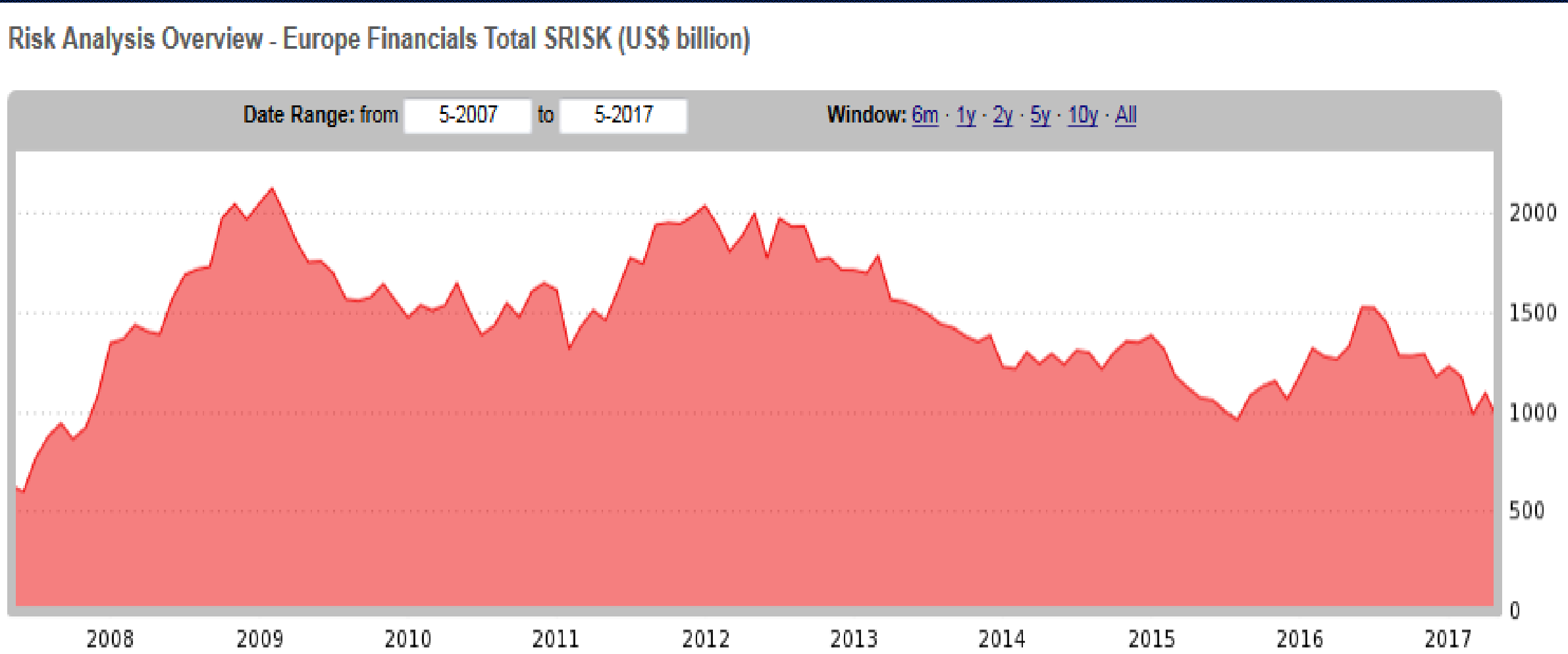
# WHERE IS THE WORLD SRISK?



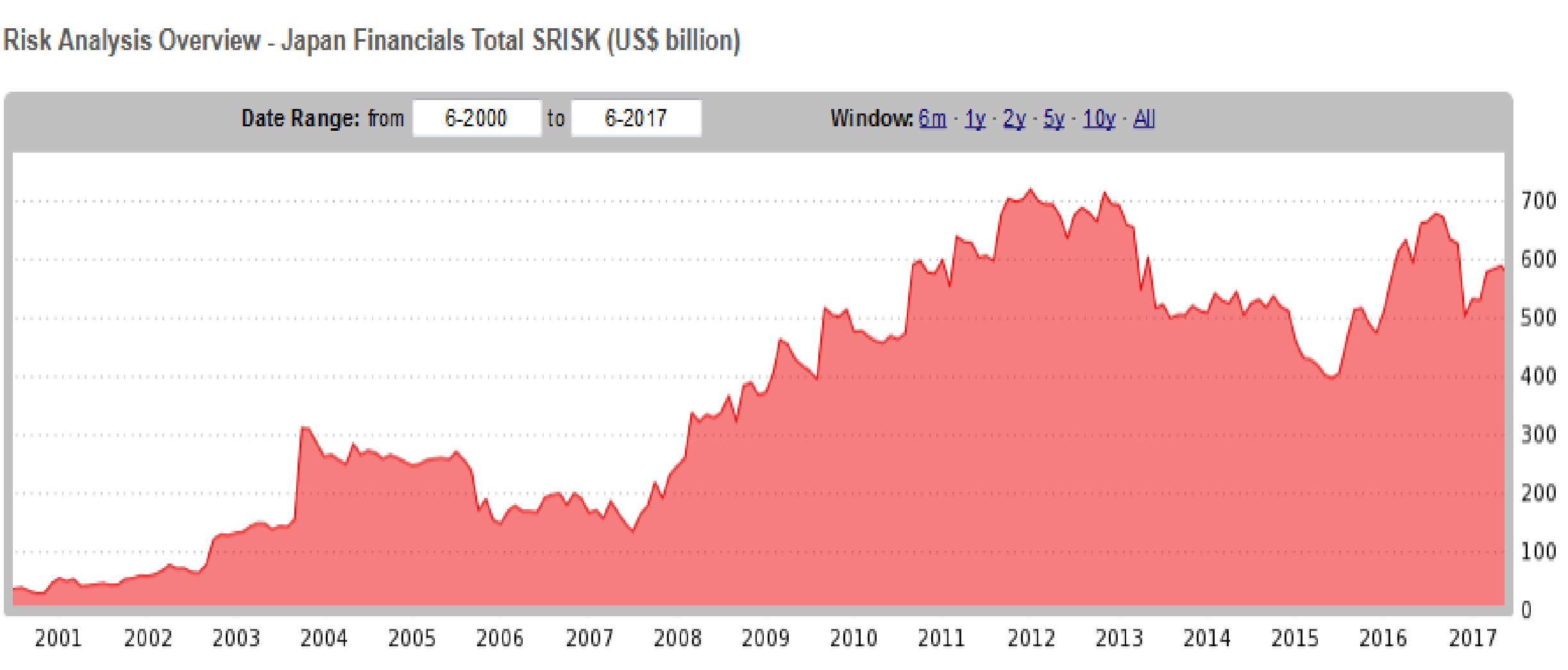
# US SRISK


Risk Analysis Overview - United States Financials Total SRISK (US$ billion)
Date Range: from 4-2007 to 4-2017
Window: 6m · 1y · 2y · 5y · 10y · All
1000
800
600
400
200
0
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

# EUROPE SRISK



# JAPAN SRISK


Risk Analysis Overview - Japan Financials Total SRISK (US$ billion)
Date Range: from 6-2000 to 6-2017
Window: 6m · 1y · 2y · 5y · 10y · All
700
600
500
400
300
200
100
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

# DEREGULATION?

- What happens when regulations are relaxed?
- President Trump has called for financial deregulation in the US and dismantling the Dodd Frank Act.
- Some of this has now been done by executive order and more is expected.
- Spiral works in reverse. Ruan calls this "race to the top".
- Equity market rises in advance of leverage increases.
- Similar features preceded GFC. Remember Countrywide?

- **Short run risk is reduced but long run risk is increased**.

# What is in their future?