The Interaction between Monetary and Macroprudential Policy:

Should Central Banks "Lean Against Wind" to Foster Macro-financial Stability?

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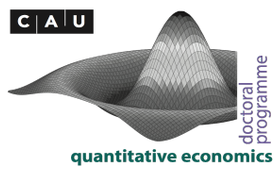
SRC Conference on

"Capital Flows, Systemic Risk, and Policy Responses"

Reykjavik, Iceland

April 28th, 2016



Outline

1. Motivation

2. The Model

3. Empirical Validation

4. Design of Experiments (DOE)

5. Results

Motivation

- <u>Pre-crisis view:</u>
  - Focus on inflation (inflation targeting)
  - main source of financial instability
  - ➡ moderate inflation rate = stable economy

- <u>Post-crisis view:</u>
  - ➡ financial stability as requirement for (not a result of) proper functioning of MP
  - other measures of economic health?
  - expansion of monetary policy goals?

“Leaning against the wind” as solution?

Motivation

Current debate on how to support macro-financial stability?

Extension of dual mandate vs. reliance on financial regulation

Pro

- Woodford (2012); Walsh (2014); Borio (2014); Stein (2014); Tarullo (2014); George (2014); Olsen (2015)
  - natural extension of dual mandate
  - bringing these topics on research agenda

Bookstaber (INET 2014):
"We have to embed financial regulation deeply within macroeconomics and in particular monetary policy, the interface between those two is untried territory"

Con

- Svensson (2014); Yellen (2014); Giese et al. (2013)
  - violation of "Tinbergen's effective assignment principle"
  - financial regulation/MPP is independent; MP not
  - overburdened MP
  - conflicting objectives (effects on primary goals are yet unknown)
  - unclear priorities

Motivation

Why using an ACE model as framework for the analysis?

- DSGE model domination in the field of OMP [Käfer (2014); Chatelain/Ralf (2014); Plosser (2014)]
- but no special role of financial sector on econ. fluctuations
- neglect development of variables linked to financial imbalances (credit growth, asset prices etc.) [Cecchetti et al. (2000); Bordo/Jeanne (2002); Borio/Lowe (2002, 2004)]
- model pluralism [Haldane/Qvigstad (2014)]
- Bookstaber (2012): “Using Agent-based models for Analyzing Threats to Financial Stability“

Agnor/da Silva (2014):
”Our simple dynamic macro model of a bank-dominated financial system provides a better starting point to think about monetary policy than the NKM which by now is largely discredited. The days of studying monetary policy in models without money/ credit are over.”

Research Question and Methodology

We want to explore whether

- the two policies affect economic activity differently
- “leaning against the wind” really leads to overburdened MP
- there is a need for policy coordination

Methodology

- use an ACE macro-model as experimental framework
  - suitable implementation of MP framework
  - suitable degrees of financial regulation
- empirically validate the data generating process of the artificial economy
- analyse the performance of 2 policy tools concerning 2 policy goals
  - macroeconomic stability (traditional)
  - financial stability (new)

  by comparing **losses** relative to a benchmark case

Findings

The results of our simulations suggest that

1. “leaning against the wind” should only serve as first line of defence in the absence of prudential financial regulation. It improves macroeconomic stability while the effect on financial stability is only marginal.

2. as independent policy tool, prudential financial regulation significantly improves financial stability

3. an additional CB response to financial sector imbalances has a negative effect on primary goals (overburdened MP)

4. both policies are inherently connected and need to be coordinated

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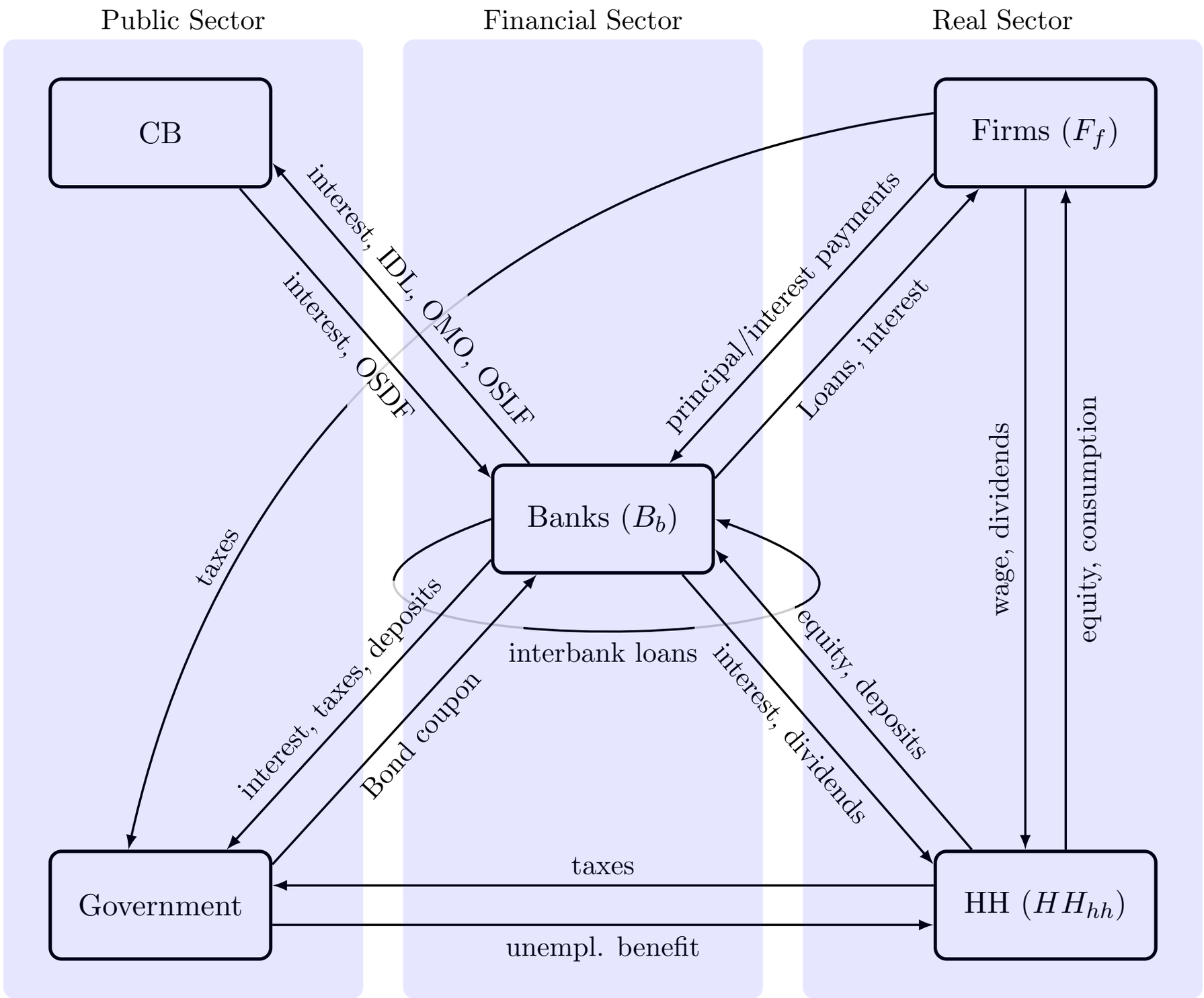
The Model

Some basic information

- Written in Scala; running on JVM like Java
- 6 types/classes of agents
- heterogeneous in their endowments (labor skill, productivity, capital etc.)
- Interaction through labor, goods, money market
- follow their own needs
- endogenous money approach [e.g. Lavoie (2003)]
- *“UK Sterling Monetary Framework”* of BoE as template

The Model - Basic Structure

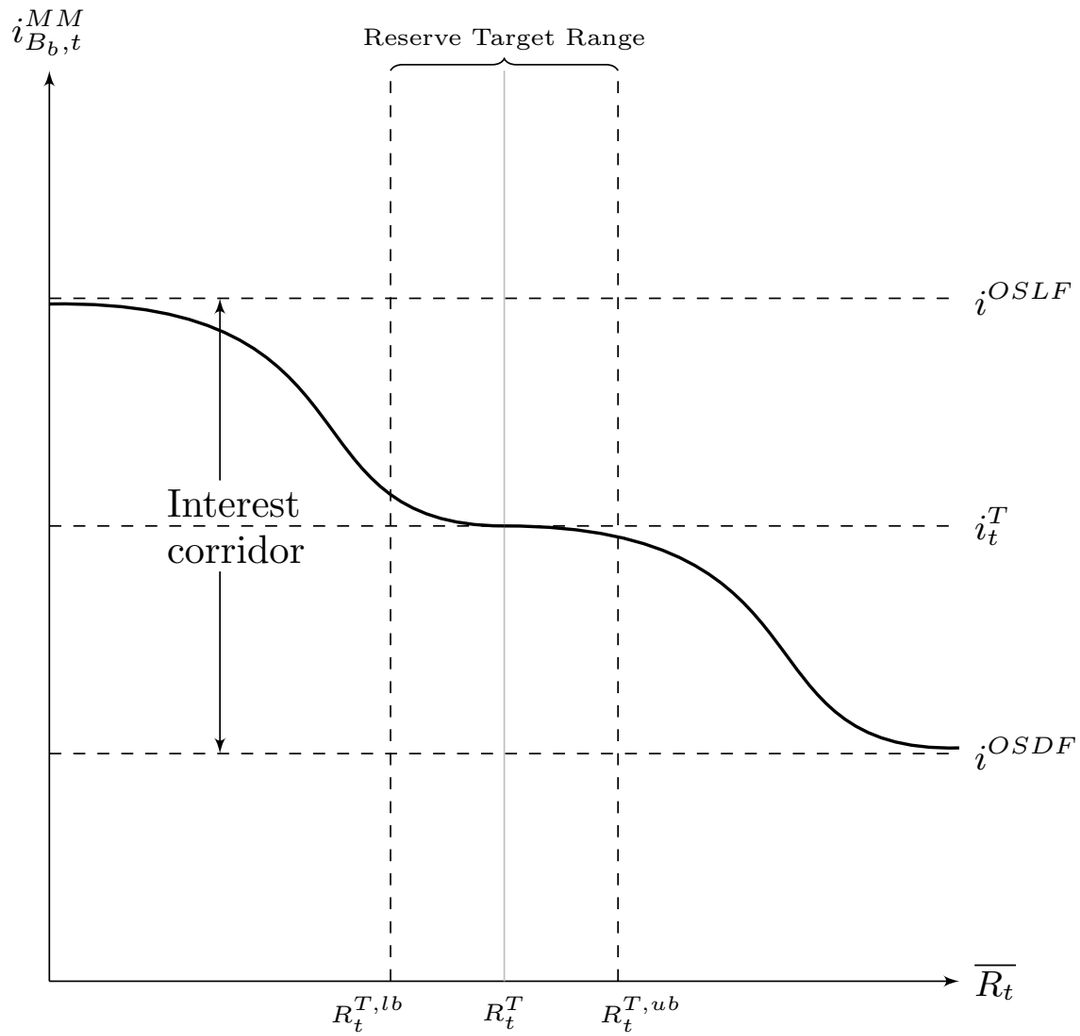
Modern Monetary Economy with Endogenous Money



The Model - Reserve Averaging Scheme

- How does the CB control economic activity through the target rate?

➡ clear in theory but how to model at the micro-level?



- RTGS system as incentive scheme
- interest on reserves only within target range
- unpredictable stream of transactions

➡ ***banks forced to actively manage their liquidity***

- CB does not serve as clearing house:
  1. interbank-reallocation of reserves
  2. usage of central bank OSF (LOLR)

➡ price of liquidity is under perfect control of the CB

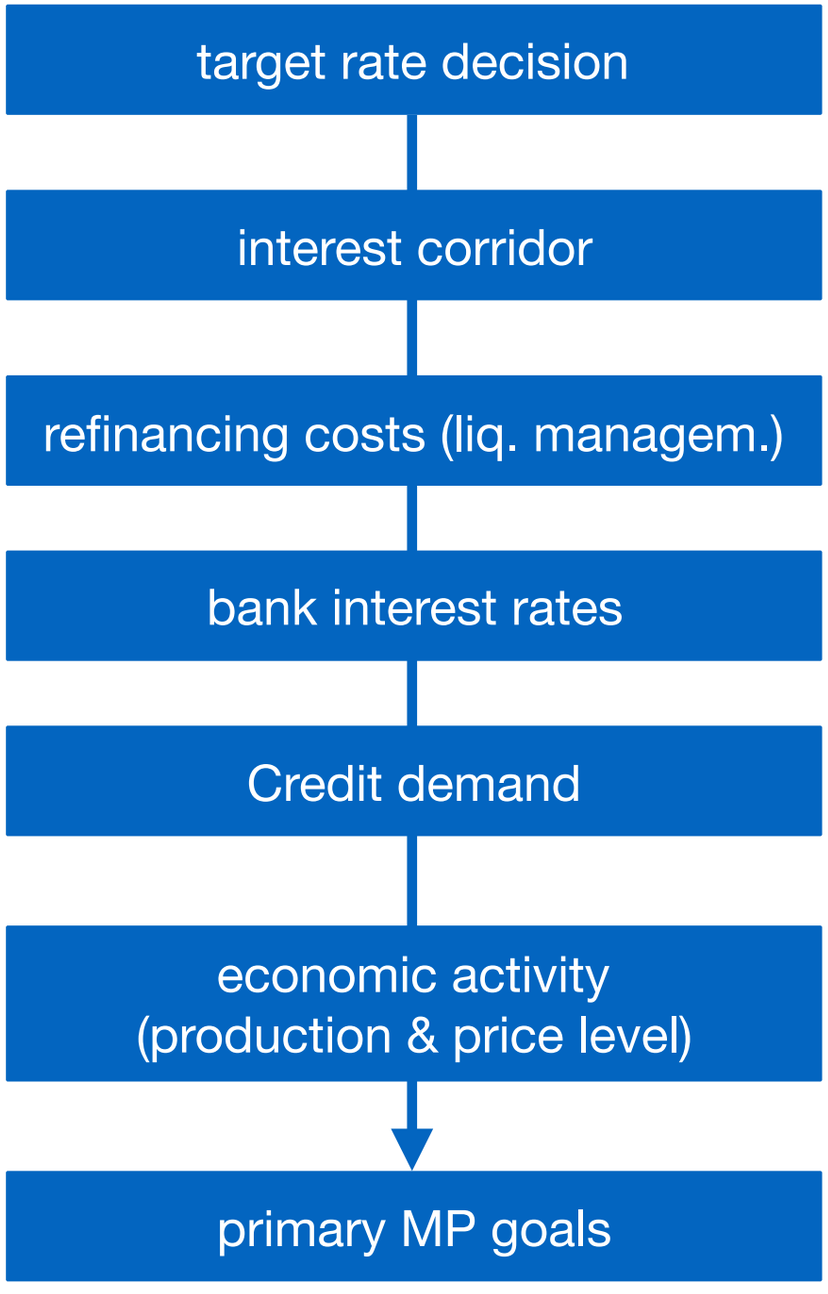
The Model - Reserve Averaging Scheme

How does the CB implement monetary policy?

- duration of maintenance period: 6 weeks
- standard TR for benchmark case:

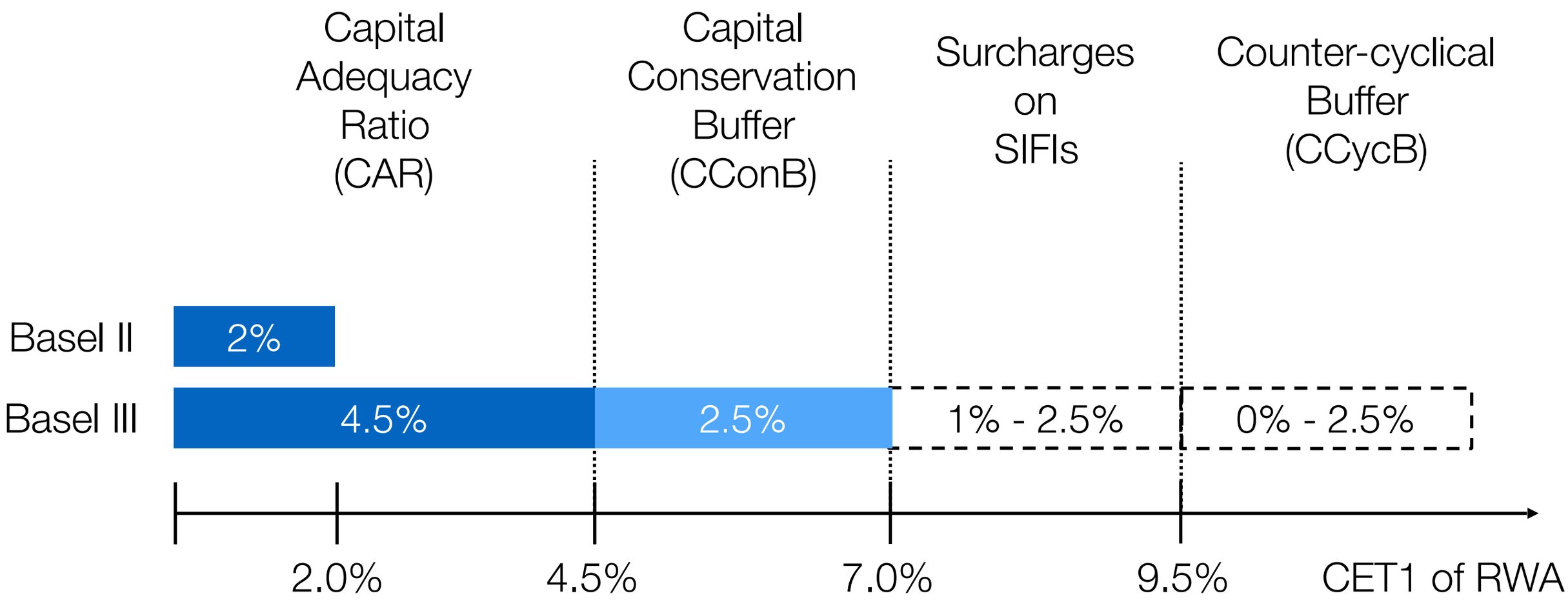
$$i_t^* = i_t^r + \pi^* + \delta_\pi(\pi_t - \pi^*) + \delta_x\left(x_t - x_t^n\right)$$

- output gap measured as deviation from HP-filtered long-term trend



The Model - Financial Regulation

Comparison of Regulatory Regimes



- Leverage Ratio (LR), non-risk sensitive

$$LR = \frac{\text{Tier 1 Capital}}{\text{Total Assets}} \geq 3\%$$

The Model from a Bird's Eye View

Sequence of Simulated Economic Activities (Pseudo Code)

- Start economic interaction of settlement period t (t = 1 … 3000)
  - Banks settle overnight interbank liabilities / standing facility liabilities
  - Banks set up repo with CB of maintenance period
  - Real sector activity (planning phase)
    - Firms plan production target, offered wage, credit demand (external financing)
    - Firms send credit requests
    - Firms announce vacancies
    - HH plan consumption
  - Government pays unemployment benefit
  - Real sector activity (production phase)
    - unemployed HH search for a job & Firms hire workers in case of a match
    - Firms produce and offer their bundle of goods
    - HH consume
  - Real/public sector debt obligations
    - Firms pay wages & repay debt (illiquidity risk)
    - Government (re)pays coupon/face value on outstanding bonds
    - Firms calc. profit, pay taxes/dividends, set up balance sheet in t, shut down if insolvent
- End of settlement period t
  - Banks determine profit, pay taxes, pay dividends to HH
  - Banks repay intra day liquidity (IDL) to the CB
  - Banks conduct interbank lending (overnight)
  - Banks use standing facility of the CB
  - CB pays interest on reserves
  - Test for insolvencies of financial sector agents (trad. banks/shadow banks) % Banks makeAnnualReport (set up current balance sheet, shut down if insolvent)
- Monetary policy decisions (target rate, counter-cyclical buffer)

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Model validation through simultaneous match of stylized facts

Fagiolo et al. (2007); Fagiolo and Roventini (2012)

B Validation of the Model

Table 3: Stylized facts replicated by the Keynes+Schumpeter-ACE model [Dosi et al. (2014)]

	Code	Stylized fact	Empirical studies (among others)
Macro	SF1	Endogenous self-sustained growth with persistent fluctuations	Burns and Mitchell (1946); Kuznets and Murphy (1966); Zarnowitz (1985); Stock and Watson (1999)
	SF2	Fat-tailed GDP growth-rate distribution	Fagiolo et al. (2008); Castaldi and Dosi (2009)
	SF3	Recession duration exponentially distributed	Ausloos et al. (2004); Wright (2005)
	SF4	Relative volatility of GDP/consum./invest.	Stock and Watson (1999); Napoletano (2006)
Credit	SF5[a]	Pro-cyclical aggregate firm investment	Wälde and Woitek (2004)
	SF6	Pro-cyclical bank profits/debt of firm sector	Lown and Morgan (2006)
	SF7	Counter-cyclical credit defaults	Lown and Morgan (2006)
	SF8	Lagged correlation between firm indebtedness & credit defaults	Foos et al. (2010); Mendoza and Terrones (2012)
Crises	SF9	Banking crises duration is right skewed	Reinhart and Rogoff (2009)
	SF10	Fat-tailed distribution of fiscal costs of banking crises-to-GDP ratio	Laeven and Valencia (2013)
	SF11[b]	the presence of the Phillips curve	Phillips (1958)

[a] In the original table of Dosi et al. (2014), aggregate R&D investments are used. We use, instead, the firm sector's requested amount of loans from banks as a proxy for their investment in the production of goods.

[b] Described as general characteristic of an economy, i.e. without explicit notion of empirical studies and found in Riccetti et al. (2014).

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Design of Experiments

1. Determination of a financial imbalance measure

- Woodford (2012) vs. Stein (2014)
- financial vs. private sector leverage
- prudent balance sheet structure vs. unsustainable credit growth

A. Composite indicator for fin. sector leverage [D/E + CC]

$$CFSI_t = \log\left(\frac{1}{b}\sum_{i=1}^{b}\xi_{B_i,t}\right) + \log\left(\frac{1}{\frac{1}{b}\sum_{i=1}^{b}\frac{E_{B_i,t}}{RWA_{B_i,t}}}\right).$$

B. Credit-to-GDP ratio $\Lambda_t = \frac{C_t}{GDP_t}.$

2. Modeling of the CB's policy response

$$i_t^* = i_t^r + \pi^* + \delta_\pi(\pi_t - \pi^*) + \delta_x\left(x_t - x_t^n\right) + \delta_s(CFSI_t - CFSI^*)$$

$$i_t^* = i_t^r + \pi^* + \delta_\pi(\pi_t - \pi^*) + \delta_x\left(x_t - x_t^n\right) + \delta_s\left(\Lambda_t - \Lambda_t^n\right)$$

Design of Experiments

3. Determination of a criterion for policy effectiveness

- Loss fct. for ***macroeconomic*** stability (trad. MP goals):

$$L^{MS}_{\delta_s,k,m} = \alpha_\pi \overline{\mathrm{Var}(\pi_{\delta_s,k,m})} + \alpha_x \overline{\mathrm{Var}(x_{\delta_s,k,m})} + \alpha_i \overline{\mathrm{Var}(i_{\delta_s,k,m})}$$

- Loss fct. for ***financial*** stability (new MP goal):

$$L^{FS}_{\delta_s,k,m} = \underbrace{\alpha_\zeta \overline{\zeta_{\delta_s,k,m}}}_{\substack{\text{avg. final costs of bank bail outs}}} + \underbrace{\alpha_\rho \overline{\rho_{\delta_s,k,m}}}_{\substack{\text{avg. bank default rate}}} + \underbrace{\alpha_\gamma \overline{\gamma_{\delta_s,k,m}}}_{\substack{\text{avg. firm default rate}}}$$

➡ Distinct losses for distinct policy goals to isolate effects & to check Tinbergen

Design of Experiments

Set up

- single run of Monte Carlo simulations:
  - 3000 periods
  - 125 HH; 25 Firms; 5 Banks
  - 20% initialization phase (600 periods)
  - 100 runs per data point
  - initial parameter step size of 0.25

- Benchmark case:
  - no leaning against the wind ($\delta_s = 0$)
  - loose / deregulated financial system (Basel II)
  - no macroprudential policy

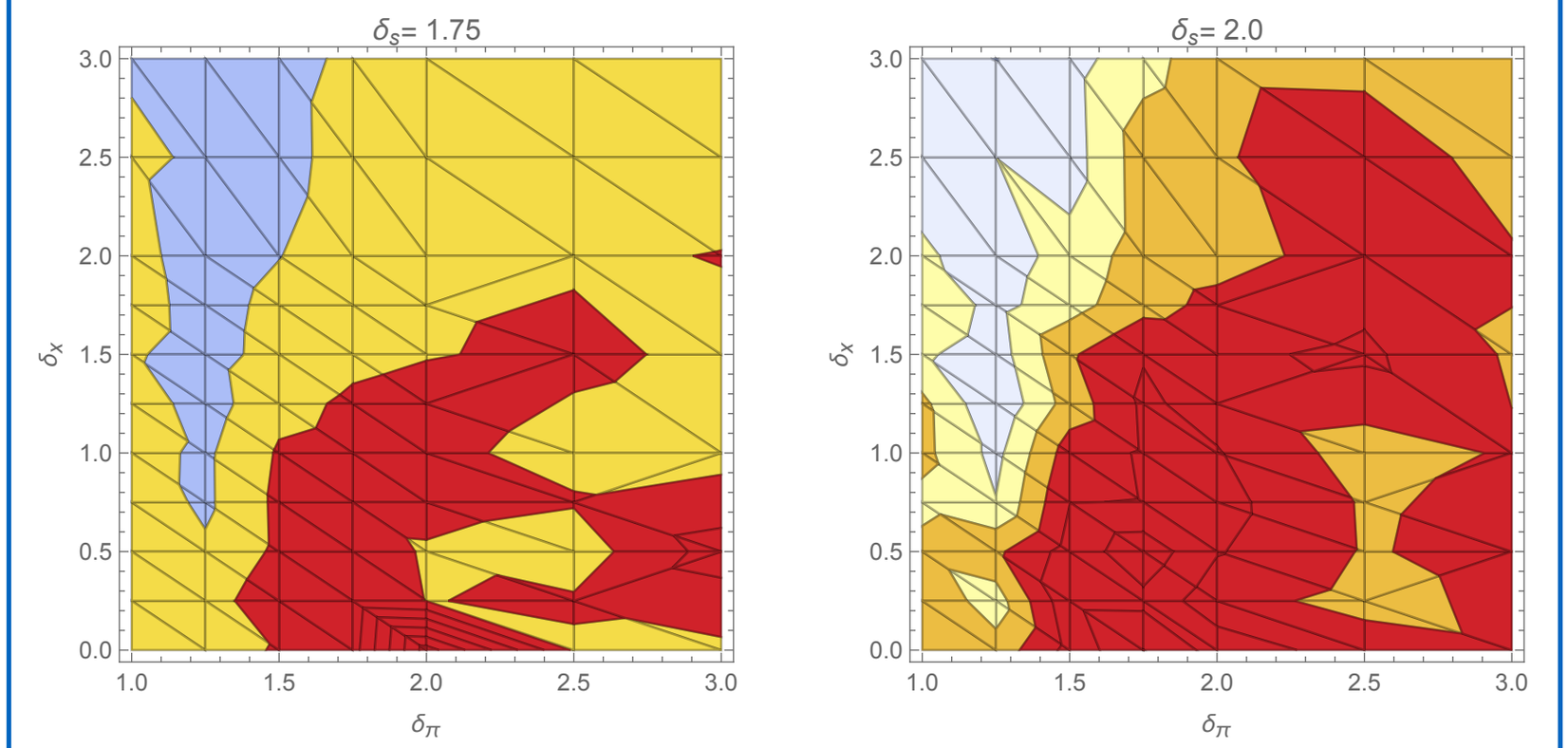
- 4 different scenarios
  1. CB response to fin. sector leverage under Basel II
  2. CB response to excessive credit growth under Basel II
  3. CB response to fin. sector leverage under Basel III
  4. CB response to excessive credit growth under Basel III

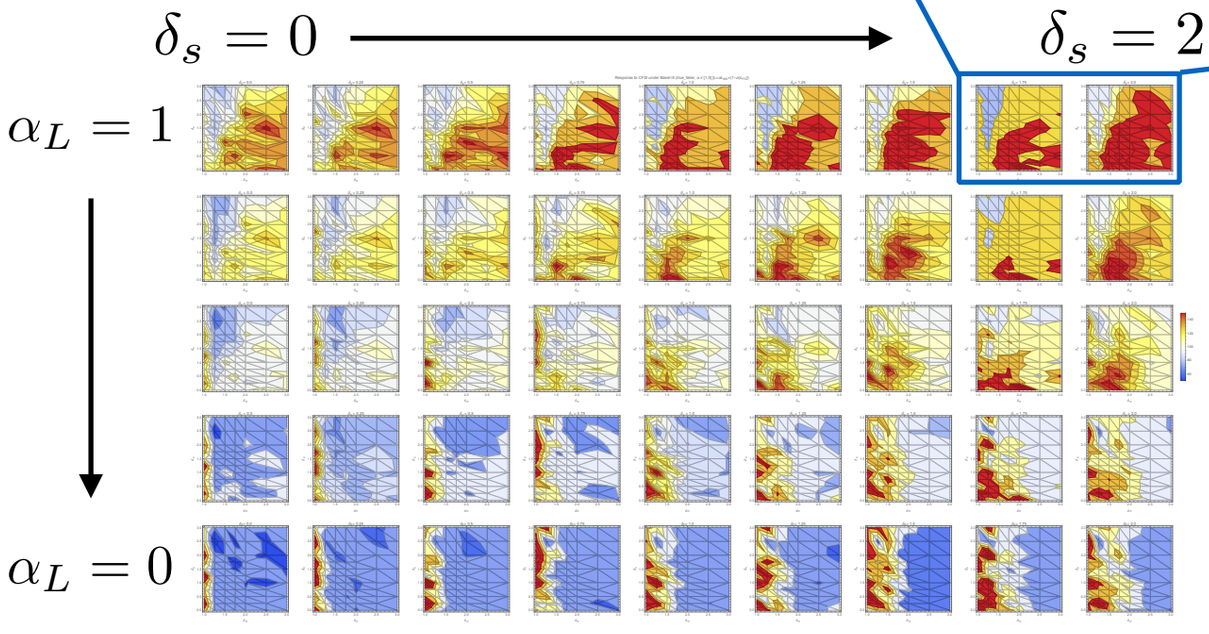
- search for min. losses relative to the benchmark case with the parameter pace spanned by [Bundesbank (2015)]

$$\delta\pi \in (1,3);\ \delta_x \in (0,3);\ \delta_s \in (0,2)$$

Simulation Results

Interpretation of Plots





Horizontal Dimension

- degree of CB response in TR
- step size: 0.25

Vertical Dimension

- differing weights of losses:

$$L = \alpha_L L^{MS}_{\delta_s,k,m} + (1-\alpha_L) L^{FS}_{\delta_s,k,m}$$

- step size: 0.25

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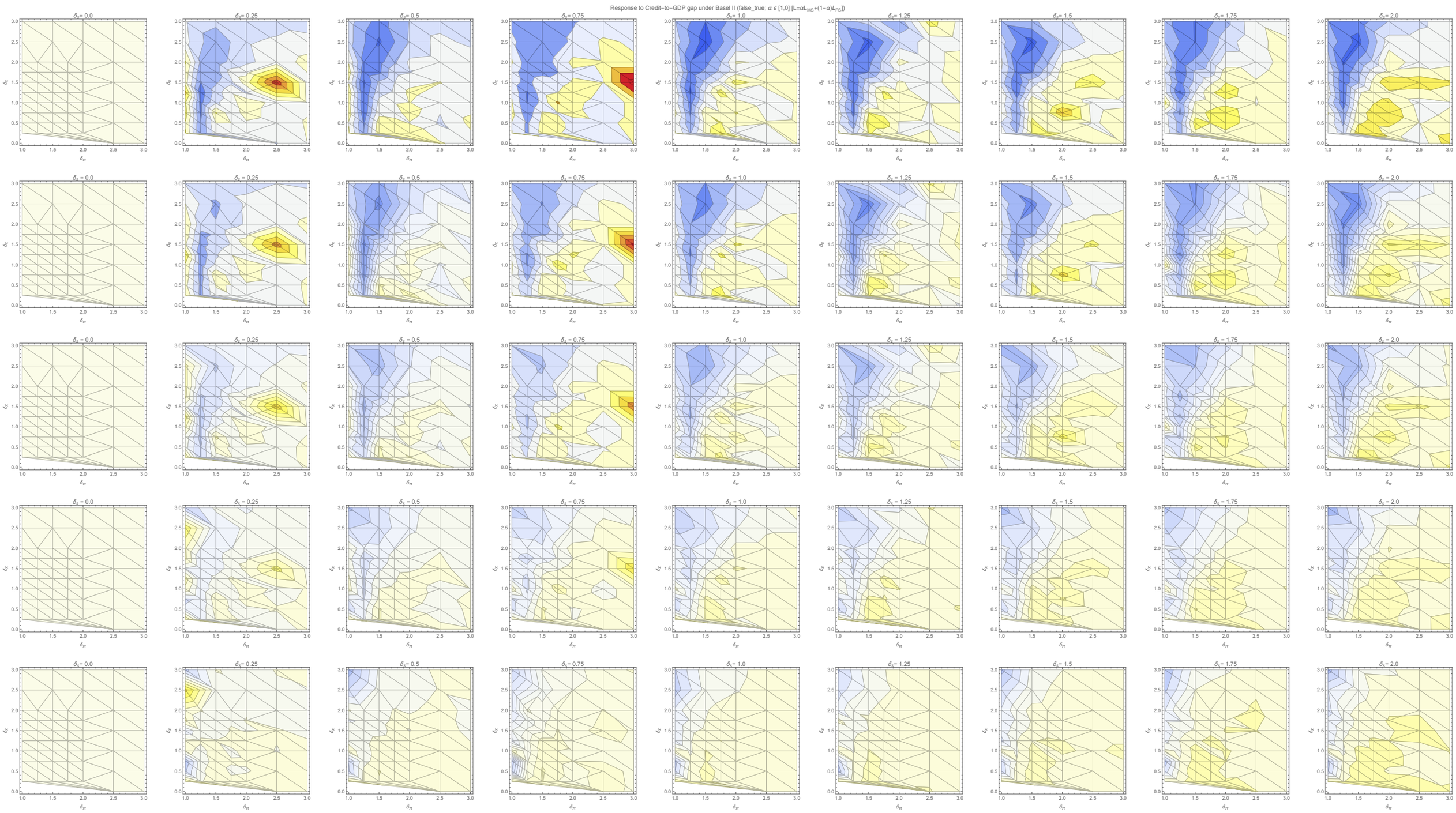
Simulation Results

CB response to unsustainable credit growth under Basel II



Simulation Results

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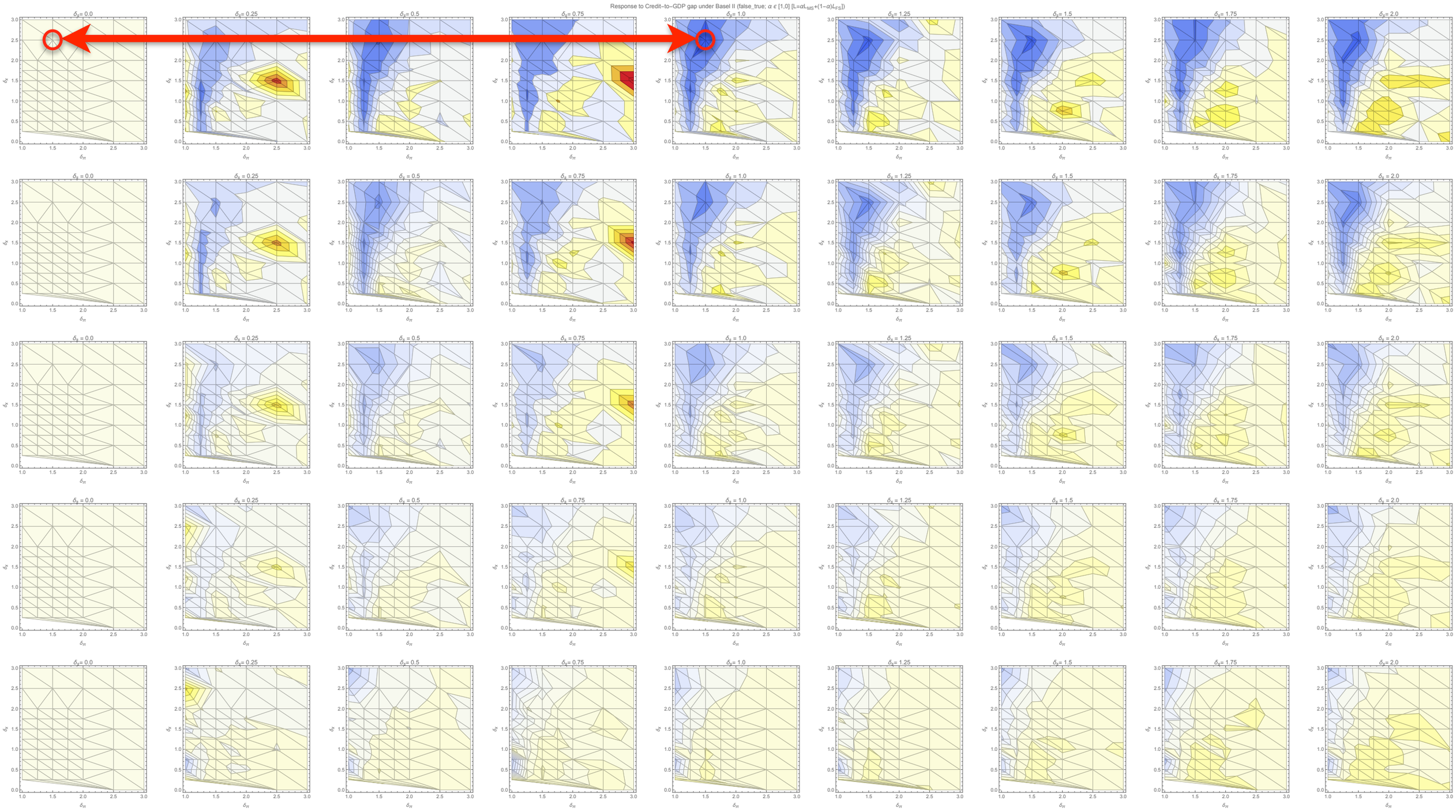


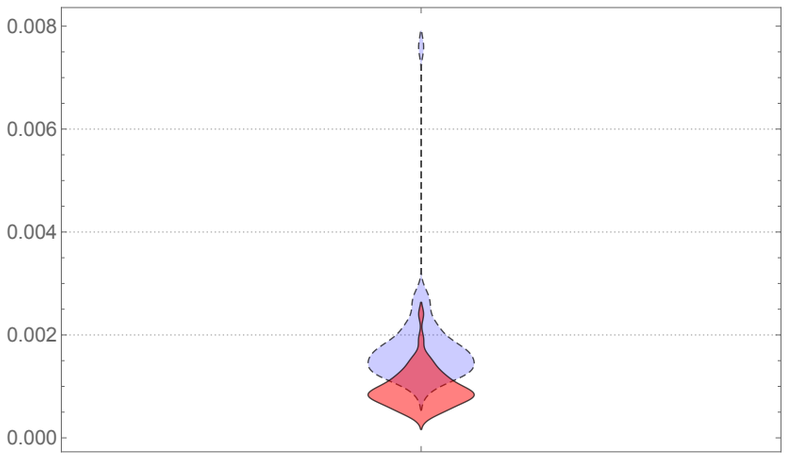
Simulation Results

Comparison of data point with benchmark

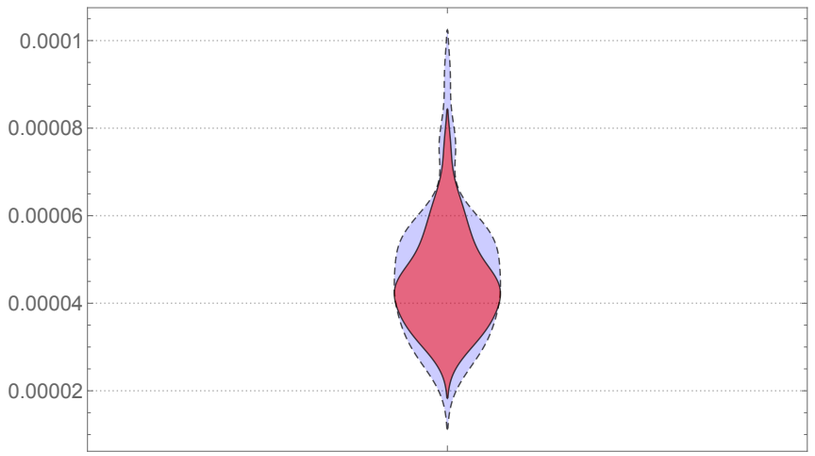
$$\delta_\pi = 1.5, \delta_x = 2.5, \delta_s = 0.0, \alpha_L = 1 \quad \text{(benchmark)}$$

vs.

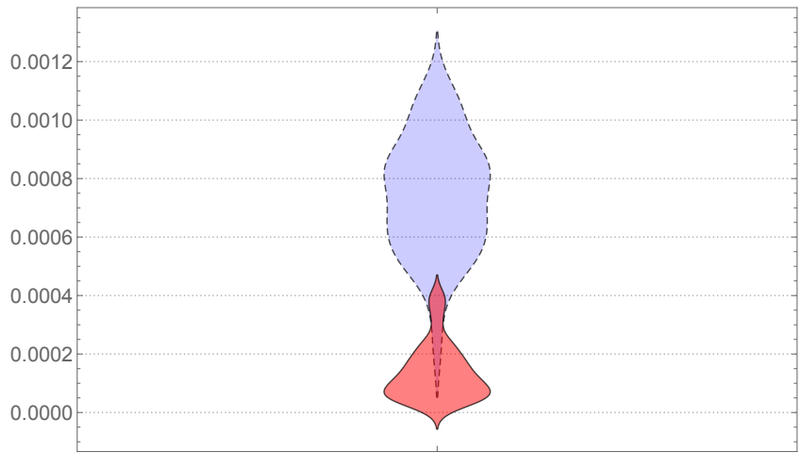
$$\delta_\pi = 1.5, \delta_x = 2.5, \delta_s = 1.0, \alpha_L = 1$$



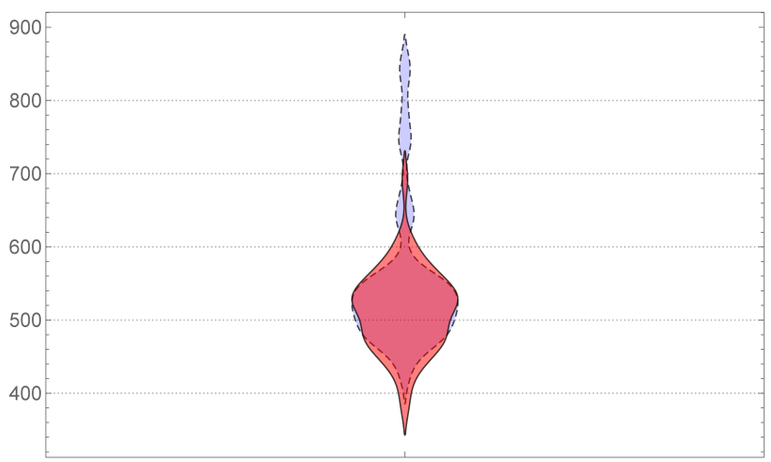
$\text{Var}(\pi)$



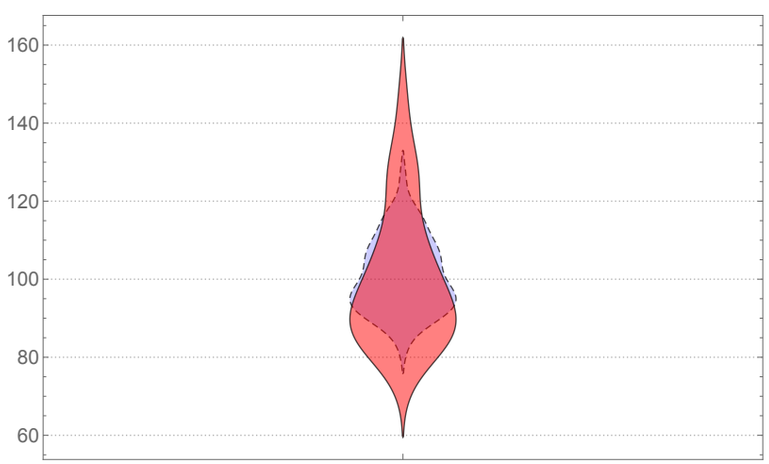
$\text{Var}(x)$



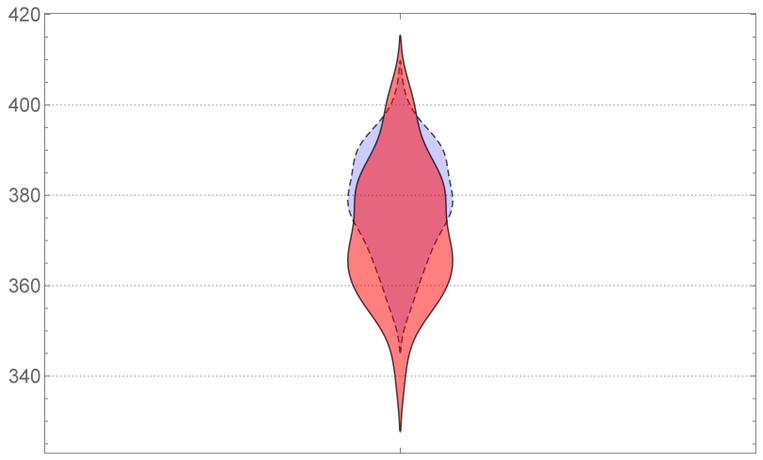
$\text{Var}(i)$



fiscal costs (ζ)



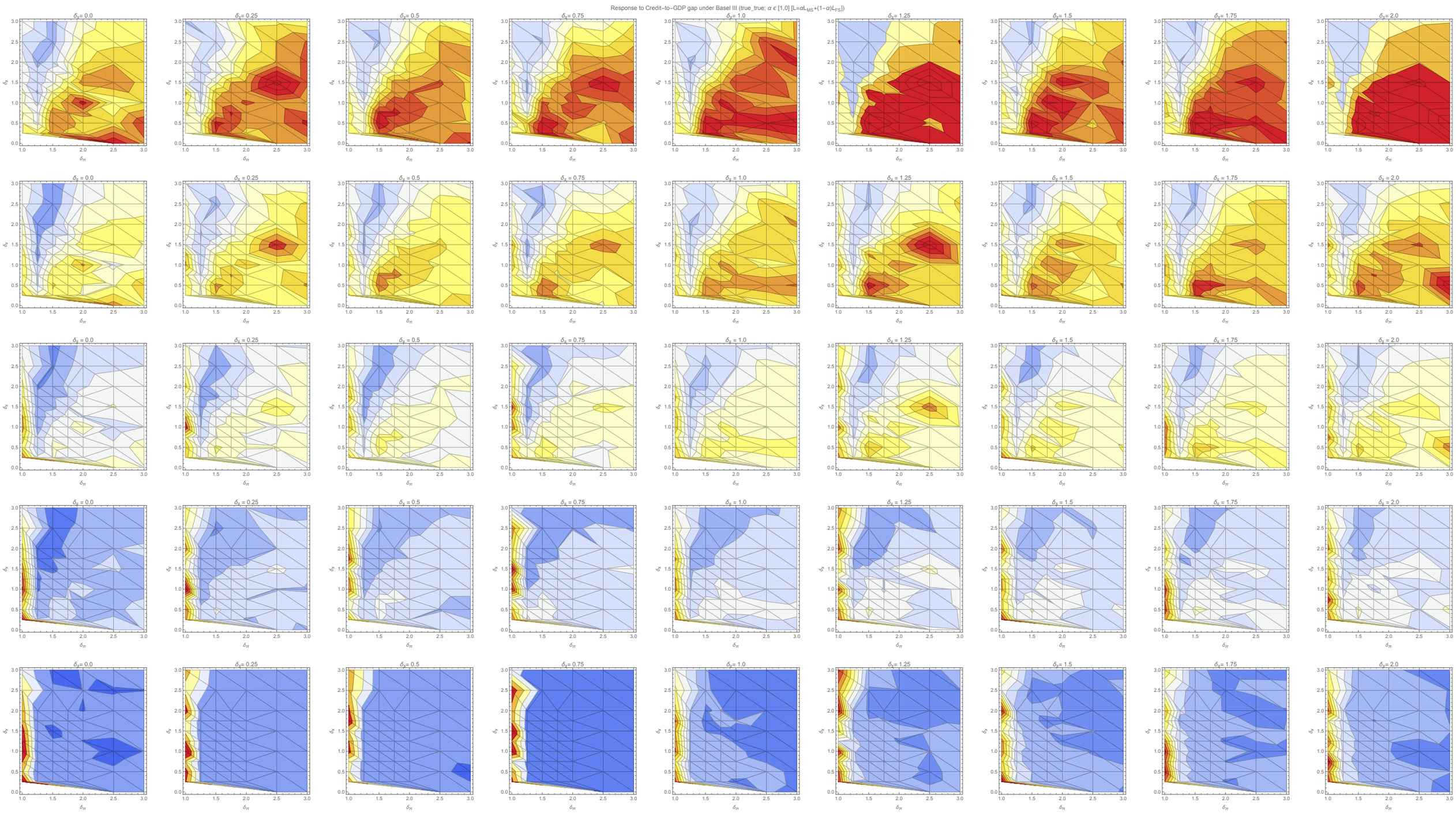
bank defaults (ρ)



firm defaults (γ)

Simulation Results

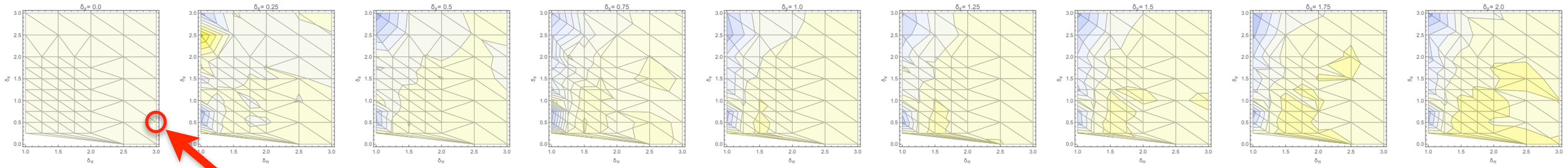
CB response to unsustainable credit growth under Basel III



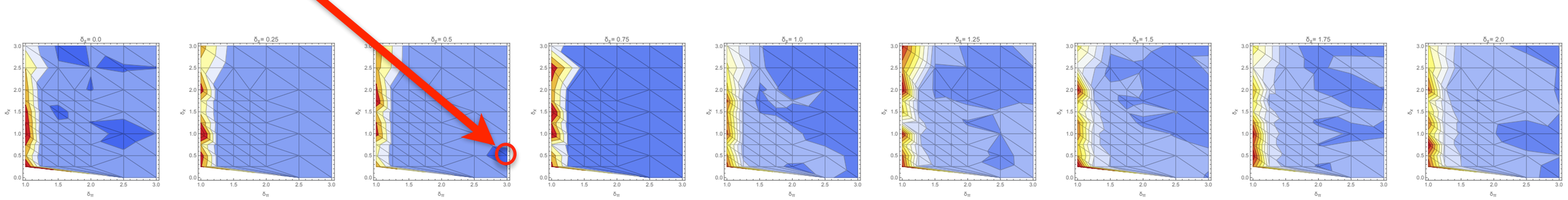
Simulation Results

CB response to unsustainable credit growth under Basel III

Basel II



Basel III



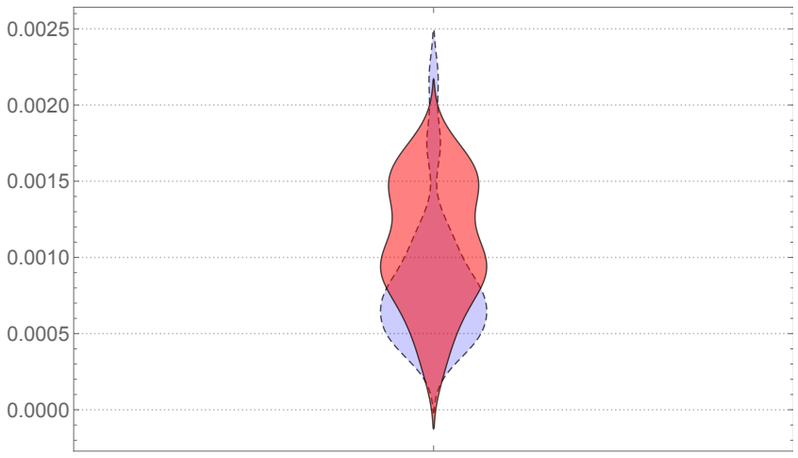
Simulation Results

CB response to unsustainable credit growth under Basel III

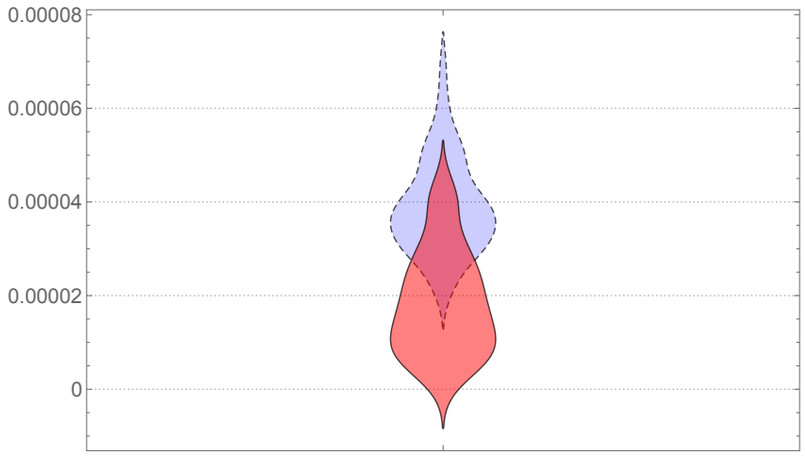
$$\delta_\pi = 3.0, \delta_x = 0.5, \delta_s = 0.0, \alpha_L = 0, \text{Basel II} \quad (\text{benchmark})$$

vs.

$$\delta_\pi = 3.0, \delta_x = 0.5, \delta_s = 0.5, \alpha_L = 0, \text{Basel III}$$

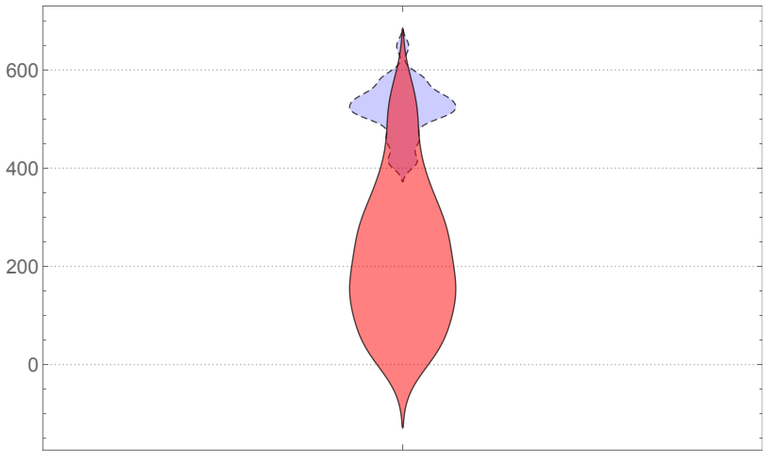


$\text{Var}(\pi)$



$\text{Var}(x)$

$\text{Var}(i)$



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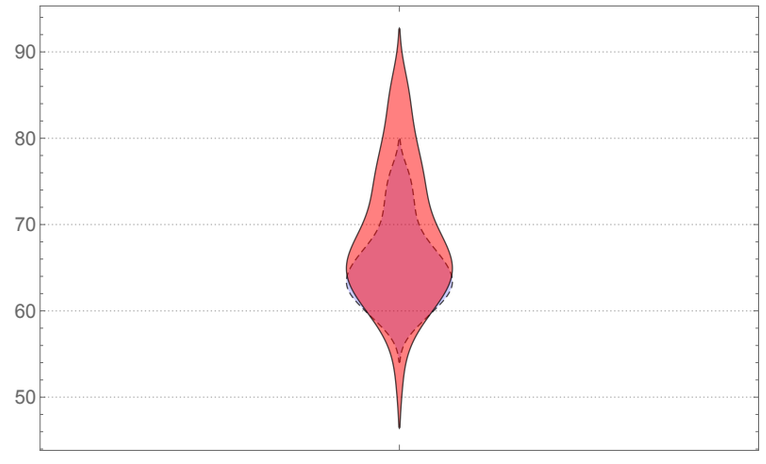

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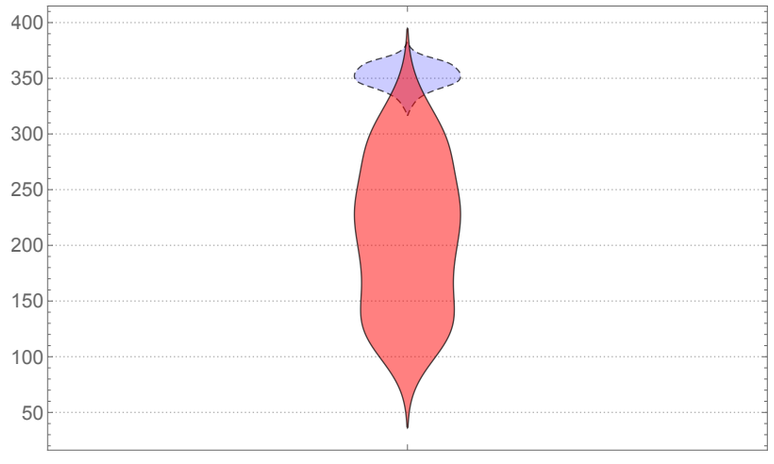

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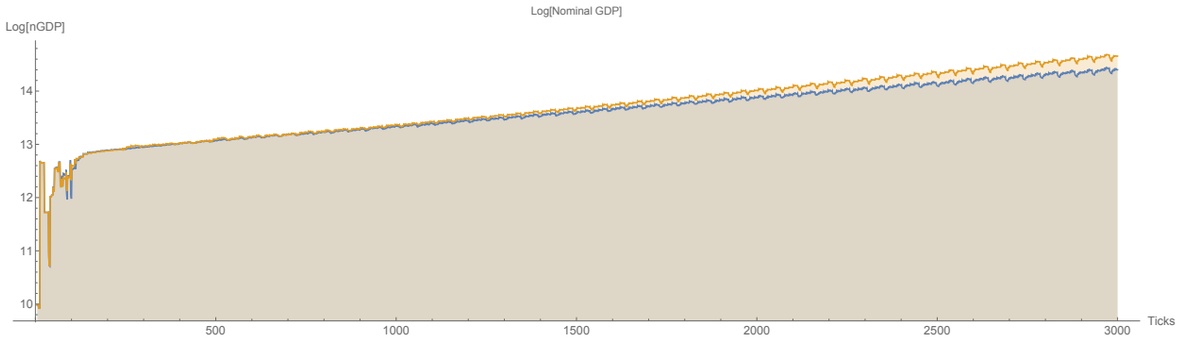
4. both policies are inherently connected and need to be coordinated


SIGILLVM ACADEMIÆ HOLSATORVM CHILONIENSIS
PAX OPTIMA RERUM
A.D. 1665

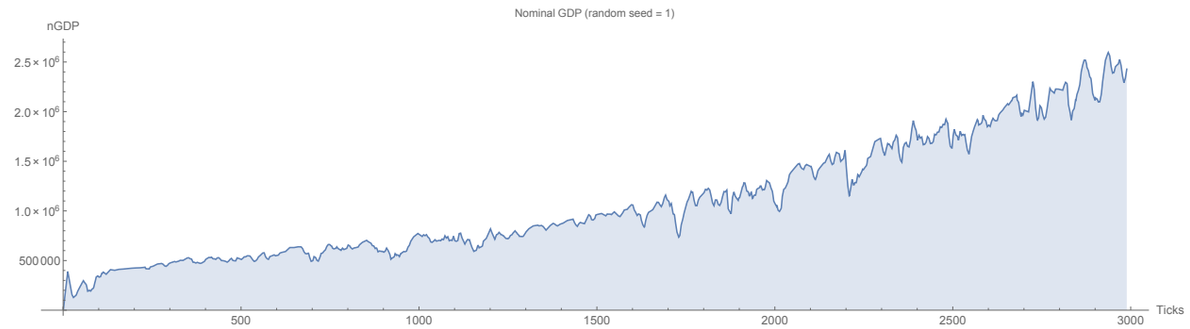
Thank you!

Endog. self-sustained growth with persistent fluctuations

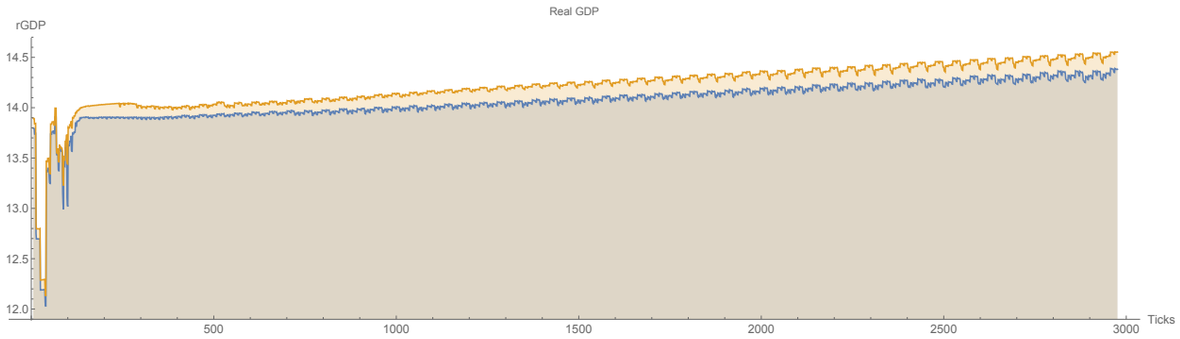
Stylized Fact 1: Burns/Mitchell (1946); Kuznets/Murphy (1966); Zarnowitz (1985); Stock/Watson (1999)



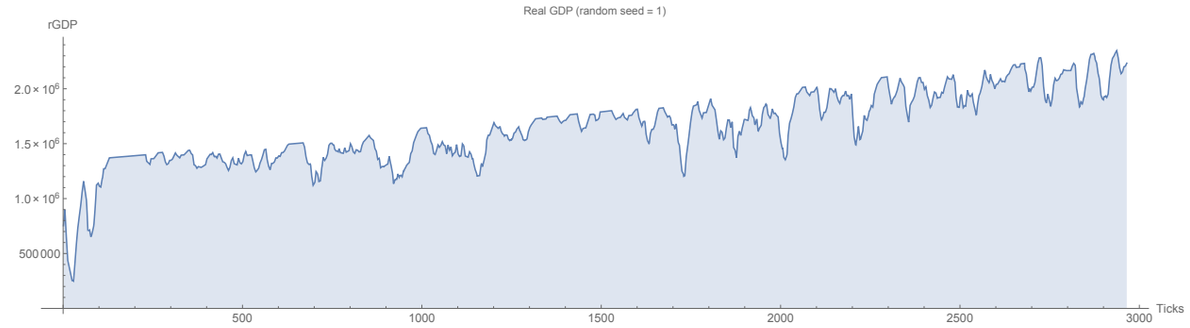
(a) Log Nominal GDP (avg. 1000 runs)



(b) Nominal GDP (single run)



(c) Log Real GDP (avg. 1000 runs)



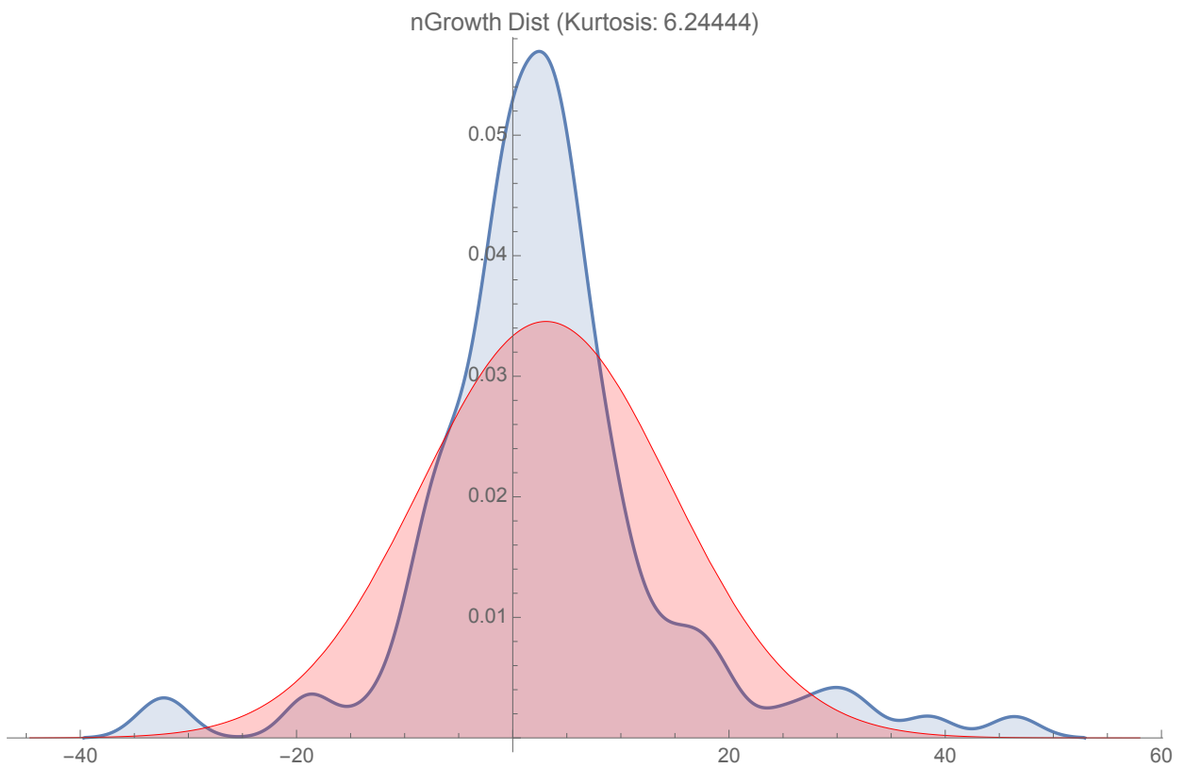
(d) Real GDP (single run)

Figure 16: Endogenous nominal/real GDP growth with persistent fluctuations [SF1]

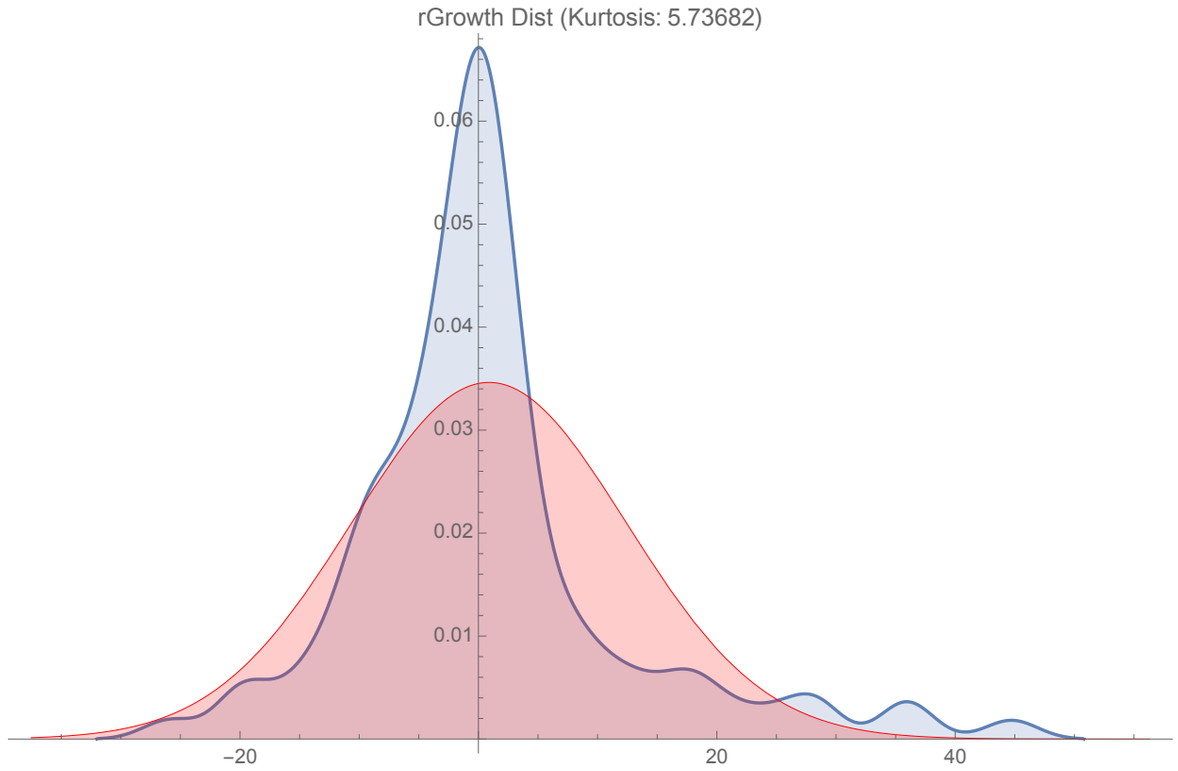
- Fluctuations increase with economic activity
- BC does not vanish on avg. but is much more regular

Fat-tailed GDP growth-rate distribution

Stylized Fact 2: Fagiolo et al. (2008); Castaldi and Dosi (2009)



(a) Distribution of nominal GDP growth-rate

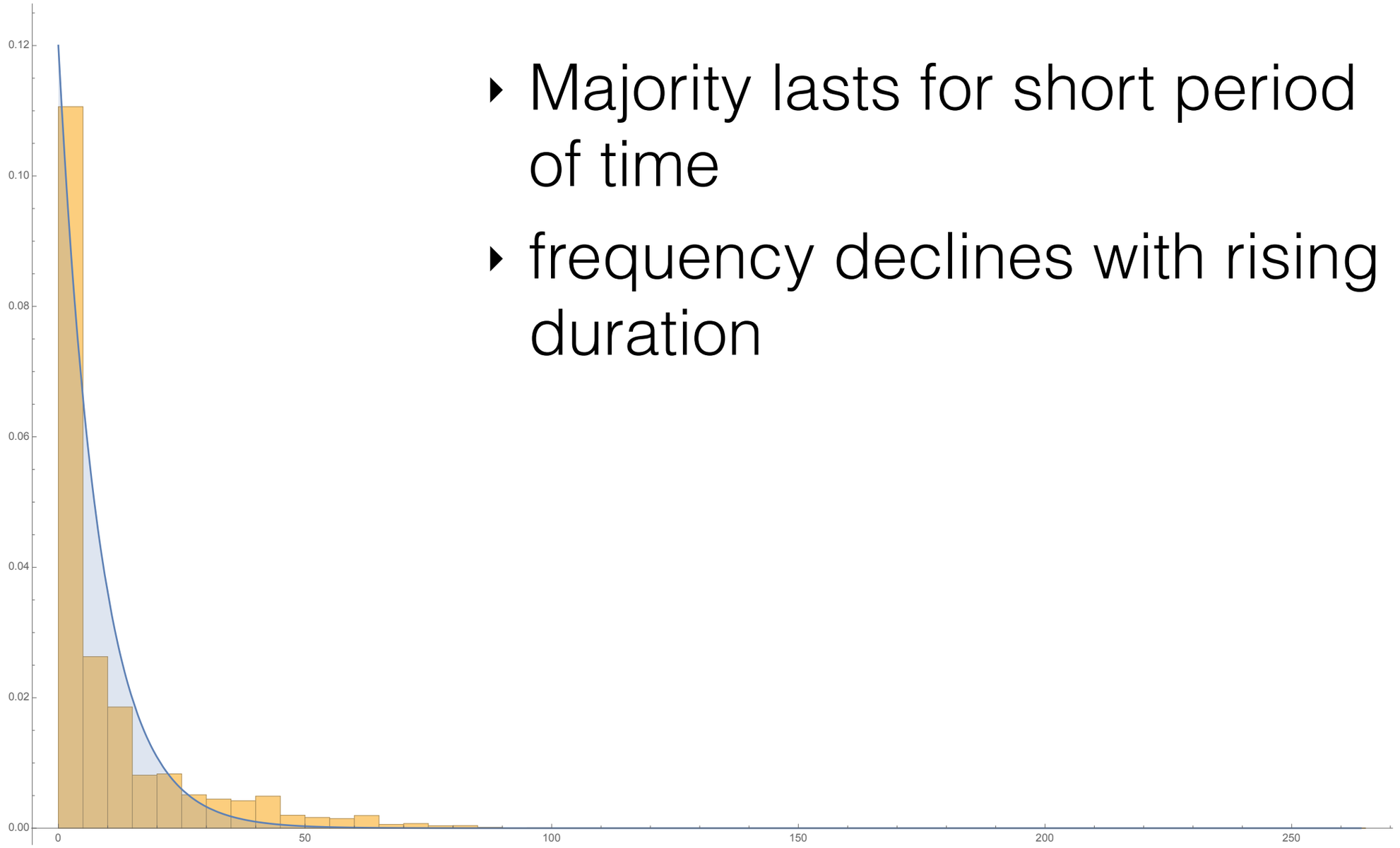


(b) Distribution of real GDP growth-rate

Figure 17: GDP growth-rate distribution (blue) compared to the Gaussian fit (red) [SF2]

Recession duration exponentially distributed

Stylized Fact 3: Ausloos et al. (2004); Wright (2005)



- Majority lasts for short period of time
- frequency declines with rising duration

Figure 18: Recession duration is exponentially distributed [SF3]

Bins represent the data form the model, blue is the exponential fit of the data.

Relative volatility of GDP/consumption/investment

Stylized Fact 4: Stock and Watson (1999); Napoletano (2006)

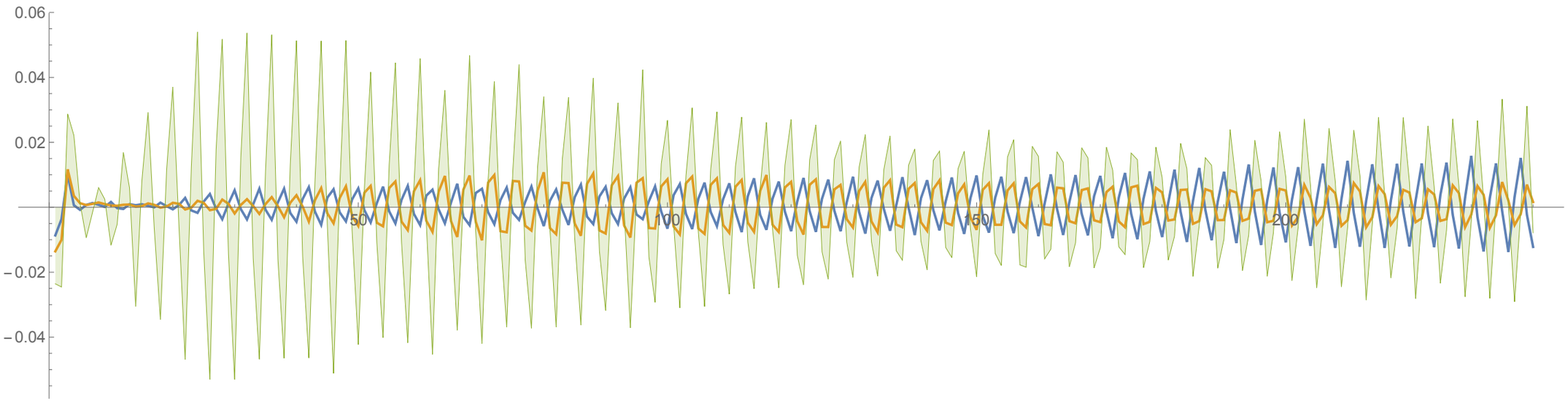


Figure 19: Bandpass filtered time series of GDP/consumption/investments to show their relative volatility [SF4]
Volatility of GDP (blue); of consumption (orange); of investments (green)

- de-trend TS using bandpass filter
- fluctuations of cons. slightly smaller than GDP
- investment is much more volatile

Pro-cyclical aggregate firm investment

Stylized Fact 5: Wälde and Woitek (2004)

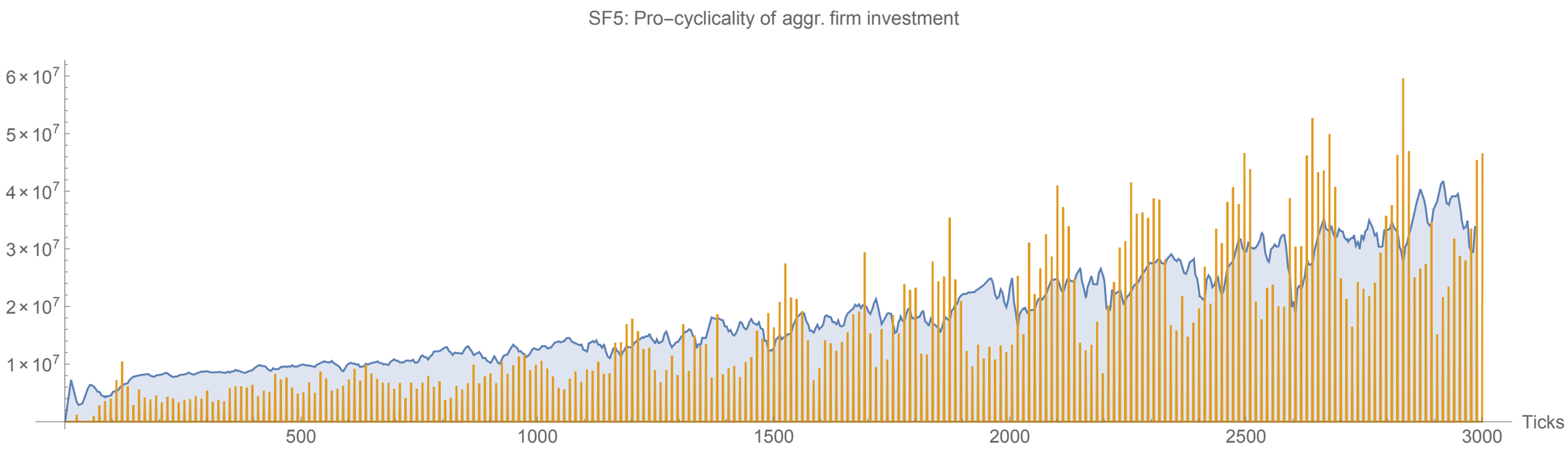
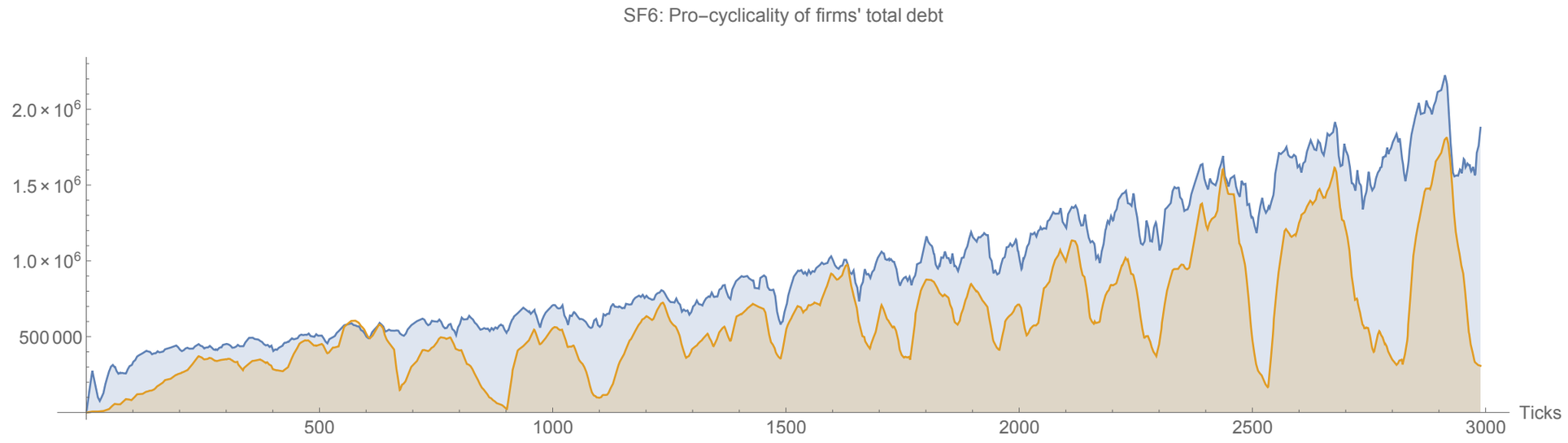


Figure 20: Pro-cyclicality of aggregate firm investment [SF5]
GPD (blue); Aggregate firm investment (orange)

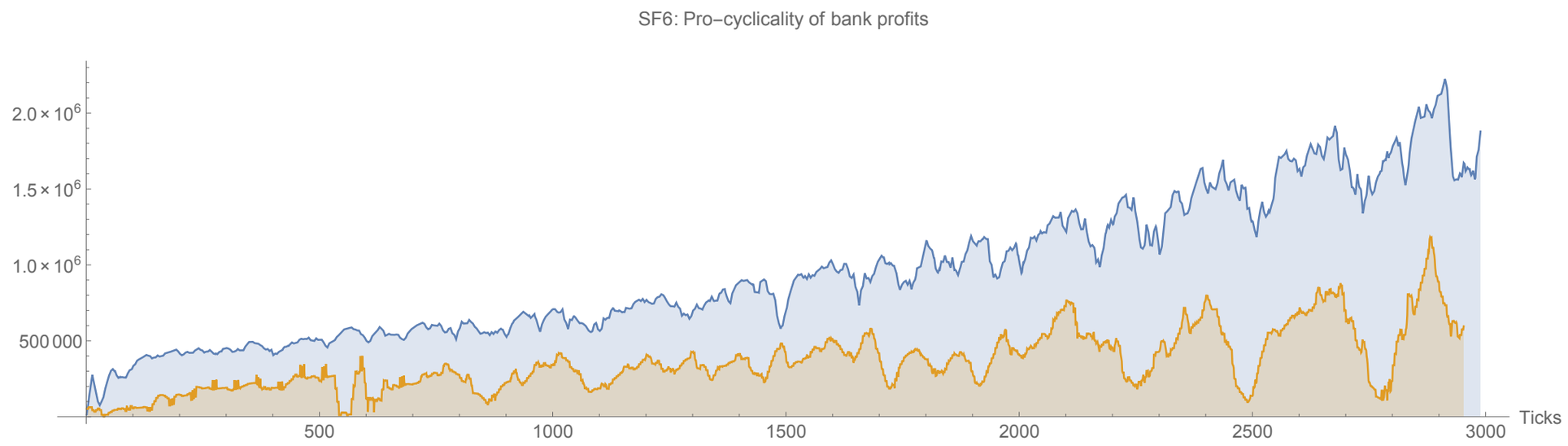
- aggr. investment tends to co-move with BC

Pro-cyclicality of bank profits/firm debt

Stylized Fact 6: Lown and Morgan (2006)



(a) Pro-cyclicality of firms' total debt



(b) Pro-cyclicality of bank profits

Figure 21: Pro-cyclical lending activity [SF6]

Ordinate scale relates to GDP (blue); whereas credit related variables (orange) are scaled appropriately to emphasize their pro-cyclicality.

Counter-cyclical credit defaults / firm indebtedness

Stylized Fact 7/8: Lown/Morgan (2006); Foos et al. (2010); Mendoza/Terrones (2012)

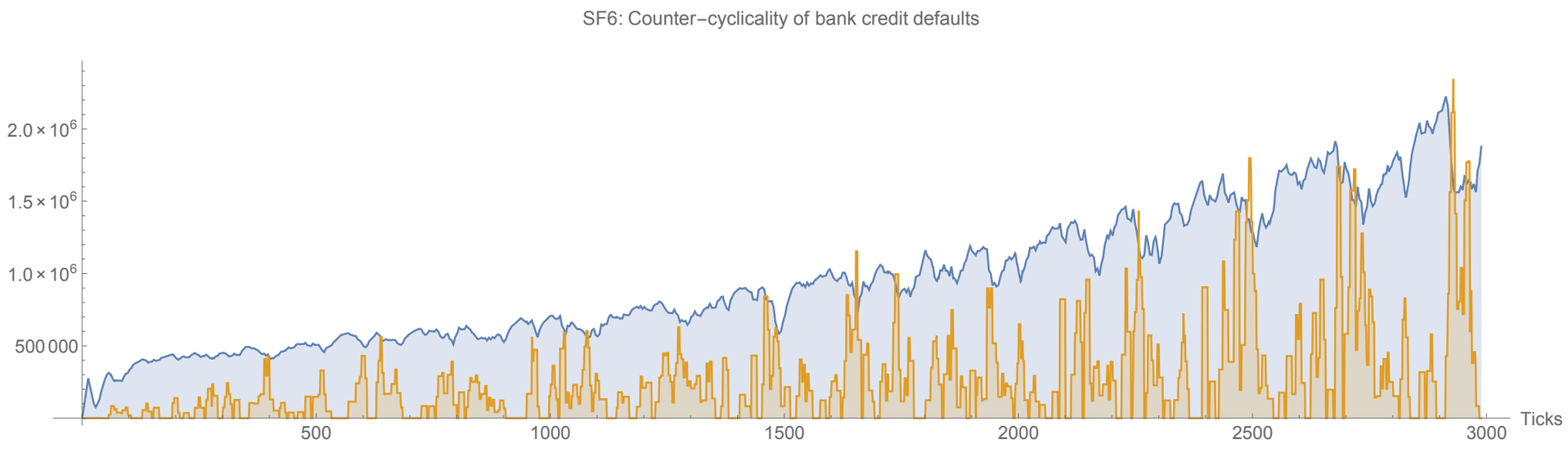
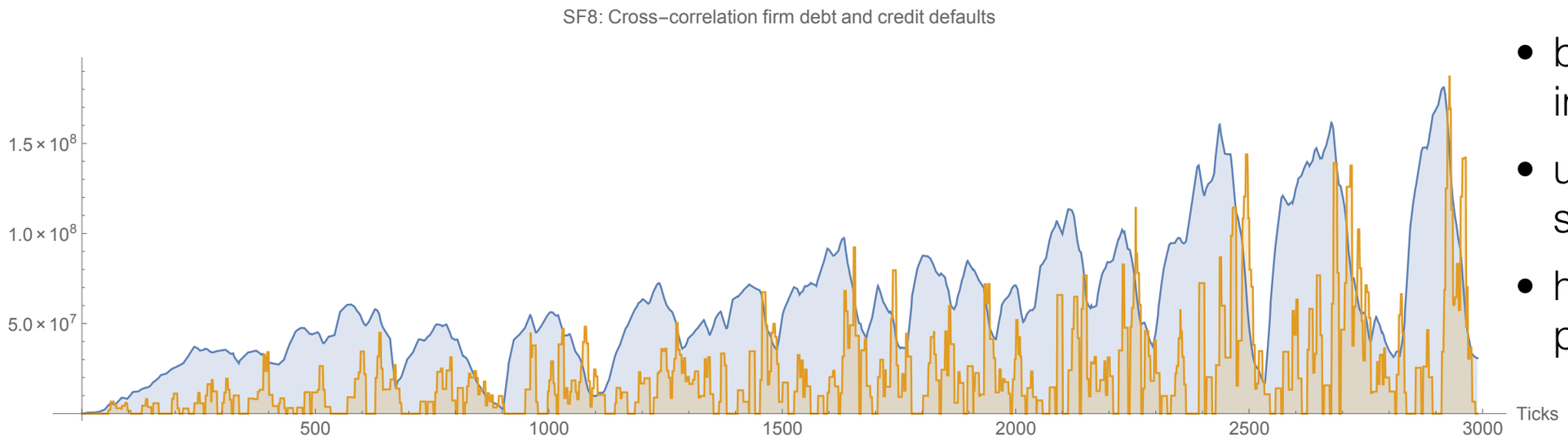


Figure 22: Counter-cyclical credit defaults [SF7]

GDP (blue); credit defaults are measured by loan losses of banks (orange).



- build-up of fin. imbalances
- unsust. level of private sector debt
- harmful deleveraging process

Figure 23: Lagged correlation of firm indebtedness and credit defaults [SF8]

Indebtedness of firm sector (blue); bad debt is measured by loan losses of banks (orange).

Right skewed distr. of banking crises duration

Stylized Fact 9: Reinhart and Rogoff (2009)

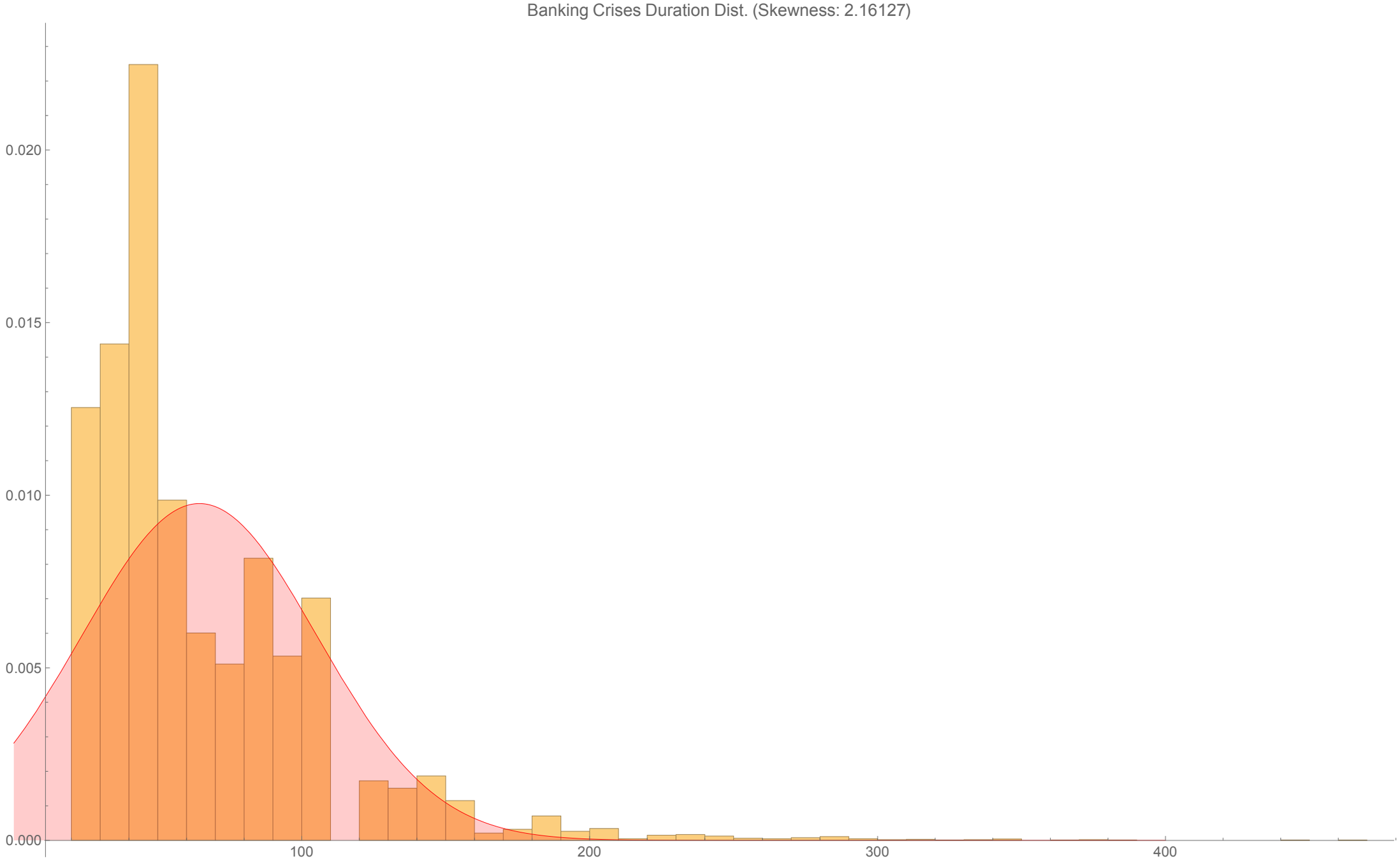


Figure 24: Banking crises duration is right-skewed compared to Gaussian data fit [SF9]

Distr. of fiscal costs of banking crises-to-GDP ratio is fat-tailed

Stylized Fact 10: Laeven and Valencia (2013)

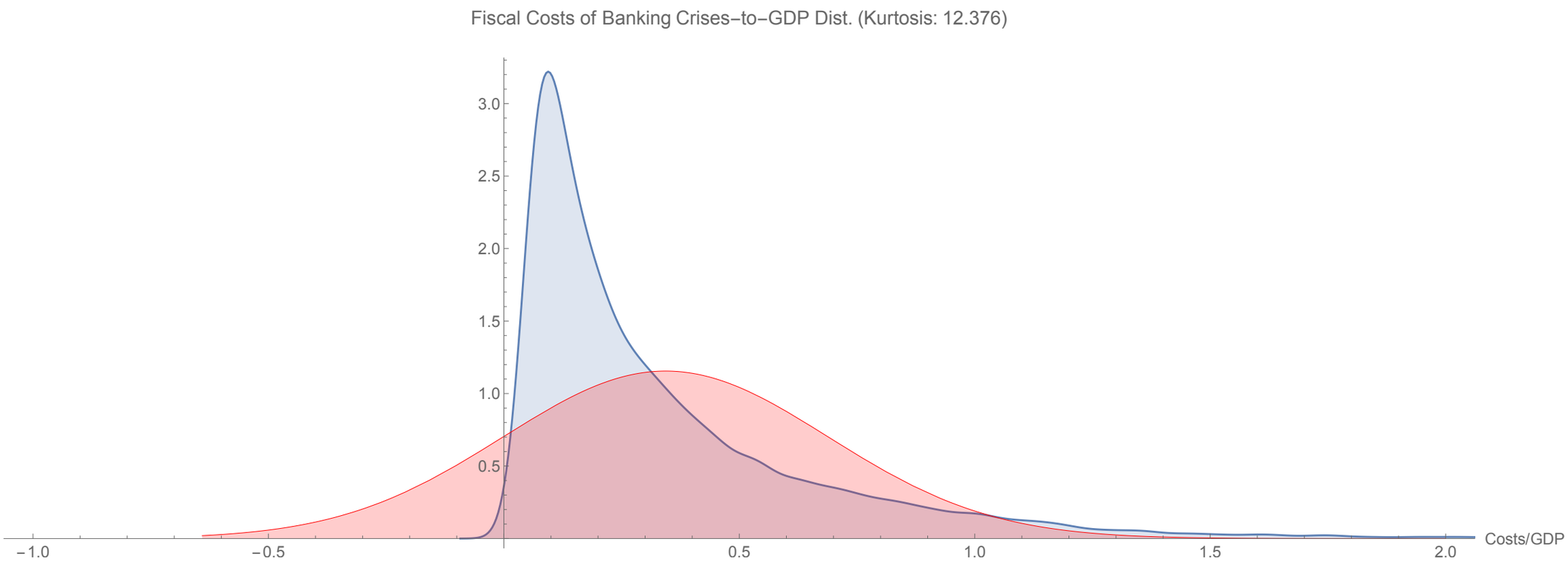


Figure 25: Fat-tailed distribution of fiscal costs of banking crises-to-GDP ratio [SF10]

- most crises have moderate costs as fraction of GDP
- some deep crises are extremely costly

The Model - Reserve Averaging Scheme

Money Market Rate and Banks' Demand for Reserves

$$i_{b,t}^{MM}\left(i_t^*, \Gamma_t, \xi_{b,t}\right) =$$

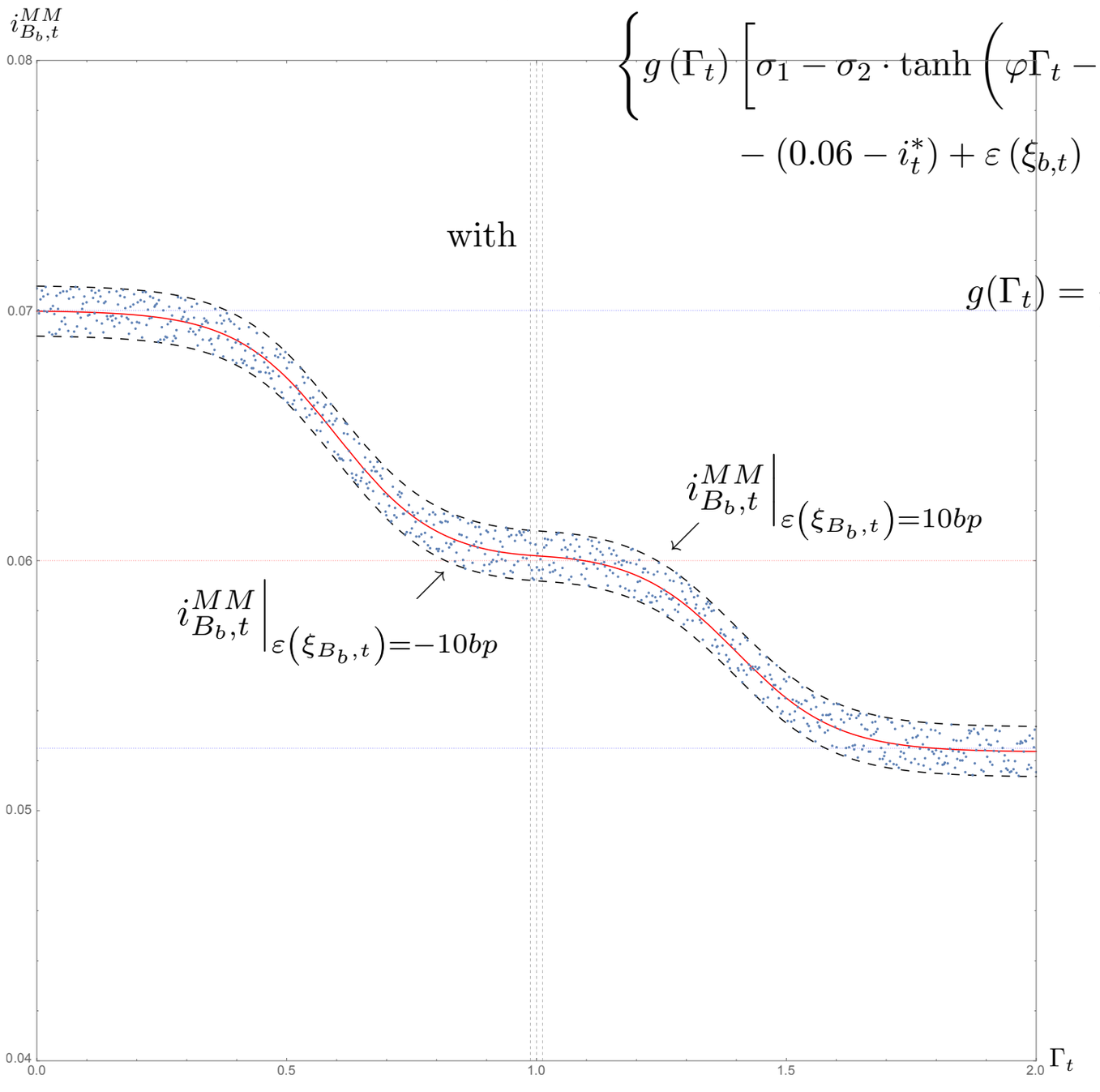
$$\left\{ g\left(\Gamma_t\right)\left[\sigma_1 - \sigma_2 \cdot \tanh\left(\varphi\Gamma_t - \frac{3}{2}\varphi\right)\right] + \left(1 - g\left(\Gamma_t\right)\right)\left[\sigma_3 - \sigma_4 \cdot \tanh\left(\varphi\Gamma_t - \frac{\varphi}{2}\right)\right] \right\}$$

$$- \left(0.06 - i_t^*\right) + \varepsilon\left(\xi_{b,t}\right) \tag{17}$$

with

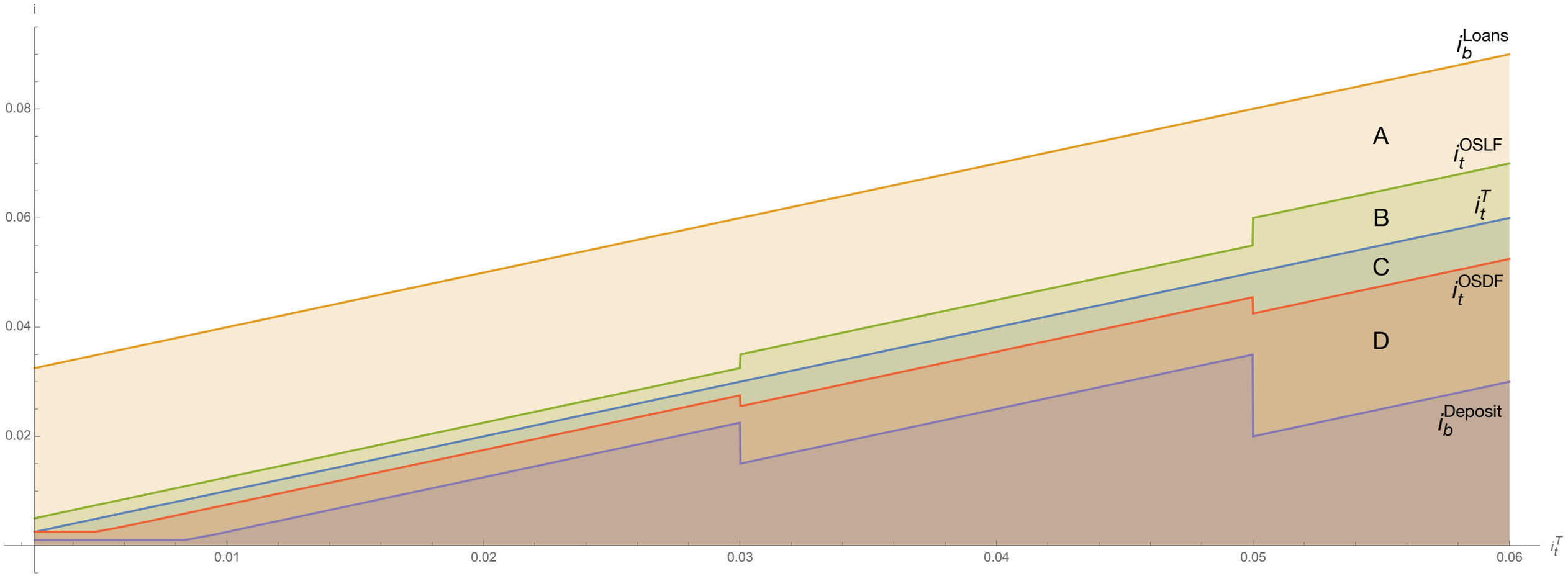
$$g(\Gamma_t) = \frac{1}{2} + \frac{1}{2}\tanh\left(\frac{\Gamma_t - 1}{0.1}\right) \tag{18}$$

$$\Gamma_t = \frac{\sum_{b=1}^{B} \overline{R_{b,t}}}{\sum_{b=1}^{B} R_{b,t}^*} = \frac{\overline{R_t}}{R_t^*}$$



(b) System within the model

Banks' Interest Scheme



Regulatory Capital

Title Text

From NPR Addendum1: Components and Tiers	
(1) Common Equity Tier 1 Capital	
+ Qualifying common stock instruments	**Common Equity Tier 1**
+ Retained earnings	
+/- Accumlated other comprehensive income	
+ Qualifying Common Equity Tier 1 minority interest	
- Regulatory deductions from Common Equity Tier 1 Capital	
+/- Regulatory adjustments to Common Equity Tier 1 Capital	
- Common Equity Tier 1 Capital deductions per the corresponding deduction approach	
- Threshold deductions	
= Common Equity Tier 1 Capital	
(2) Additional Tier 1 Capital	
+ Additional Tier 1 Capital instruments	**Additional Tier 1**
+ Tier 1 minority interest that is not included in Common Equity Tier 1 Capital	
+ Non-qualifying Tier 1 Capital instruments subject to the transition phase-out and SBLF related instruments	
- Investments in a banking organization's own additional Tier 1 Capital instruments	
- Additional Tier 1 Capital deductions per the corresponding deduction approach	
= Additional Tier 1 Capital	
(3) Tier 2 Capital	
+ Tier 2 Capital instruments	**Tier 2**
+Total Capital minority interest that is not included in Tier 1 Capital	
+ ALLL	
- Investments in a banking organization's own Tier 2 Capital instruments	
- Tier 2 Capital deductions per the corresponding deduction approach	
+ Non-qualifying Tier 2 Capital instruments subject to transition phase-out and SBLF related instruments	
= Tier 2 Capital	
Total Capital = Common Equity Tier 1 + Additional Tier 1 + Tier 2	

Capital Conservation Buffer (CConB)

What happens when Bank's capital falls below requirement?

Indiv. bank min. capital conservation standards of Basel III

CET1 Ratio	Minimum Capital Conservation Ratios	Unconstrained % of earnings for distribution
4.5% - 5.125%	100 %	0 %
5.125% - 5.750%	80 %	20 %
5.750% - 6.375%	60 %	40 %
6.375% - 7.0%	40 %	60 %
> 7.0%	0 %	100 %

Basel III Components

Capital Requirements - SIB Surcharges

G-SIBs as of November 2013[5] allocated to buckets corresponding to required level of additional loss absorbency

Bucket[6]	G-SIBs in alphabetical order within each bucket
5 **(3.5%)**	(Empty)
4 **(2.5%)**	HSBC JP Morgan Chase
3 **(2.0%)**	Barclays BNP Paribas Citigroup Deutsche Bank
2 **(1.5%)**	Bank of America Credit Suisse Goldman Sachs Group Crédit Agricole Mitsubishi UFJ FG Morgan Stanley Royal Bank of Scotland UBS
1 **(1.0%)**	Bank of China Bank of New York Mellon BBVA Groupe BPCE Industrial and Commercial Bank of China Limited ING Bank Mizuho FG Nordea Santander Société Générale Standard Chartered State Street Sumitomo Mitsui FG Unicredit Group Wells Fargo

- add. loss absorbency requirement
- indicator based:
  - size
  - interconnectedness
  - substitutability
  - cross-jurisdictional activity
  - complexity