Learning from History: Volatility and Financial Crises

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London Quant Group — LQG
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"Learning from History: Volatility and Financial Crises"

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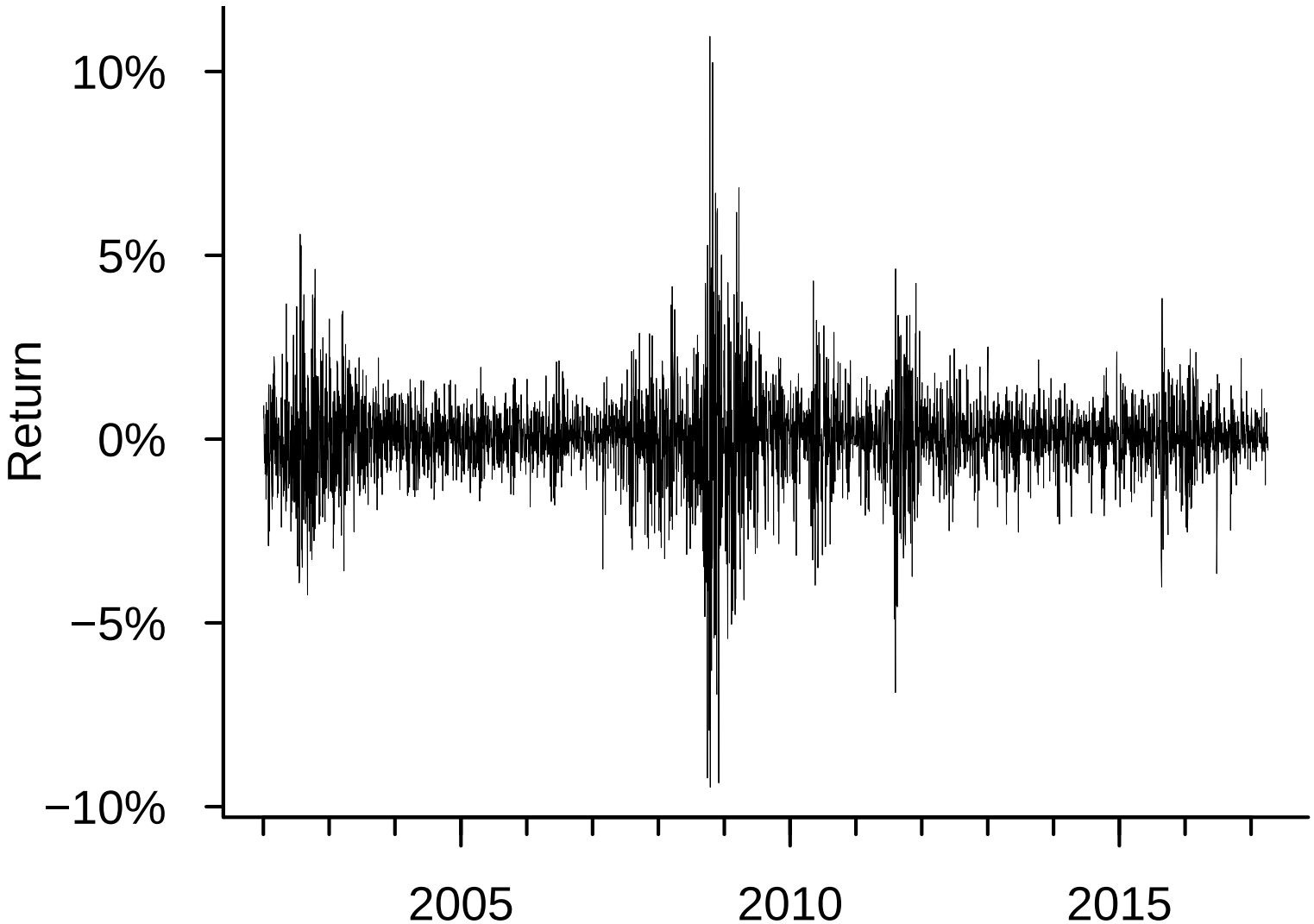
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2872651

"Volatility in markets is at low levels, both actual and expected, ... to the extent that low levels of volatility may induce risk-taking behavior ... is a concern to me and to the Committee."

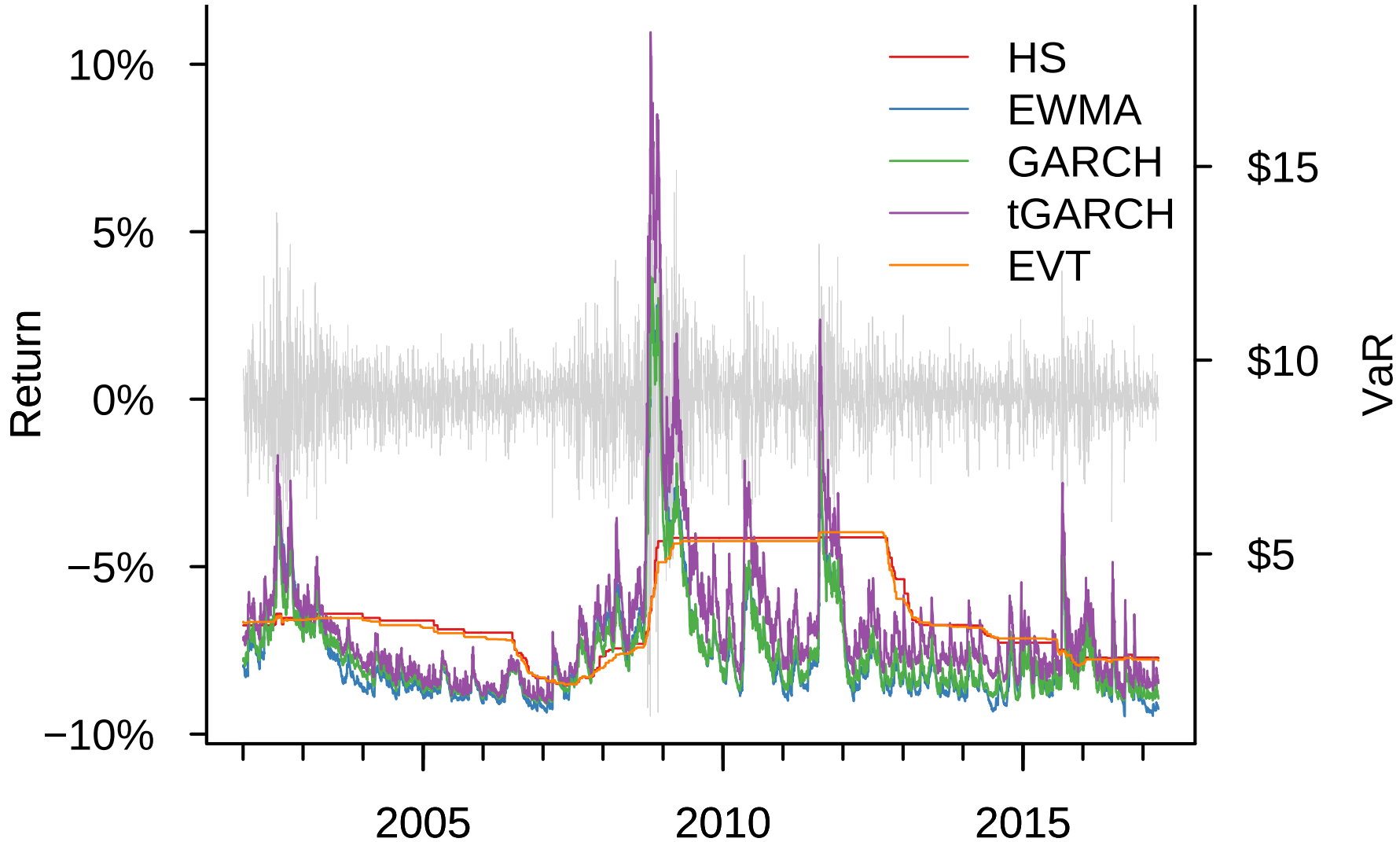
Federal Reserve Chair Janet Yellen, 2014.

S&P–500



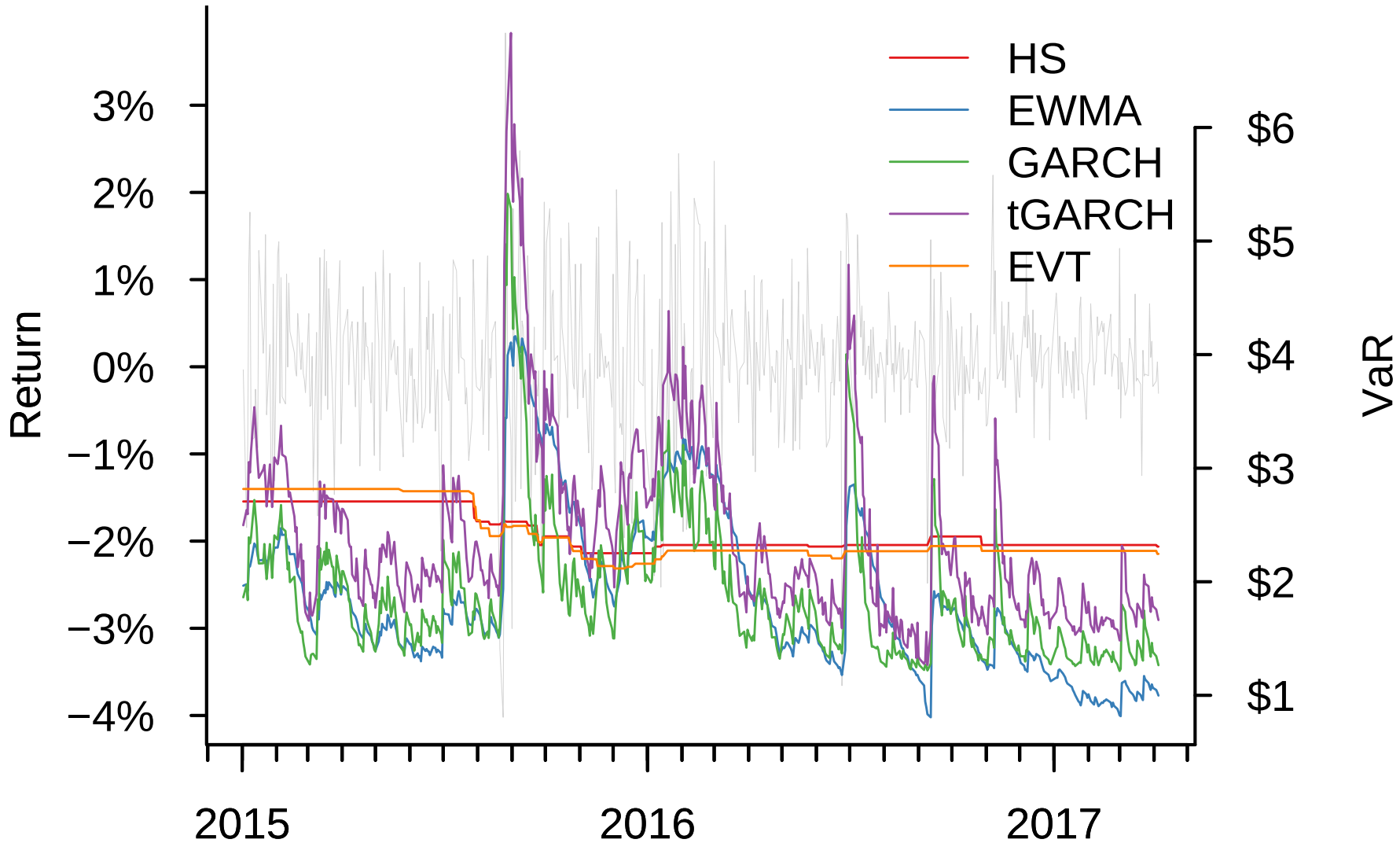
S&P–500

from www.modelsandrisk.org



S&P–500 Zoom

from www.modelsandrisk.org



The volatility — crisis cycle

volatility
low

The volatility — crisis cycle

volatility
low

Appetite
for risk ↑

The volatility — crisis cycle

volatility low

Credit ↑

Appetite for risk ↑

The volatility — crisis cycle

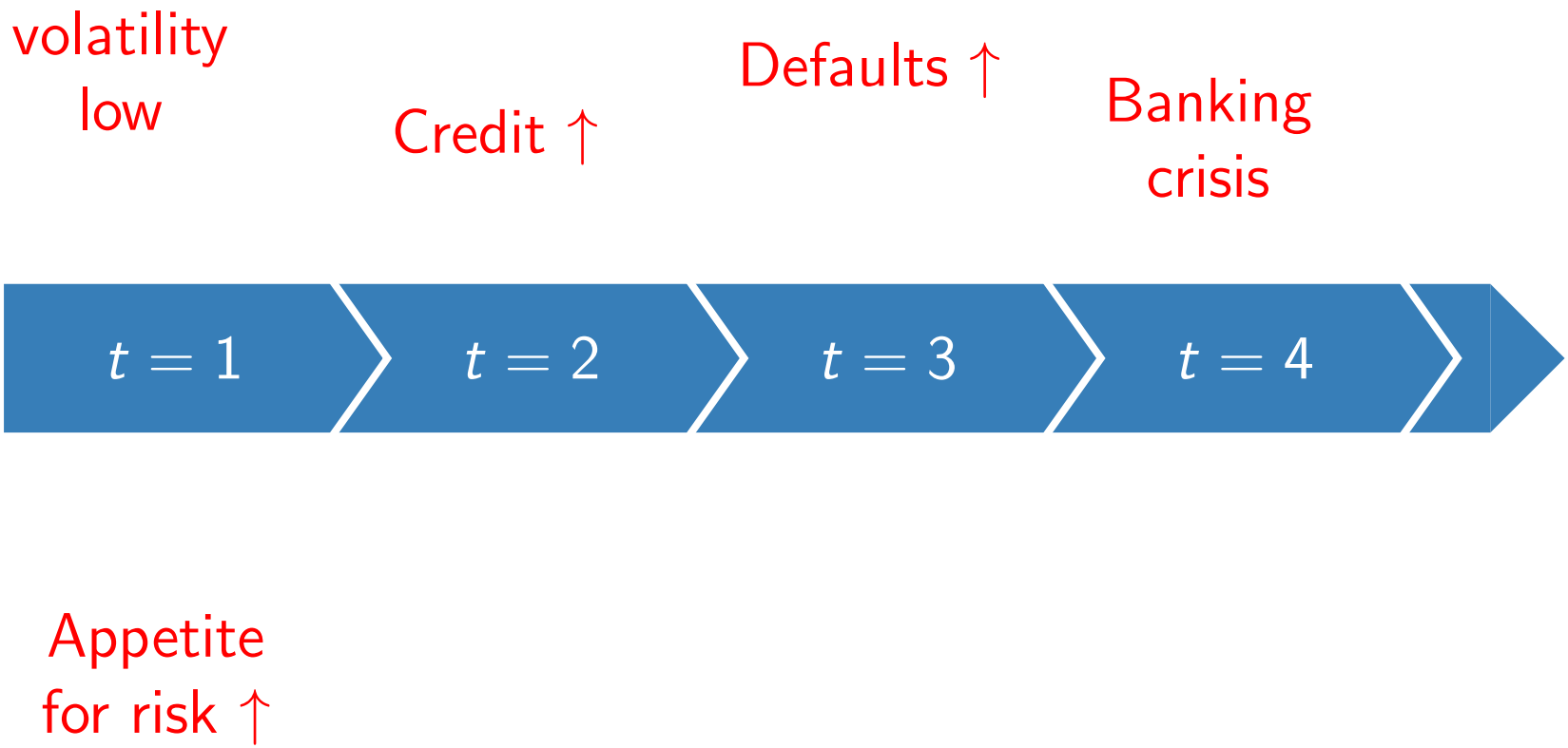
volatility low

Credit ↑

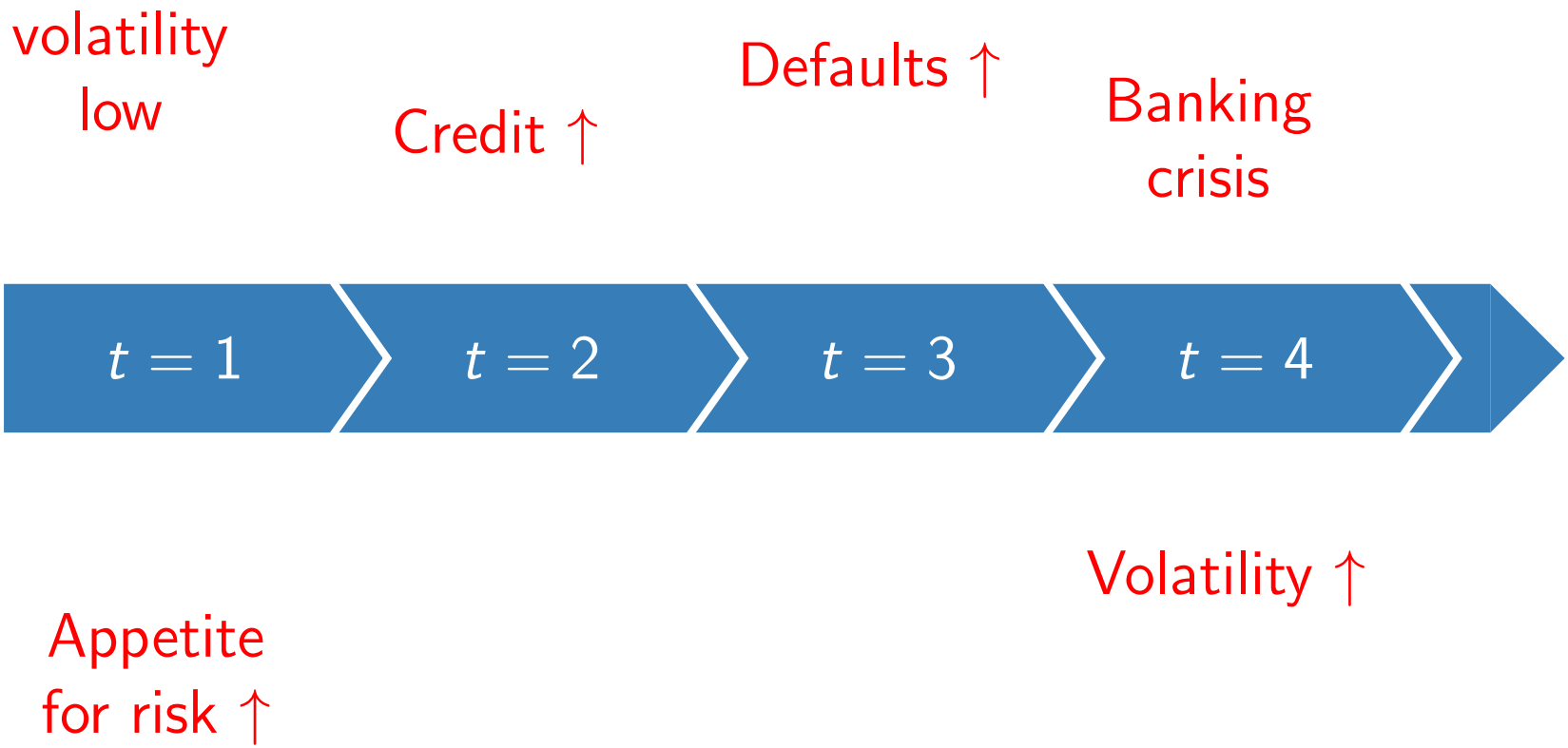
Defaults ↑

Appetite for risk ↑

The volatility — crisis cycle



The volatility — crisis cycle



What drives risk?

- 2008 happened because of decisions made years earlier
- In 2003 all the signs pointed to risk being low
- The authorities and the private sector thought we were safe
- And so it was perfectly OK to take extra risk
- But
- "*Stability is destabilizing*" (Minsky)

Risk is endogenous

Danielsson–Shin (2002)

- Risk is *exogenous* or *endogenous*

  exogenous Shocks to the financial system arrive from outside the system, like with an asteroid

  endogenous Financial risk is created by the interaction of market participants

"The received wisdom is that risk increases in recessions and falls in booms. In contrast, it may be more helpful to think of risk as increasing during upswings, as financial imbalances build up, and materialising in recessions."
Andrew Crockett, then head of the BIS, 2000

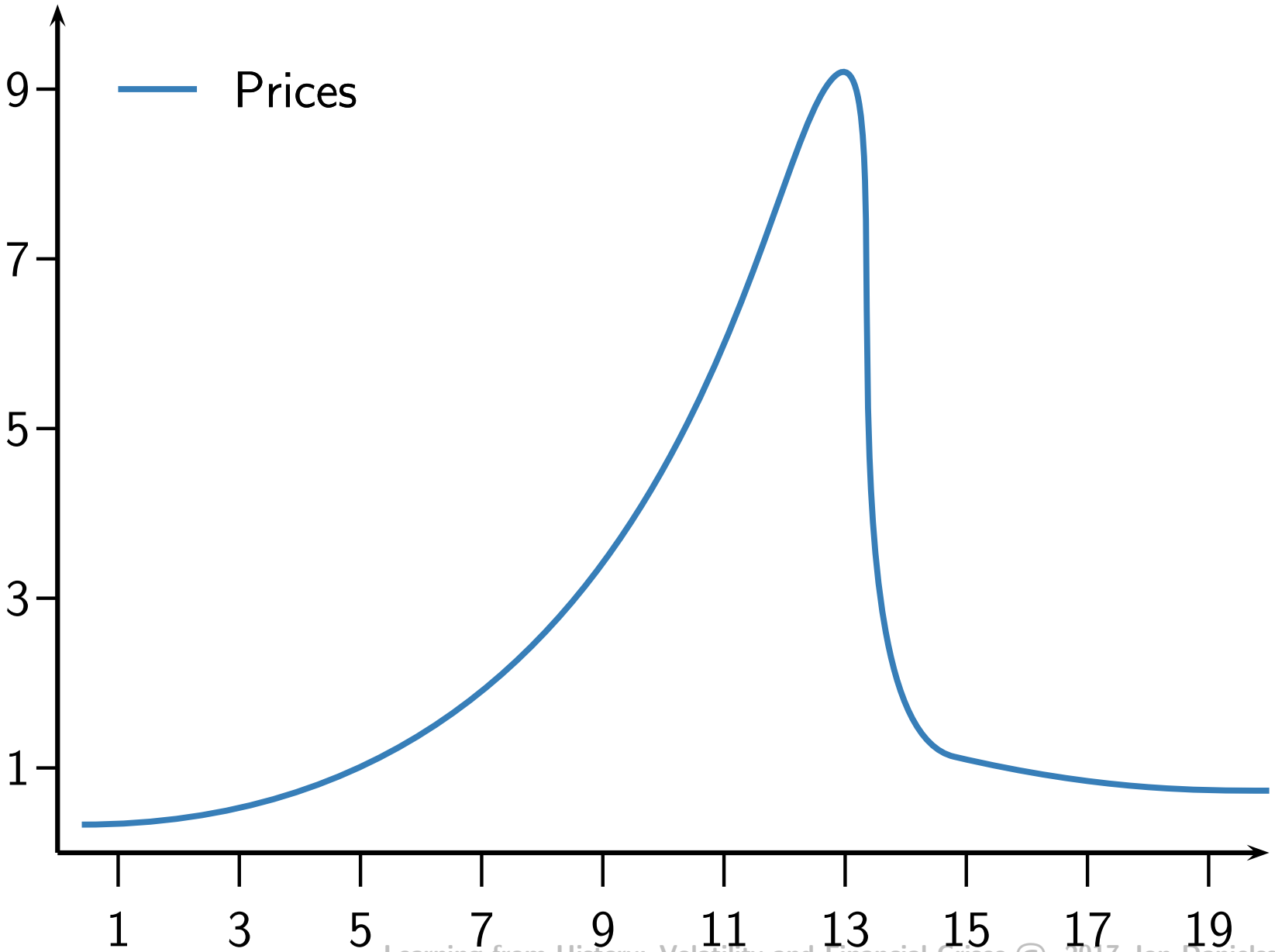
- Market participants are guided by a myriad of models and rules, many dictate myopia
- Prices don't follow random walks in adverse states of nature
- Because that is when the constraints bind
- Endogenous risk is created by the interaction of human beings
- All with their own objectives, abilities, resources, biases
- *All large market outcomes are endogenous*

Risk models underestimate risk during calm times and overestimate risk during crisis — they get it wrong in all states of the world

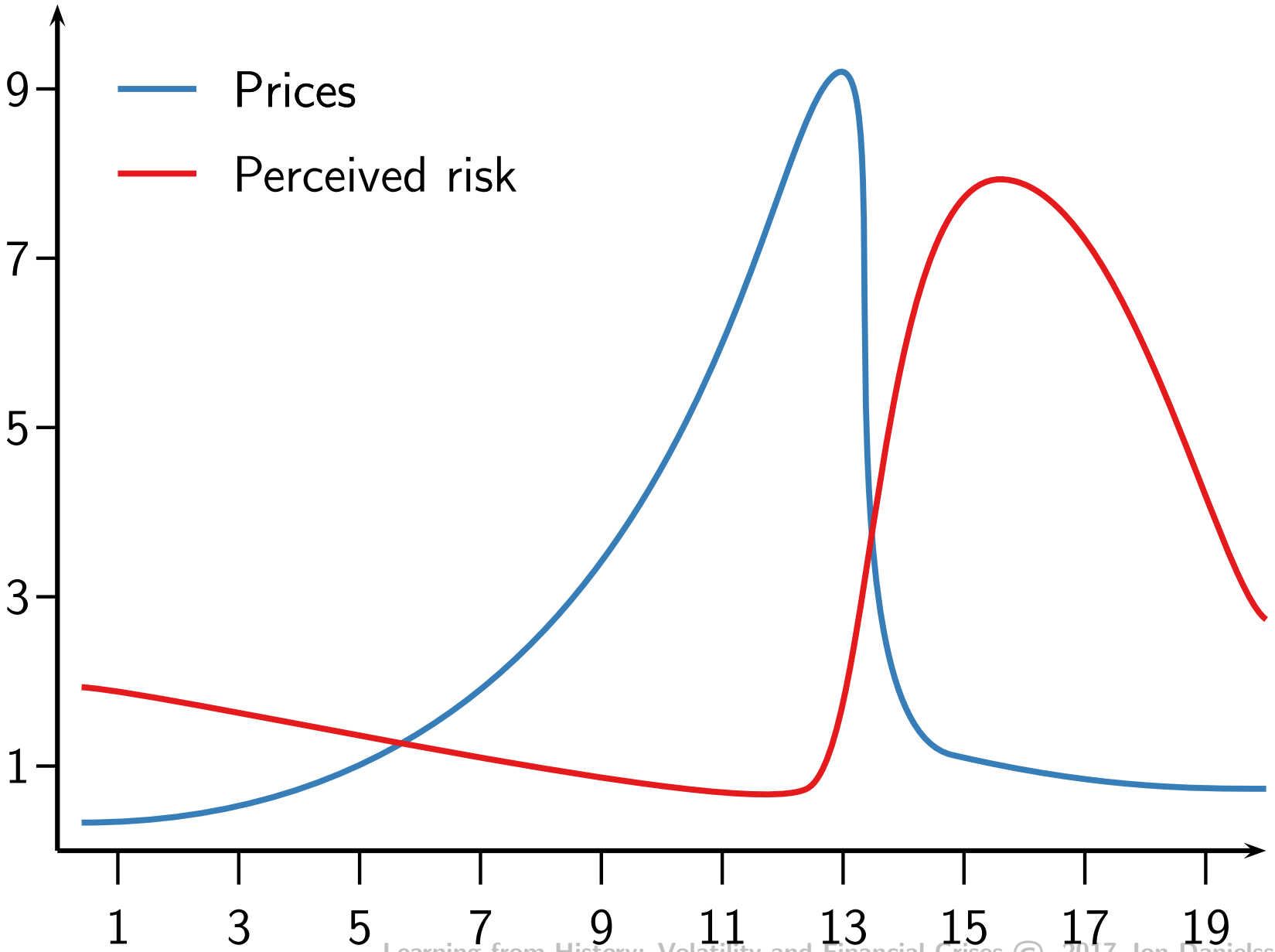
Two faces of risk

- When individuals observe *and* react — affecting their operating environment
- Financial system is not invariant under observation
- We cycle between virtuous and vicious feedbacks
  - *perceived risk* — as reported by risk models
  - *actual risk* — hidden but ever present

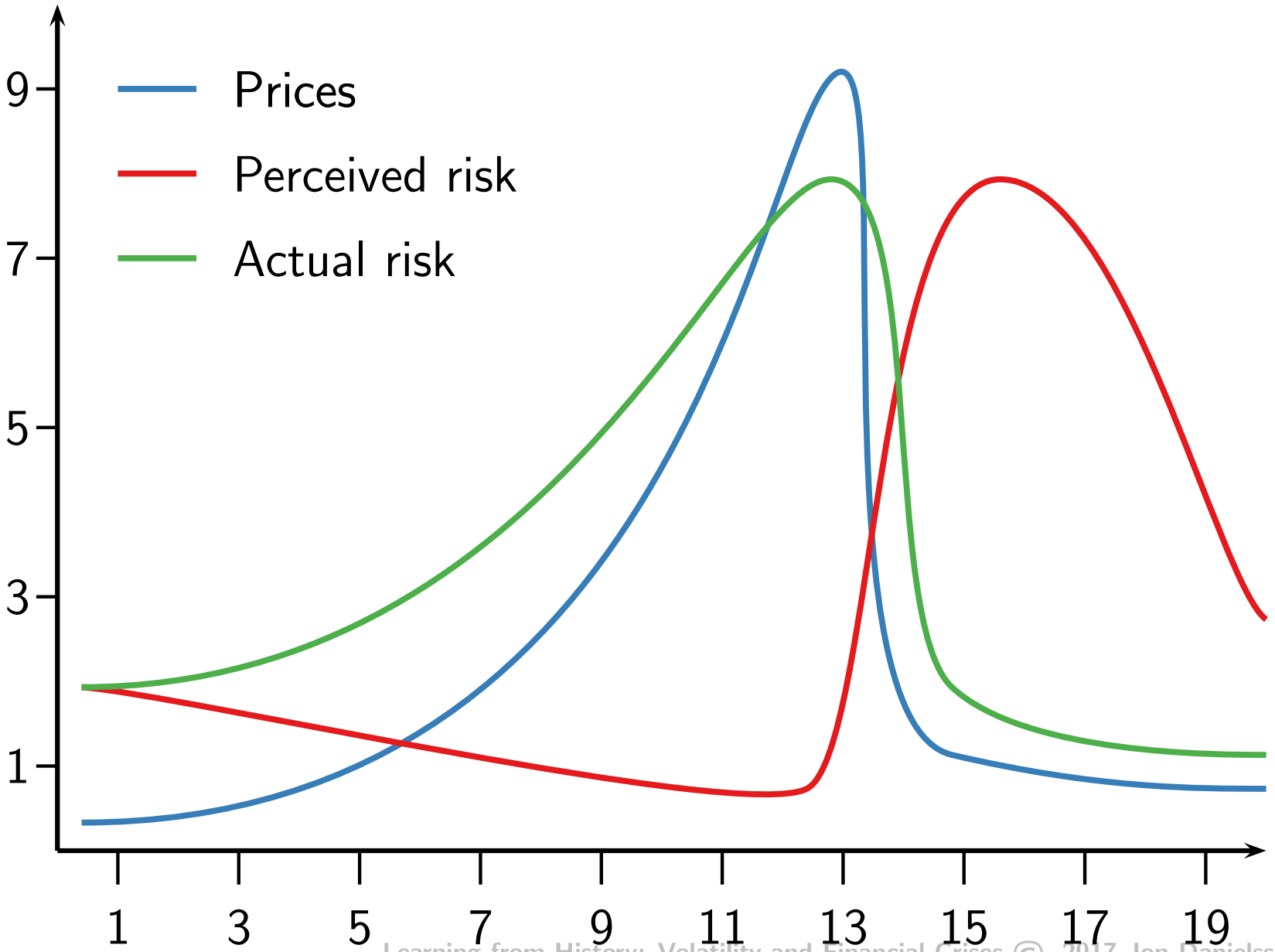
Endogenous bubble



Endogenous bubble



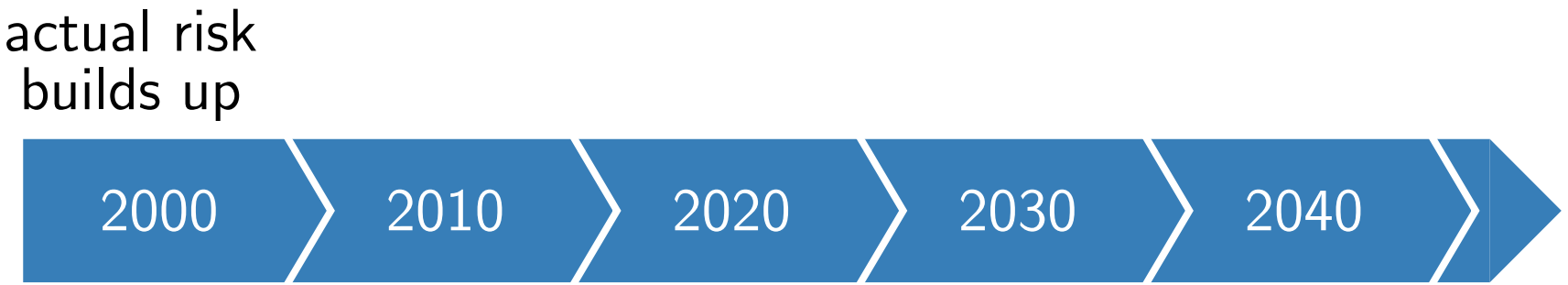
Endogenous bubble



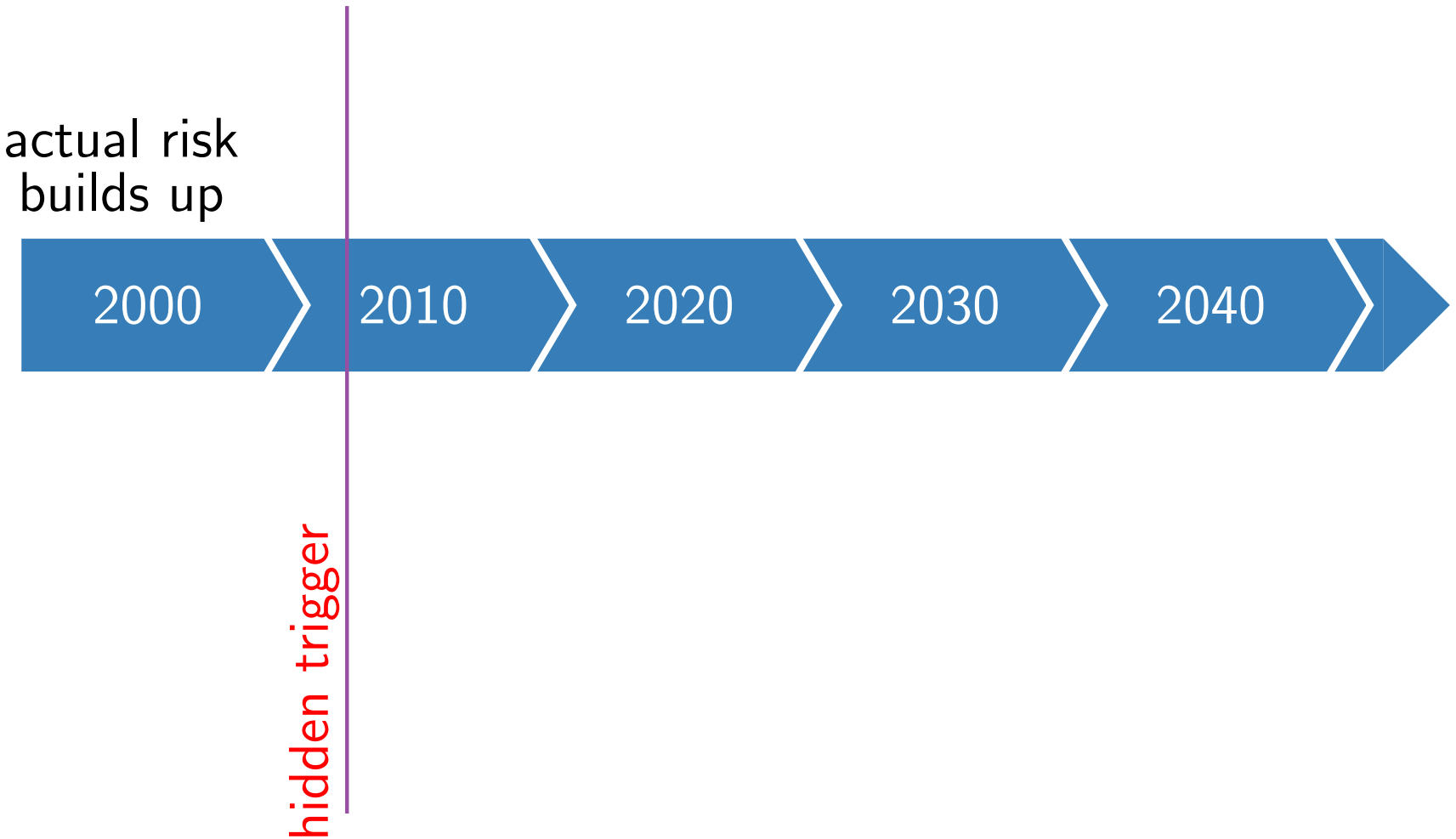
How often do systemic crises happen?

- Ask the IMF–WB systemic crises database (only OECD)
- Every 43 years (17 for UK)
- Best indication of the target probability for policymakers
- However, most indicators focus on much more frequent events
- Typically every month to every five months

The 43 year cycle of systemic risk



The 43 year cycle of systemic risk



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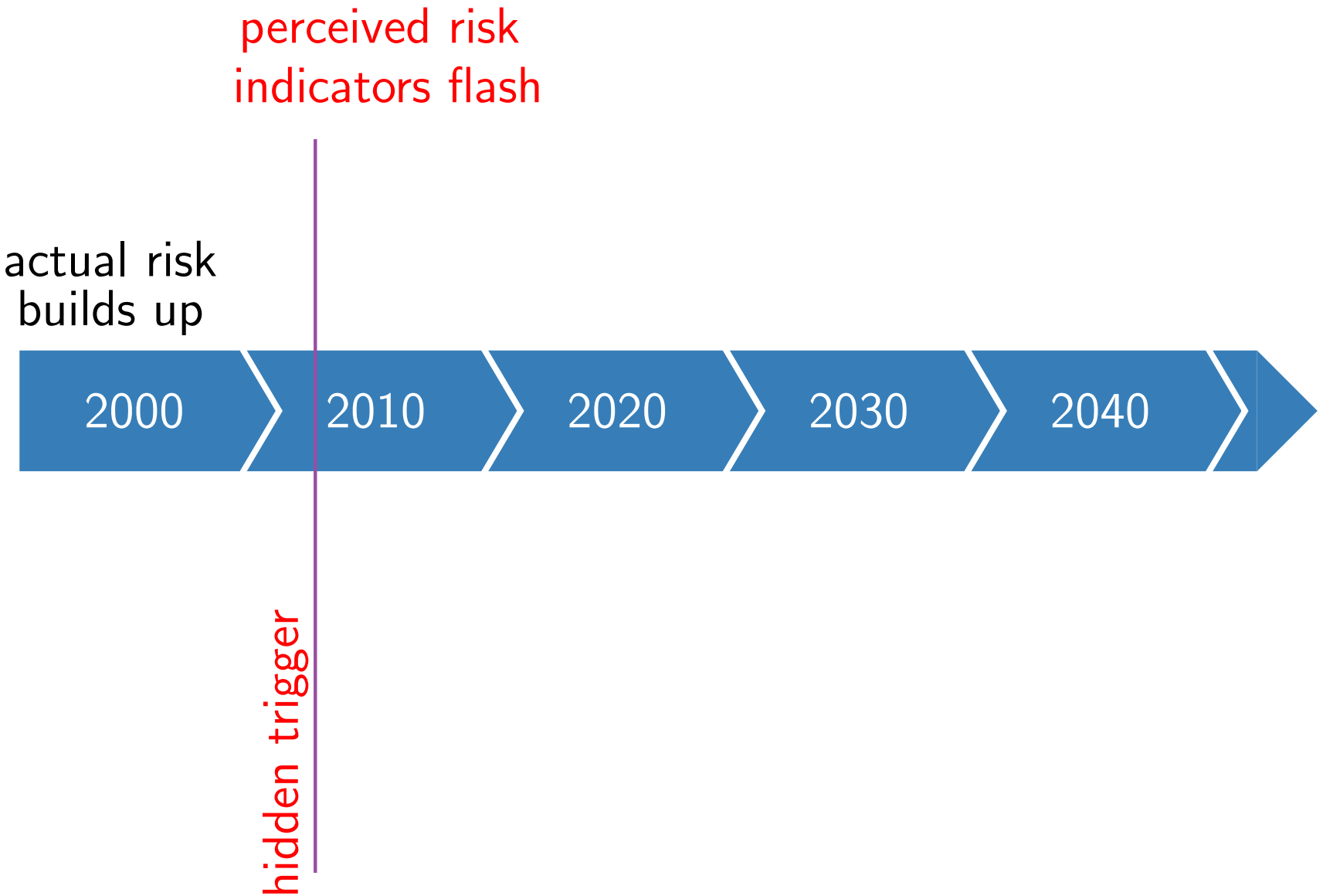

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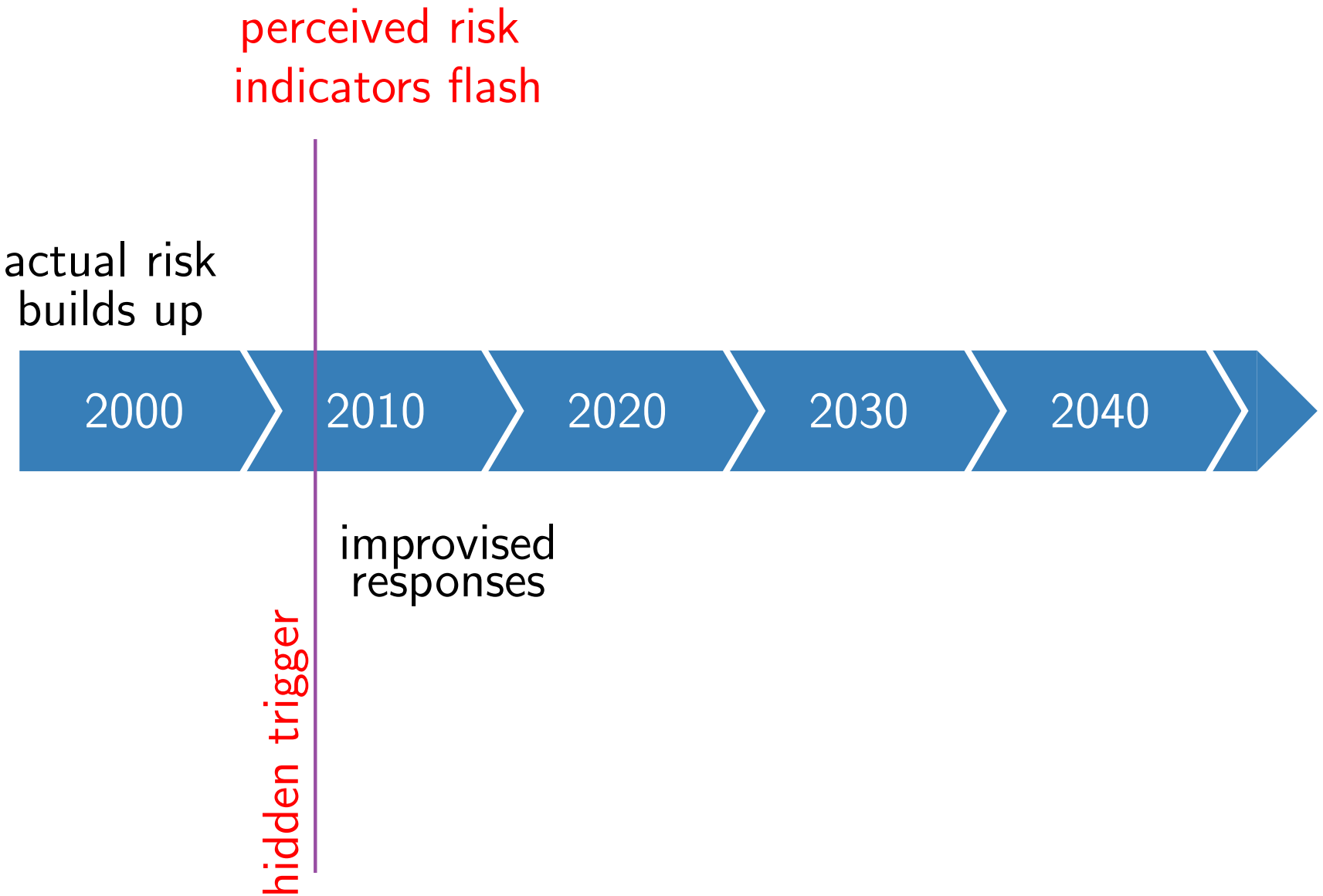

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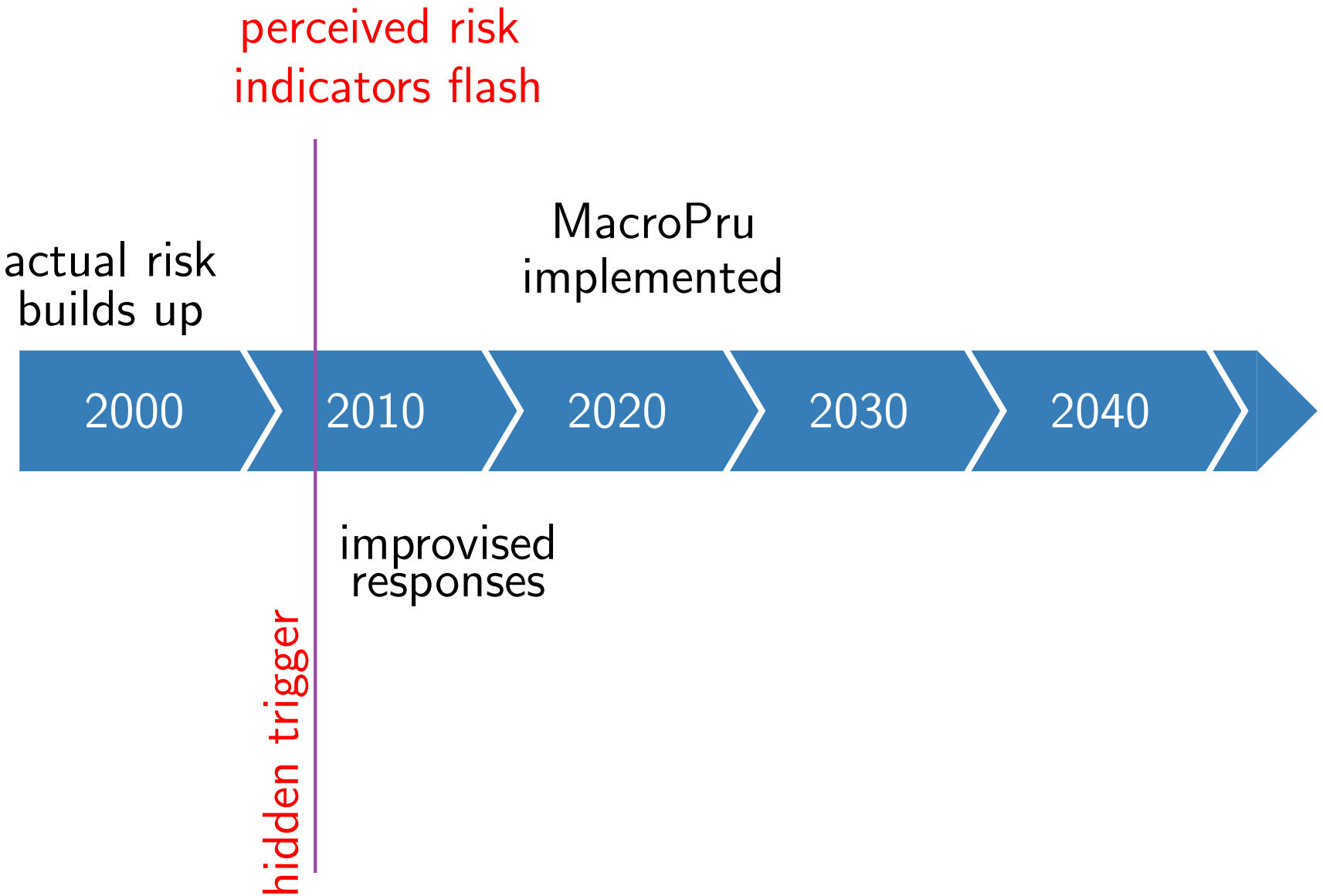

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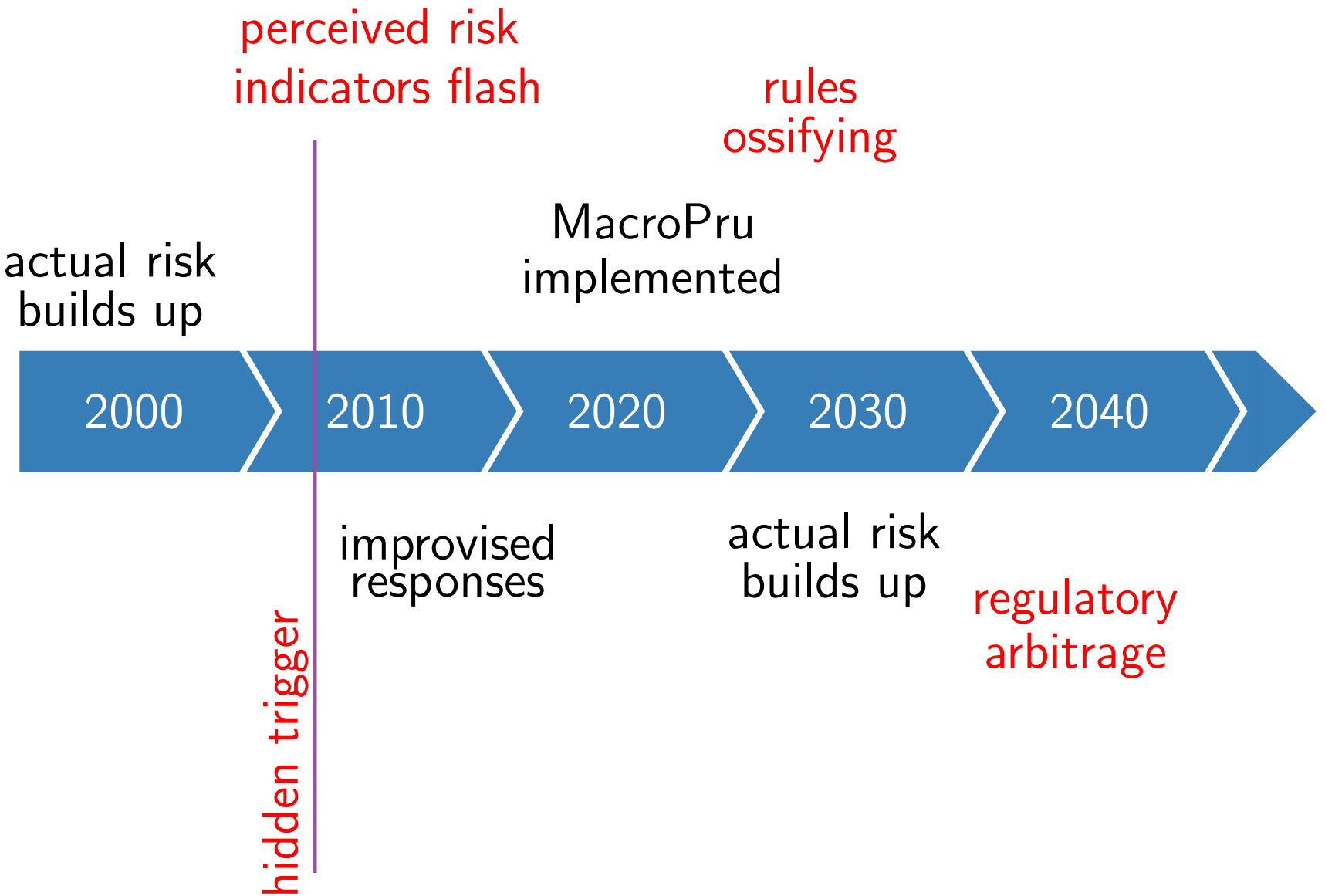

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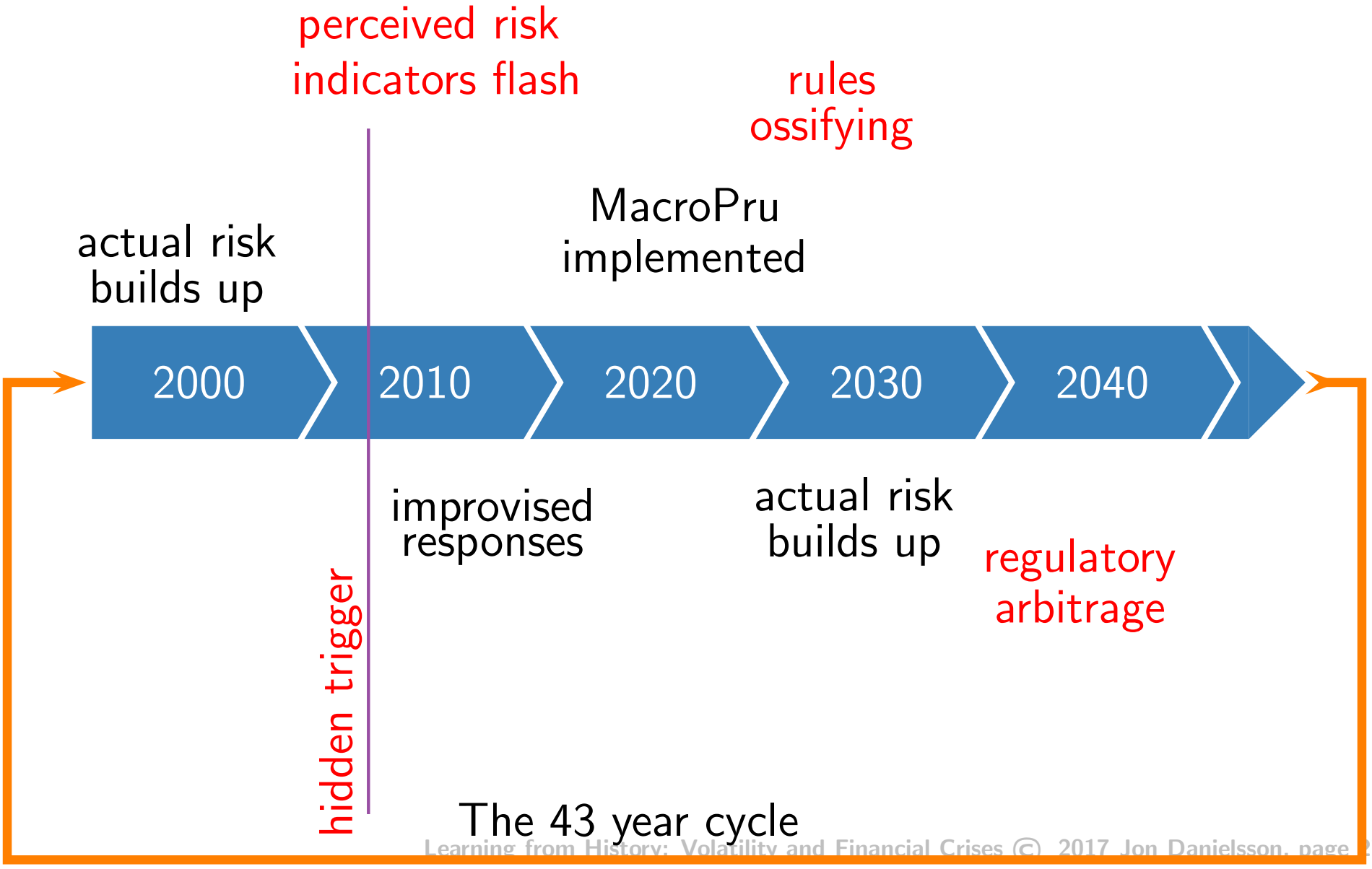

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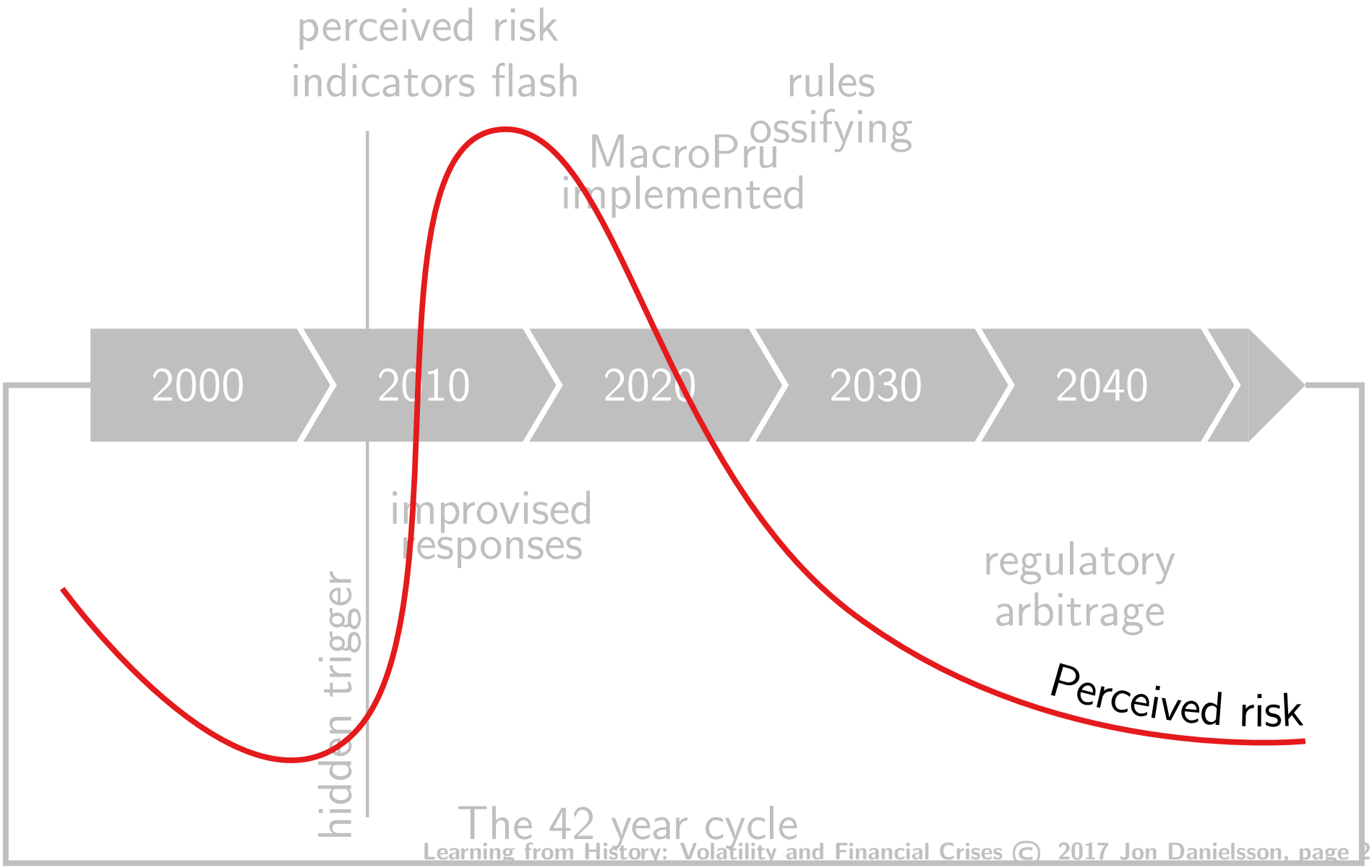

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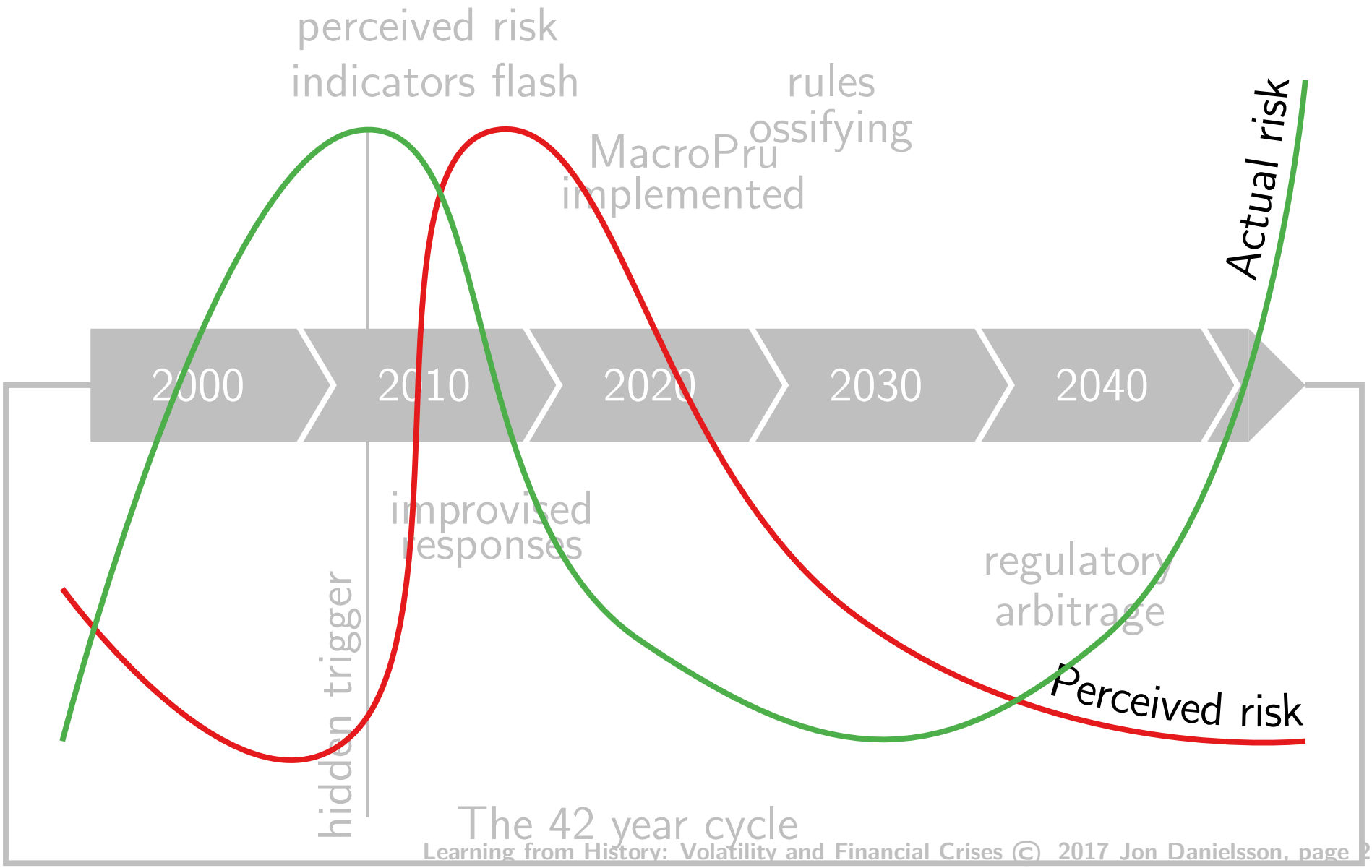
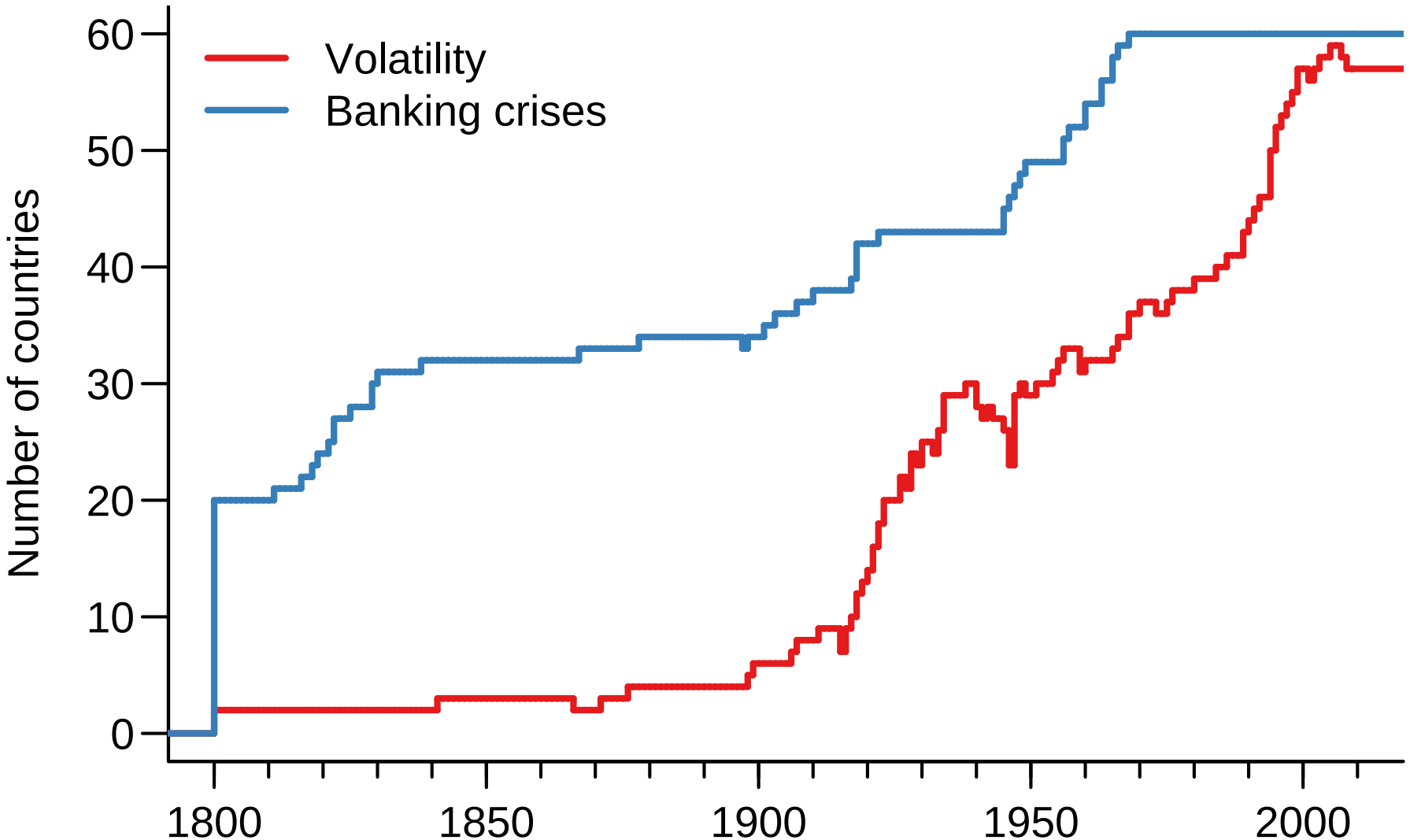


Data

- Comprehensive database on monthly returns (1800 to 2010, 60 countries)
  - Global Financial Data
  - On average 62 years of historical observations per country
- Banking crises (Reinhart and Rogoff)
  - Binary indicator of whether a *banking crisis starts* in a given year and a given country
- Risk-taking (credit-to-GDP)
- Control variables

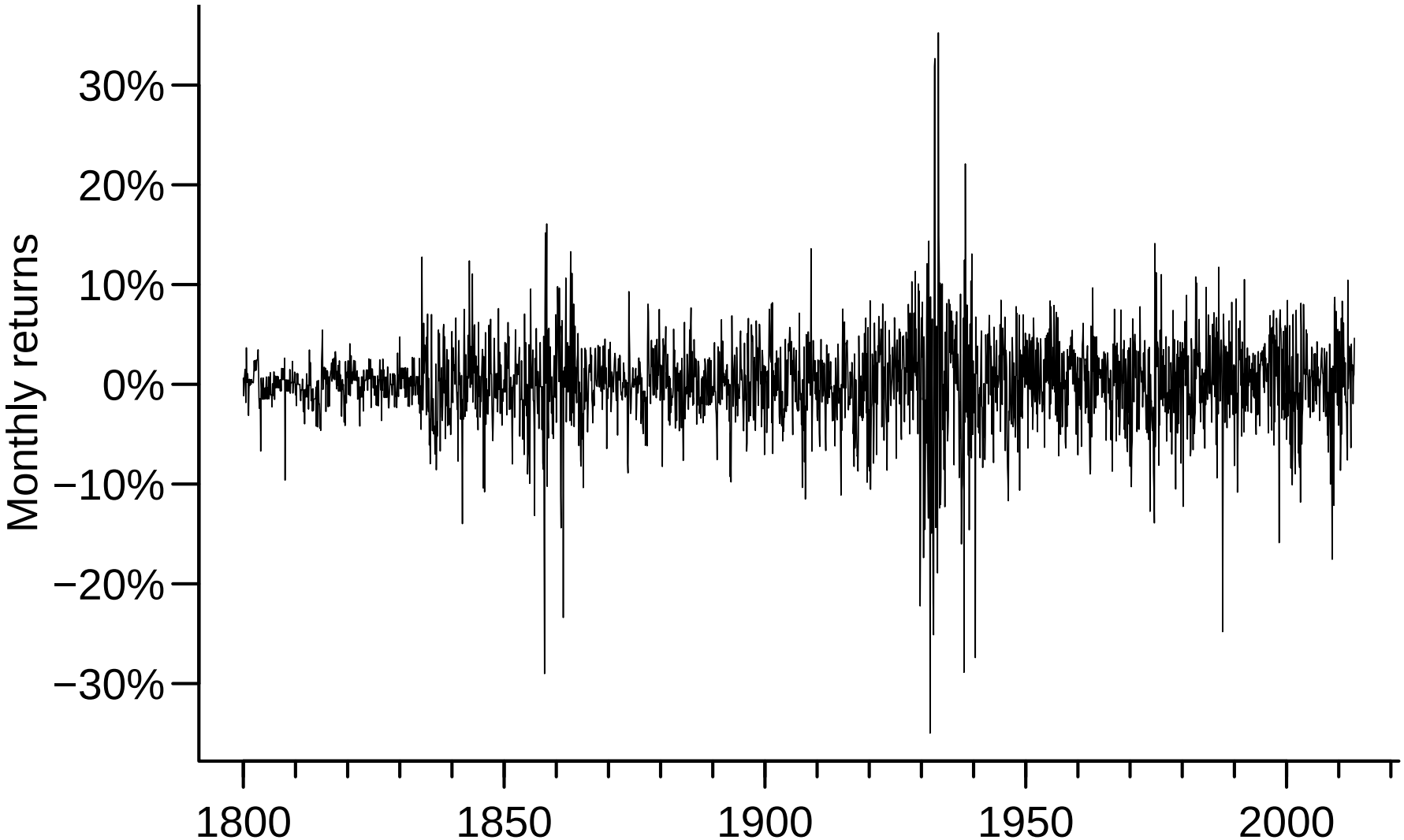
Coverage


Volatility
Banking crises
Number of countries
60
50
40
30
20
10
0
1800
1850
1900
1950
2000

Obtaining volatilities

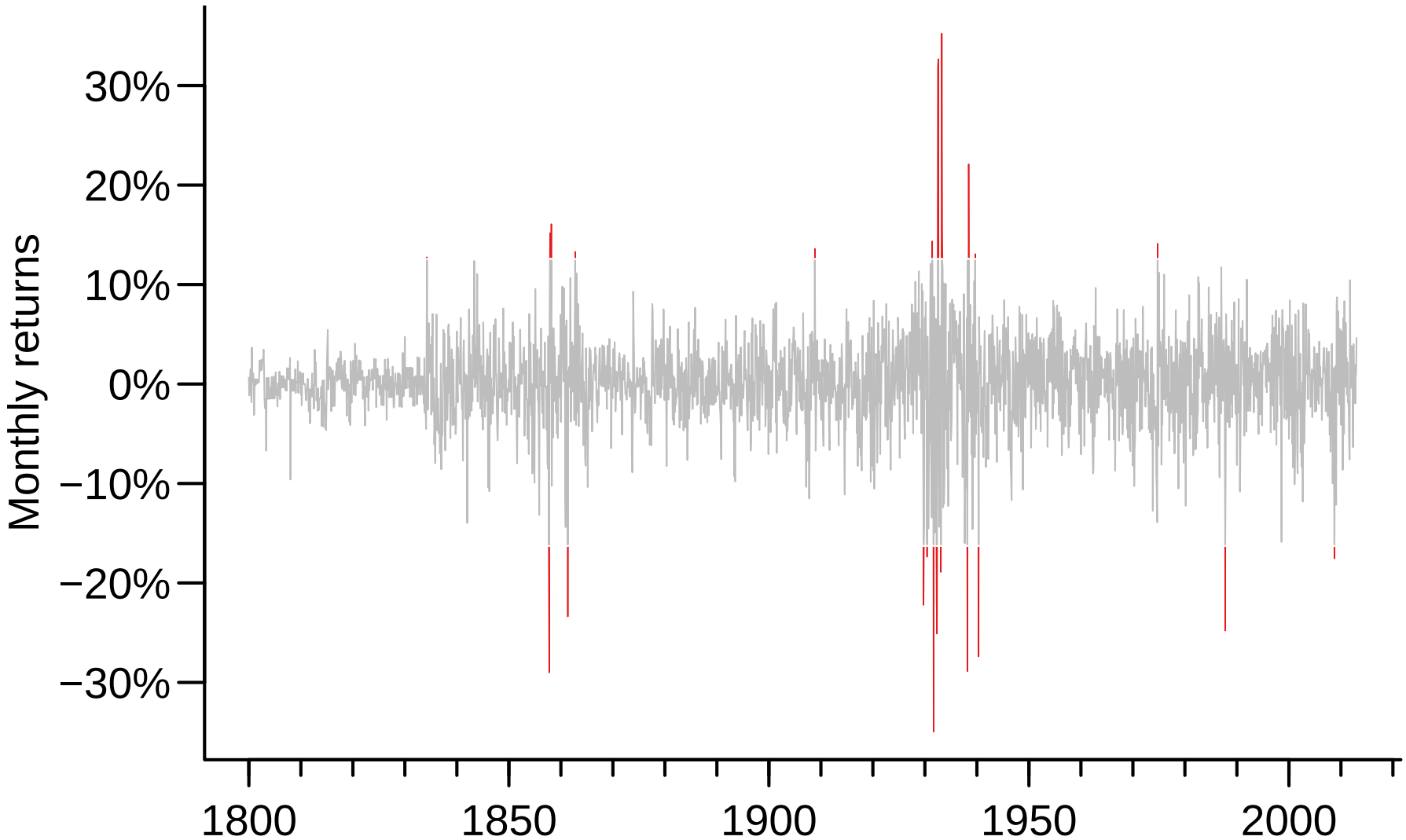
- GARCH? No
- *Realized volatility* (standard deviation of 12 past monthly real returns)
- Wars and hyperinflations result in extremes. We know that realized (and GARCH) volatilities are not robust in presence of extremes, and so
- *Winsorized* — ($^{+}/_{-}$ 0.5% of tails)

SP-500



SP-500

with winsorization



Volatility decomposition

- We could use the annual volatility ($\sigma_{i,t}$) as a crisis predictor, or
- Volatility decomposed into *trend* and *deviation from trend*
    - Different countries have different volatility levels
    - High volatility for a country and time could be low or typical in another period or country
    - Deviation from the prevailing volatility regime
- *High volatility:* volatility that is *above* the trend
- *Low volatility:* volatility that is *below* the trend
- One could use Markov switching, but that is a bad idea, instead:

Hodrick and Prescott (HP) filter

- Smoothing parameter, $\lambda = 5000$, which quantifies the degree to which volatility deviates from its trend
- Two sided (run recursively, past data used for current trend)

$$\min_{\{\tau_t(\lambda)\}_{t=1}^{T}} \sum_{t=1}^{T} \left[\sigma_t - \tau_t(\lambda)\right]^2 + \lambda \sum_{t=2}^{T-1} \left\{\left[\tau_{t+1}(\lambda) - \tau_t(\lambda)\right] - \left[\tau_t(\lambda) - \tau_{t-1}(\lambda)\right]\right\}^2$$

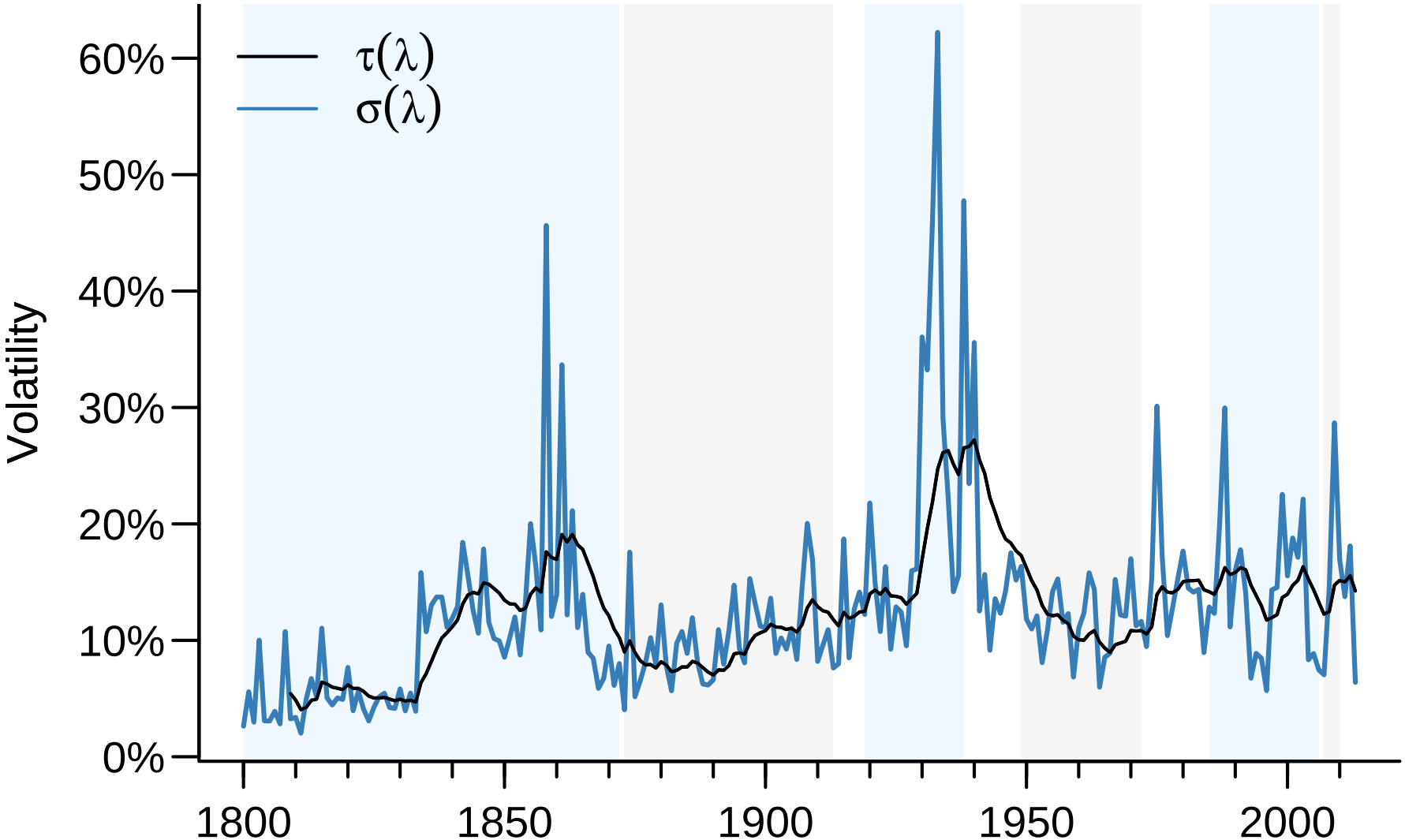
$$\sigma_t = \tau_t + \delta_t$$

- Low and high volatilities

$$\delta_t^{\text{high}} = \begin{cases} \sigma_t - \tau_t & \text{if } \sigma_t \geq \tau_t \\ 0 & \text{otherwise,} \end{cases}$$

$$\delta_t^{\text{low}} = \begin{cases} |\sigma_t - \tau_t| & \text{if } \sigma_t < \tau_t \\ 0 & \text{otherwise.} \end{cases}$$

SP-500



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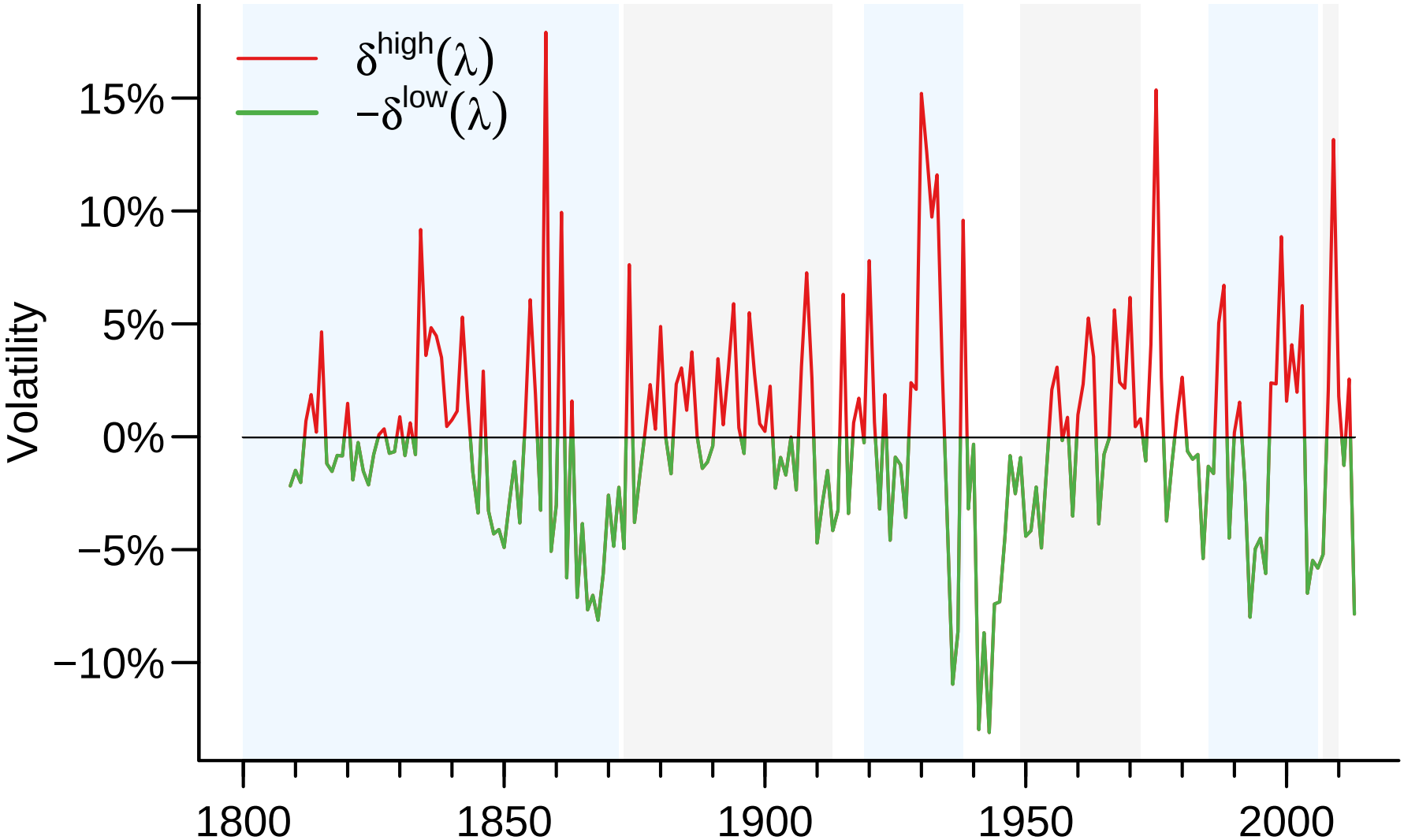
$\delta^{high}(\lambda)$
$-\delta^{low}(\lambda)$
15%
10%
5%
0%
−5%
−10%
Volatility
1800
1850
1900
1950
2000

Control variables — $X_{t,i}$

- Lags of the crisis dummy
- log *GDP*: GDP per capita to control for the economic development of a country
- *INFLATION*: annual CPI inflation rate
- $\Delta PD/GDP$: change in public-debt to GDP ratio
- *POLCOMP*: the degree of political competition as a proxy for institutional quality
- Time series and cross sectional fixed effects

Econometric Model

- The dependent variable is the *start* of a crisis,

$$C_{i,t}$$

i country index
t starting year of a crisis

- Moving average variables

$$\overline{z}_{i,t-1 \text{ to } t-L} = \frac{1}{L}\sum_{j=1}^{L} z_{i,t-j}, \quad z = C, \delta, X$$

- L_1, L_2 are the first and last lags, respectively
- Baseline: $L_1 = t-1$, $L_2 = t-5$

Panel-logit regressions

$$
\begin{aligned}
C_{i,t} = & \beta_1 \overline{C}_{i,L_1\_L_2} \\
& + \beta_2 \overline{\delta^{\text{high}}}_{i,L_1\_L_2} \\
& + \beta_3 \overline{\delta^{\text{low}}}_{i,L_1\_L_2} \\
& + \beta_4 \overline{X}_{i,L_1\_L_2} \\
& + \varepsilon_{i,t}
\end{aligned}
$$

Volatility and risk-taking

$C_{i,t}$	I	II	III	IV
$\sigma_{i,t-1 \text{ to } t-5}$	0.07**	-0.01		
$\delta^{\text{high}}_{i,t-1 \text{ to } t-5}$			0.26**	0.20
$\delta^{\text{low}}_{i,t-1 \text{ to } t-5}$			0.30***	0.31***
Control variables	No	Yes	No	Yes

So

- Volatility predicts crises *but not* when control variables are included
- High volatility predicts crises *but not* when control variables are included
- Low volatility predicts crises *including* when control variables are included
- A 1% decrease in volatility below its trend translates into a 1.01% increase in the probability of a crisis
- Economic importance increases monotonically and reaches a maximum at $L = 5$ and decreases then after dies out after $L = 10$

Volatility and risk-taking

- We use credit-to-GDP ratio gap (the difference between the credit-to-GDP ratio and its long-run trend) (and credit growth) as a proxy for risk-taking

$$R_{i,t} = \beta_1 \overline{\delta}^{\text{high}}_{i,L_1\_L_2} + \beta_2 \overline{\delta}^{\text{low}}_{i,L_1\_L_2} + \beta_3 \overline{X}_{i,L_1\_L_2} + \varepsilon_{i,t}$$

	$CR\_GAP^{BIS}_{i,t}$	$\Delta logCR^{BIS}_{i,t}$	$CR\_GAP^{ST}_{i,t}$	$\Delta logCR^{ST}_{i,t}$
$\delta^{high}_{i,t-1 \text{ to } t-L}$	-1.66	0.02	-0.01***	-0.91
$\delta^{low}_{i,t-1 \text{ to } t-L}$	4.53***	0.97***	0.01**	1.32**

- Low levels of financial volatility are followed by credit booms

Conclusion

Summary

1. Volatility and high volatility weakly predict crises
2. Low volatilities strongly predict crises 5 to 10 year into the future
3. Prolonged periods of low volatility lead to excessive risk taking
4. Empirical support of Minsky's financial instability hypothesis

$\Rightarrow$ *"Stability is destabilizing", Minsky (1992)*