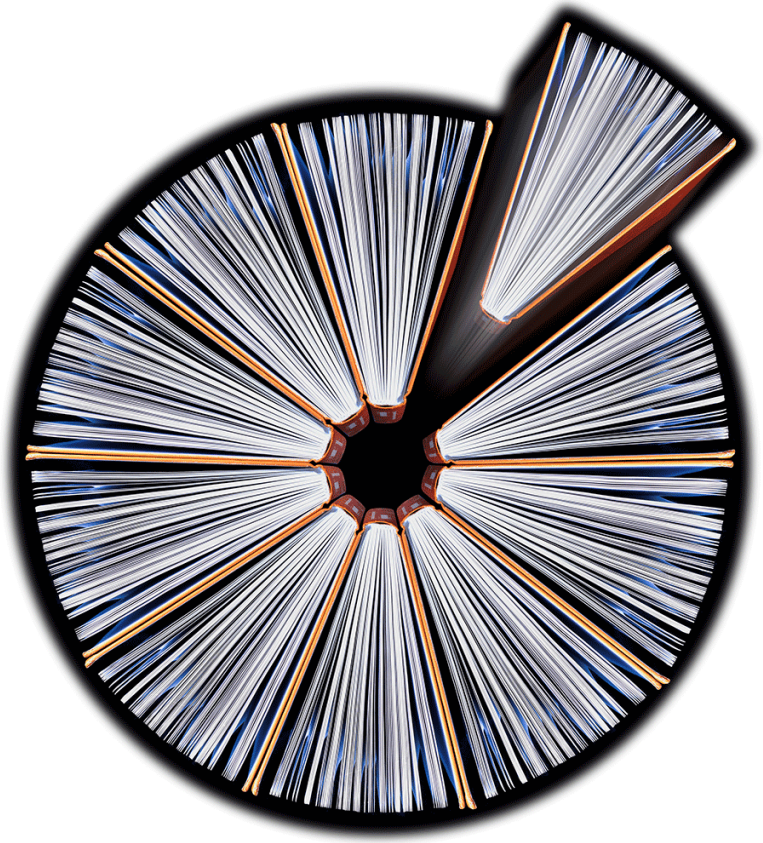
Deloitte.



IFRS 9: Does one model fit all?

Lessons from the ashes of the Great Moderation

Hugo Chim

August 2017

Introduction

Getting to know you…

Hugo Chim

Assistant Manager – Deloitte Financial Services Risk Advisory

Hugo Chim is an Assistant Manager in the Risk Modelling Team of Deloitte's Financial Services Risk Advisory Practice. Hugo has been a key modeller and SME in Expected Credit Loss (ECL) models for major European banks with systemic importance.

He has also applied advanced Econometric techniques to both retail and non-retail credit risk problems such as forecasting multiple-scenario PD using Vector Auto-regression and Error Correction, Logistic Models, and EMV techniques. Before joining the FS Practice, he was an Economist in Deloitte Economic Consulting.

Hugo graduated from Warwick University with Distinction in MSc Economics.

Agenda

Topics to cover today

Current modelling challenges

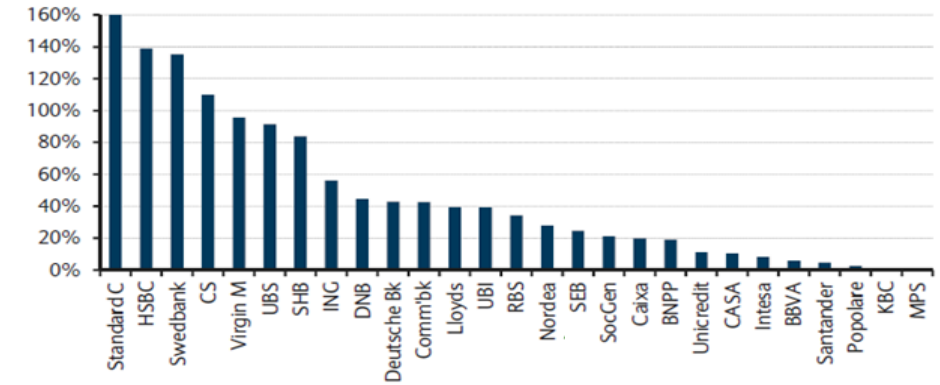
Why should we care?

Why should we care?

IFRS 9 is expected to have a significant impact on provision stock and pricing.

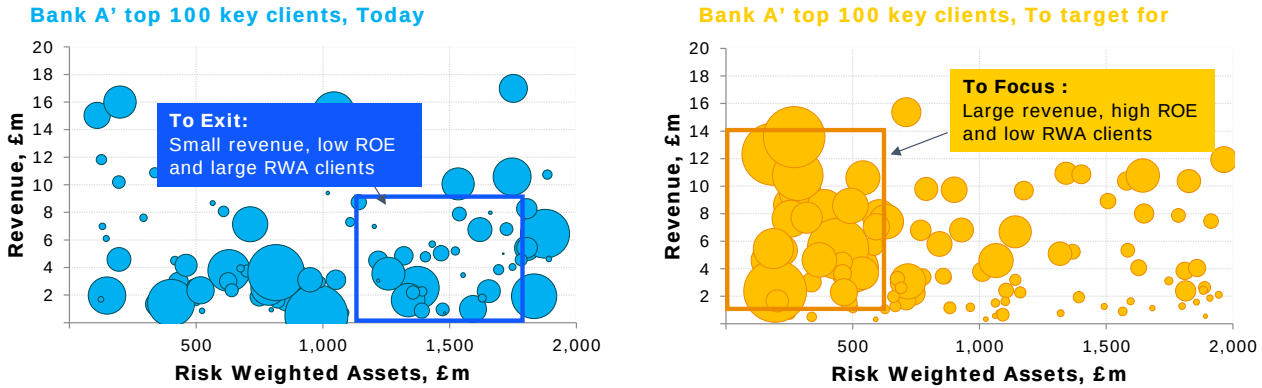
Expected significant increase in provisions

Increase in provision stock under IFRS 9 (vs 2015e level)



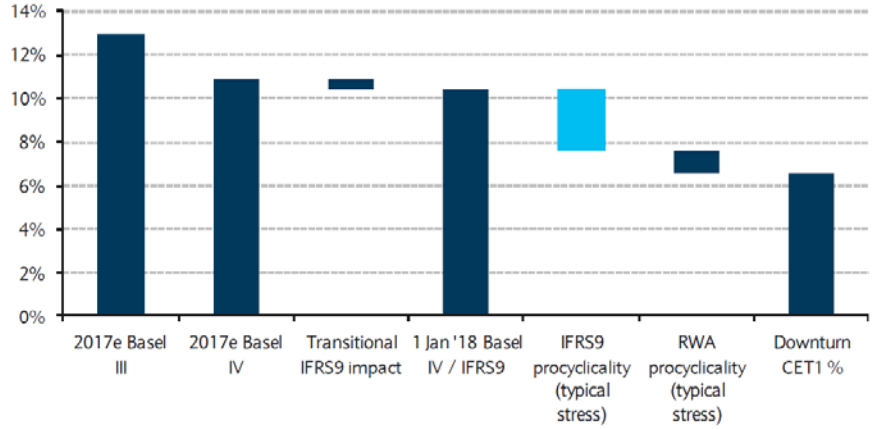
Source: Company disclosures, Barclays Research

Revenue Source and portfolio composition



IFRS 9 cyclicality and capital impact

IFRS 9 Pro-cyclicality could drive CET1 ratio below 7% in a downturn.

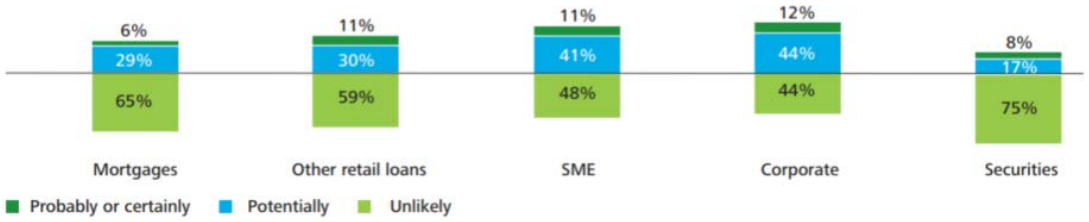


Source: Barclays Research

Cost of product offerings and pricing impact

Price makers who think IFRS 9 will affect costs in each products:

Price takers who think IFRS 9 will affect costs in each products:



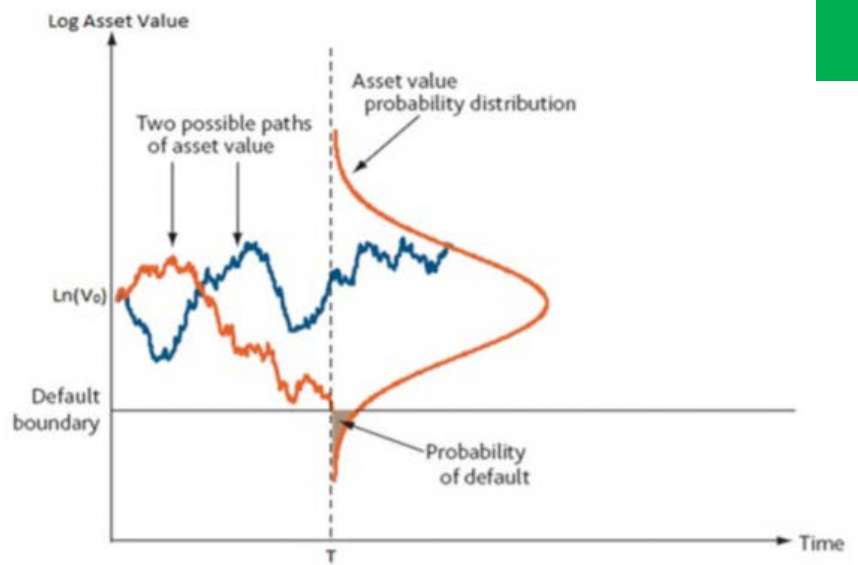
Source: Deloitte Research

The starting point

The common Merton-Vasicek Framework

Default Risks for Obligor i → Obligor i asset value (returns) index → Systematic risk factor (Z_t) + Macro factors (S_t) + Obligor specific risk factor (ε_i)

Implicit mean-reversion assumption



Credit: CCBS Handbook #34 - Modelling Credit Risk. Bank of England

Vasicek Model (Yang 2013 Probit-linear formulation)

$$PD(Z_t) = P(R_{it} < threshold_i | S_{kt}) = \Phi(\alpha + \sum_{k=1}^{m} \beta_k S_{kt} + \tau\varepsilon_i)$$

Where,

- $\sum_{k=1}^{m} \beta_k S_{kt} = \sqrt{\rho} Z_t$, $\boldsymbol{Z_t \sim N(0,1)}$ is the systematic, and factor; and
- $\tau\varepsilon_i = \sqrt{1-\rho}\,\varepsilon_i$, $\varepsilon_i \sim N(0,1)$ is the idiosyncratic factor.

Merton-Vasicek model (2002)

- The Vasicek (2002) model decomposes default risks into systematic (z_t) and obligor specific factors (ε_i).
- The standard practice is to model default risks as an unobserved latent asset return index (R_{it}) that is positively correlated to a given obligor's asset value on book. Intuitively, a lower expected future return (which leads to a lower asset value) is expected to increase default risks.
- When the index falls below a given threshold (default boundary), e.g. when asset values is below liability value, the obligor is expected to default.

Current modelling challenges

Challenges we have come across at our clients when they were modelling the systematic factor under the Vasicek framework.

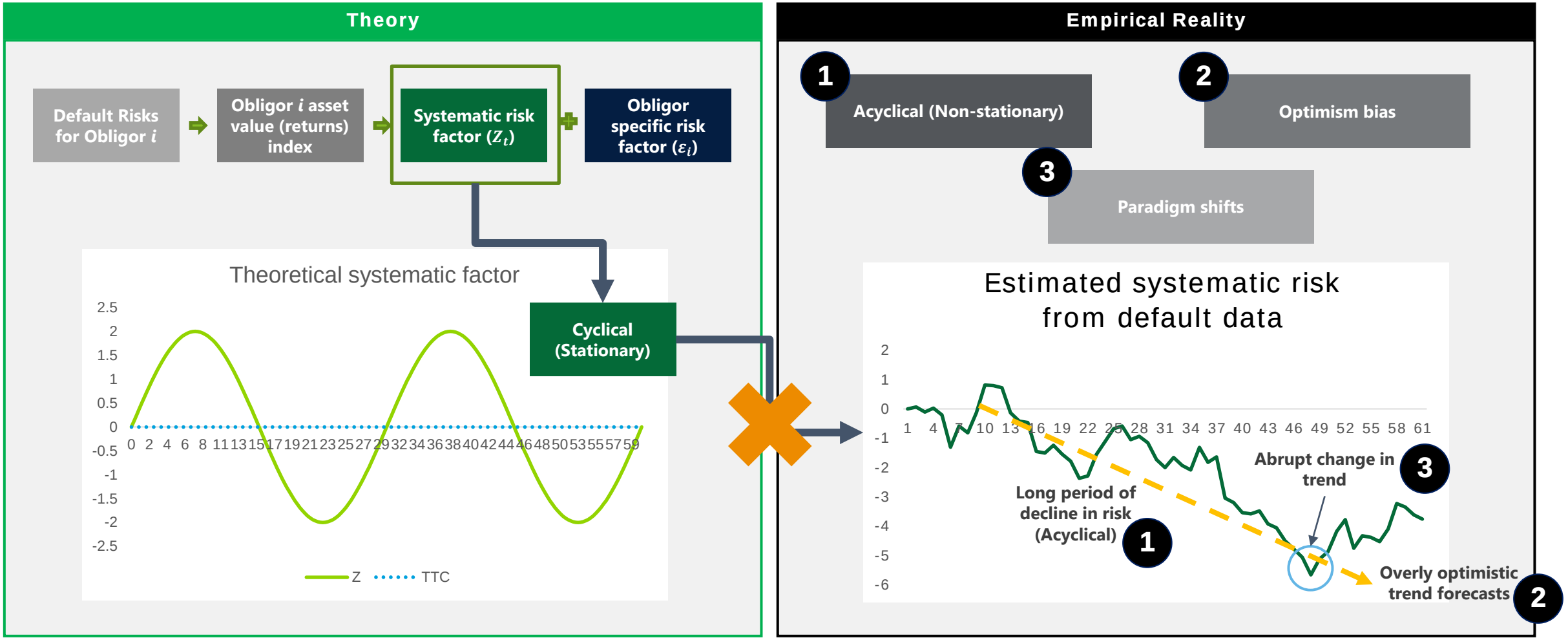
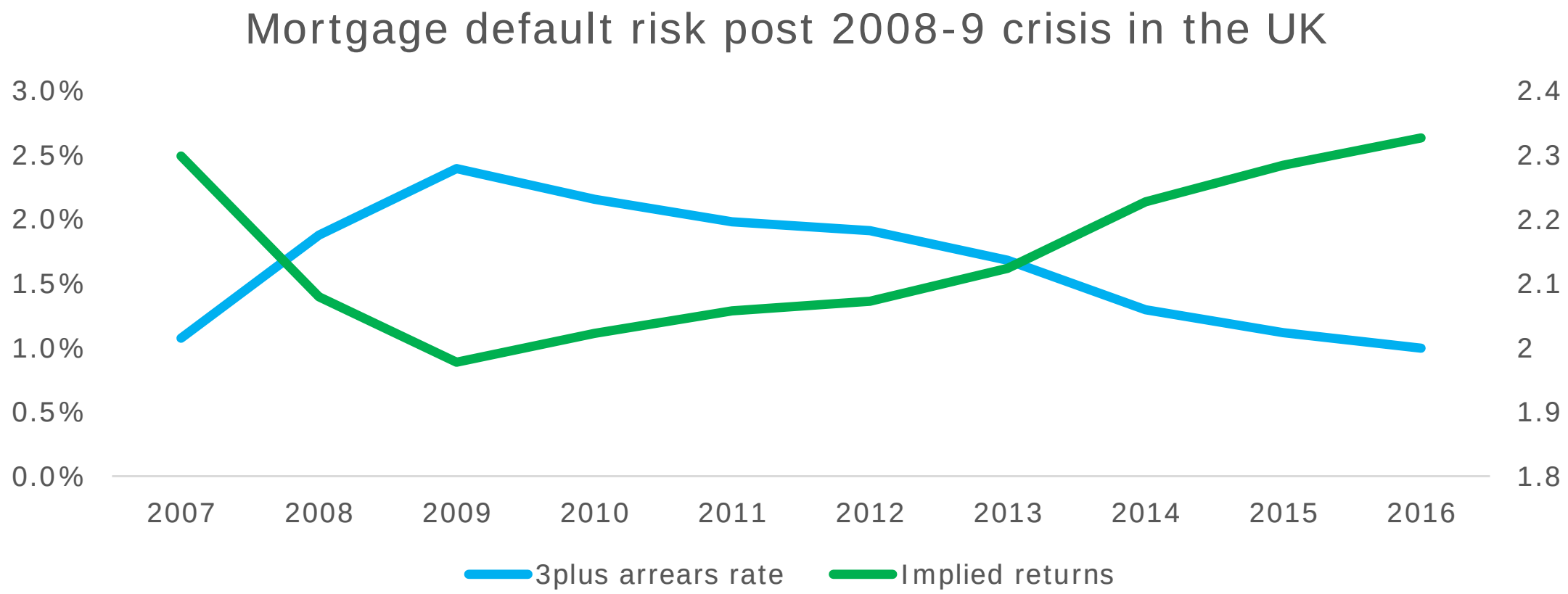


Illustration only

Challenge 1: Absence of cyclical behaviours

Since the last financial crisis, UK mortgage default rates have been decreasing. Cyclical behaviour has not been observed in the last 10 years.



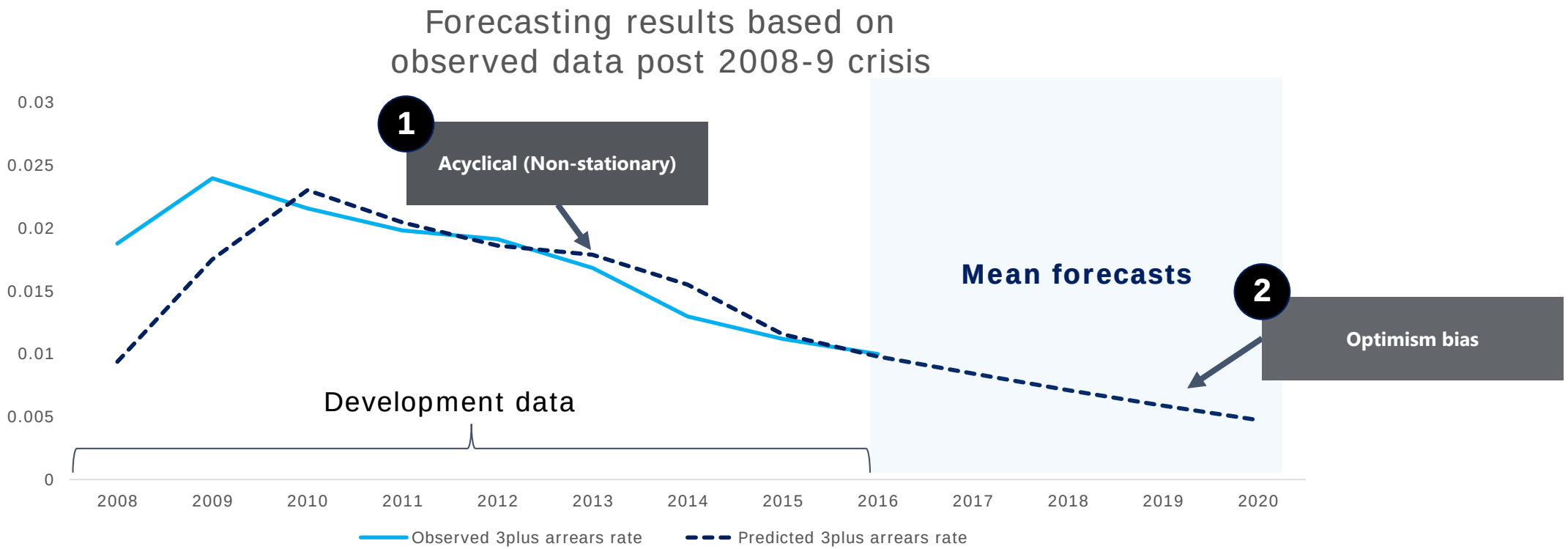
Source: CML 2017

Challenge 1: Absence of cyclical behaviours

Standard models tend to predict the downward trend to continue.

Q1 Is it tenable to argue for cyclical behaviour around a stable TTC PD?

Q2 Can credit risk be trending down indefinitely?



Source: CML 2017 and Deloitte analysis

In July 2007, Charles Prince (Ex-Citi CEO) told the Financial Times that global liquidity was enormous and only a significant disruptive event could create difficulty in the leveraged buyout market.

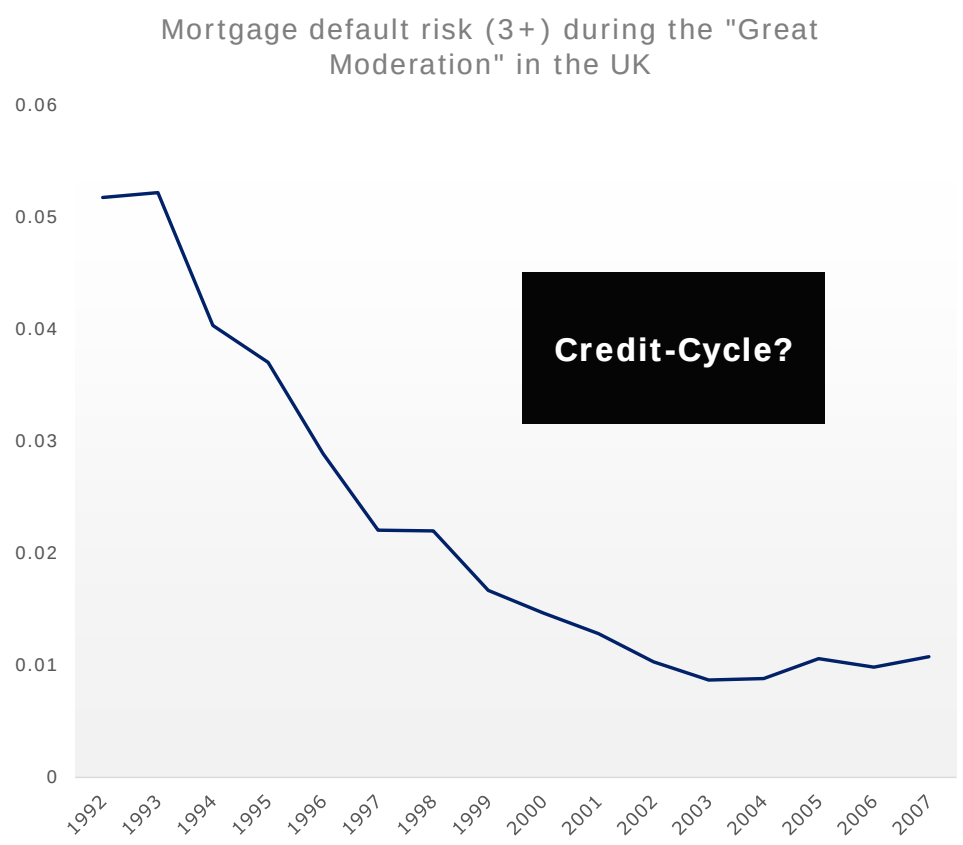
"As long as the music is playing, you've got to get up and dance...We're still dancing."

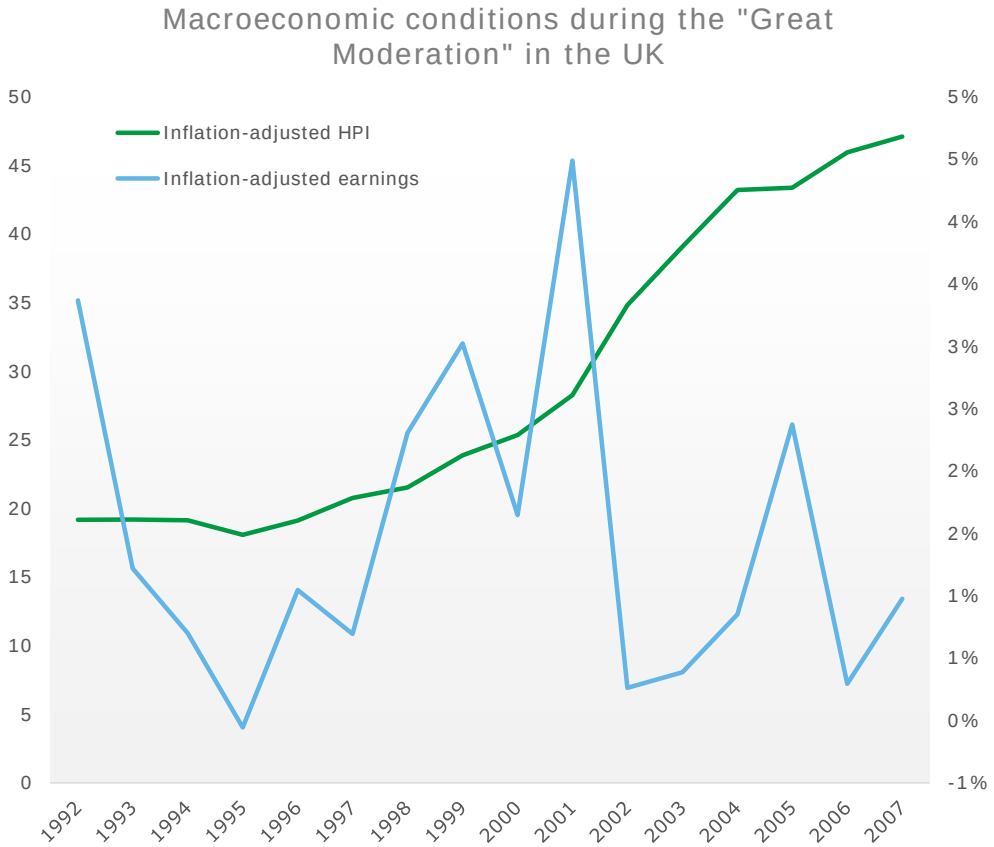
Source: Reuters

Credit: The New York Times

Challenge 2: Good-time optimism bias

During the Great Moderation between the end of 1991 recession and the 2008 financial crisis, the UK experienced 63 consecutive quarters of economic growth. During the UK's (and the US') Great Moderation, many argued that the old laws of economics had been abolished.






Fears for first-time buyers as the cost of an average home hits £200,000

HOUSE PRICES DOUBLE IN 4 YEARS

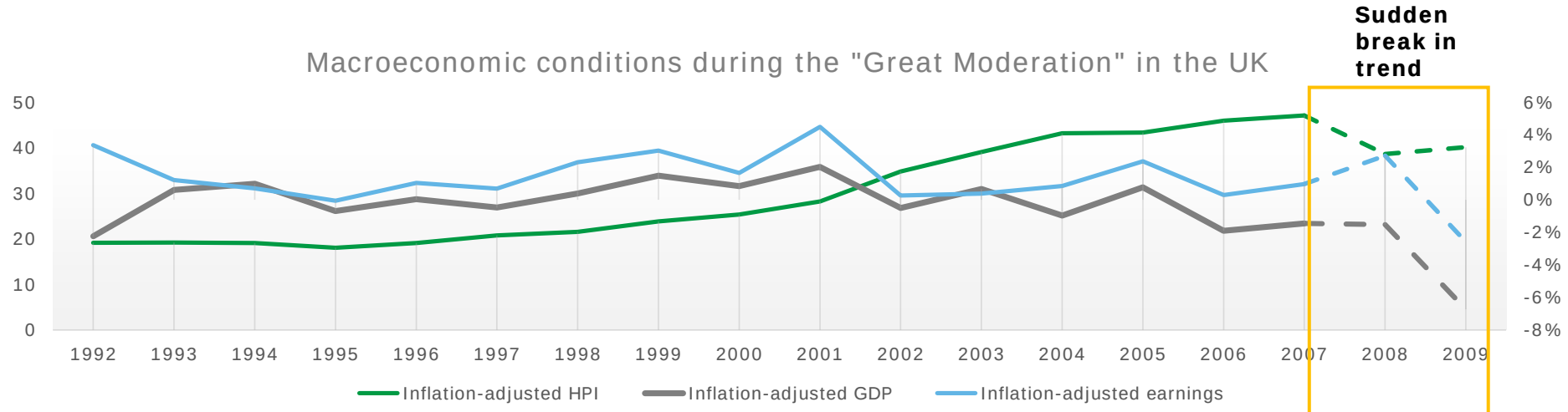
HOUSE prices have doubled in only four years – taking the average cost of a home in England over the £200,000 mark.

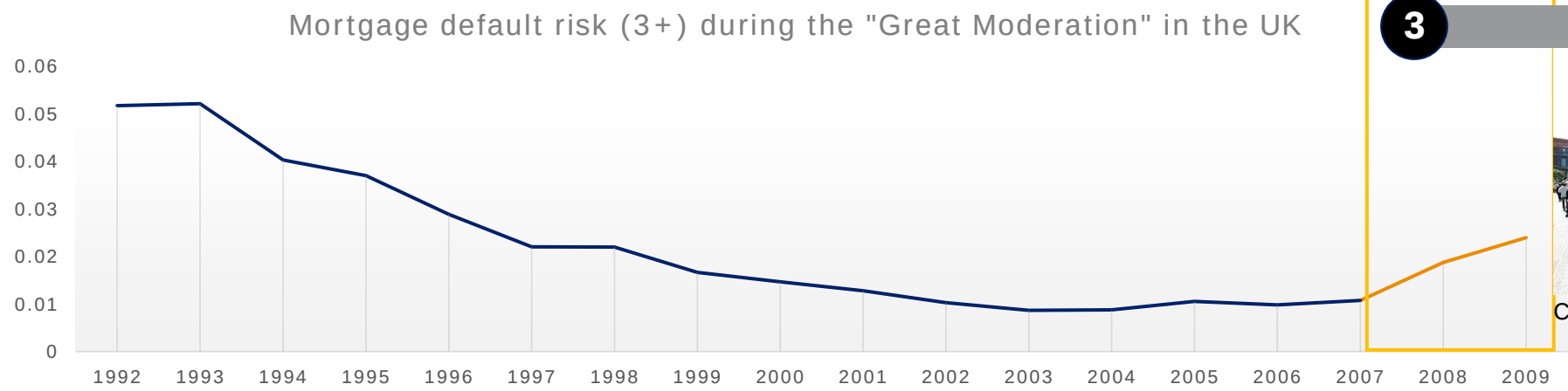
Source: BBC Nov 2006

Source: CML 2017

Challenge 2: Good-time optimism bias

The Great Moderation however did end abruptly and dramatically.





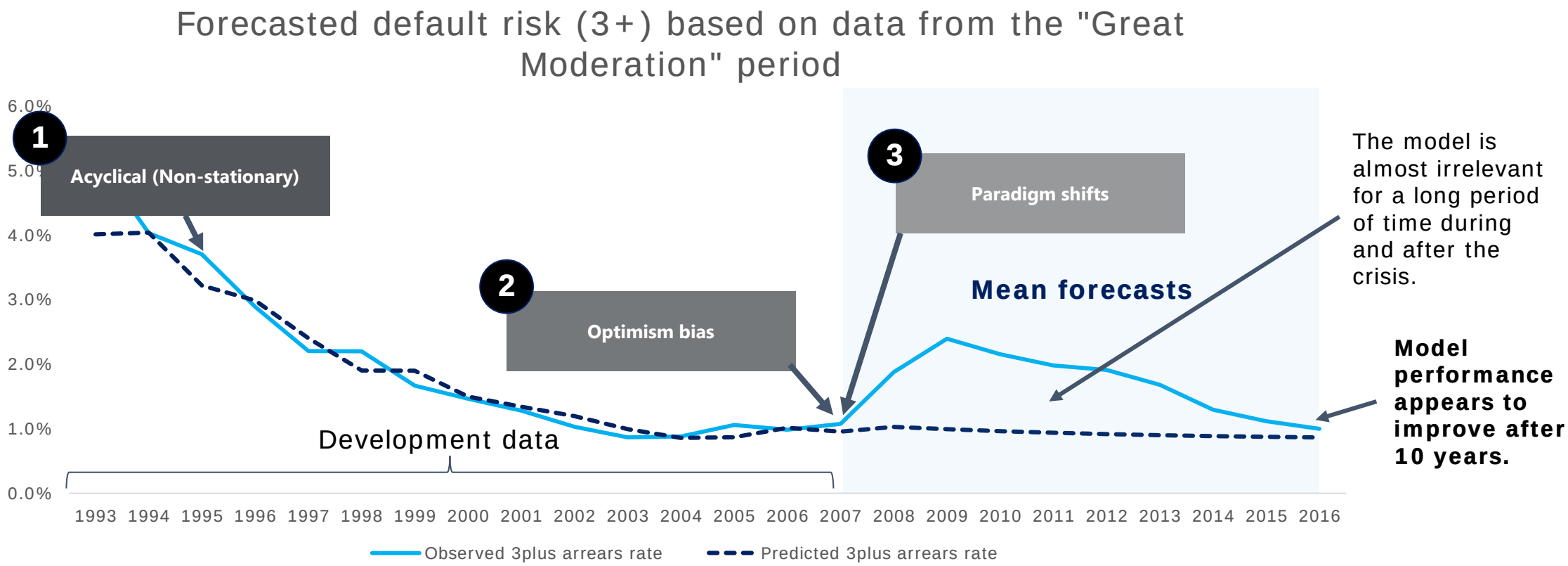
3 Paradigm shifts

Credit: The Telegraph

Source: CML 2017

Challenge 2: Good-time optimism bias

Predictions made based on the data from the Great Moderation period exhibited a continuing downward trend. As such, the forecast errors after the 2008-9 crisis assuming the same trend will be significant and persistent.



Source: CML 2017 and Deloitte Analysis

Steve Jobs' Stanford University Commencement address in 2015.

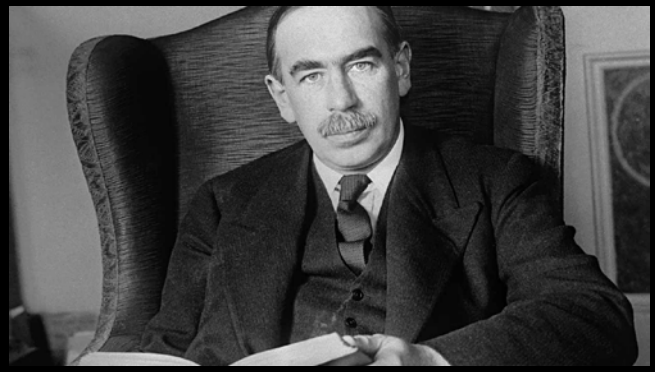
"If you live each day as if it was your last..."

"someday you'll most certainly be right."

Credit: Esquire

A Tract on Monetary Reform (1923) - John Maynard Keynes

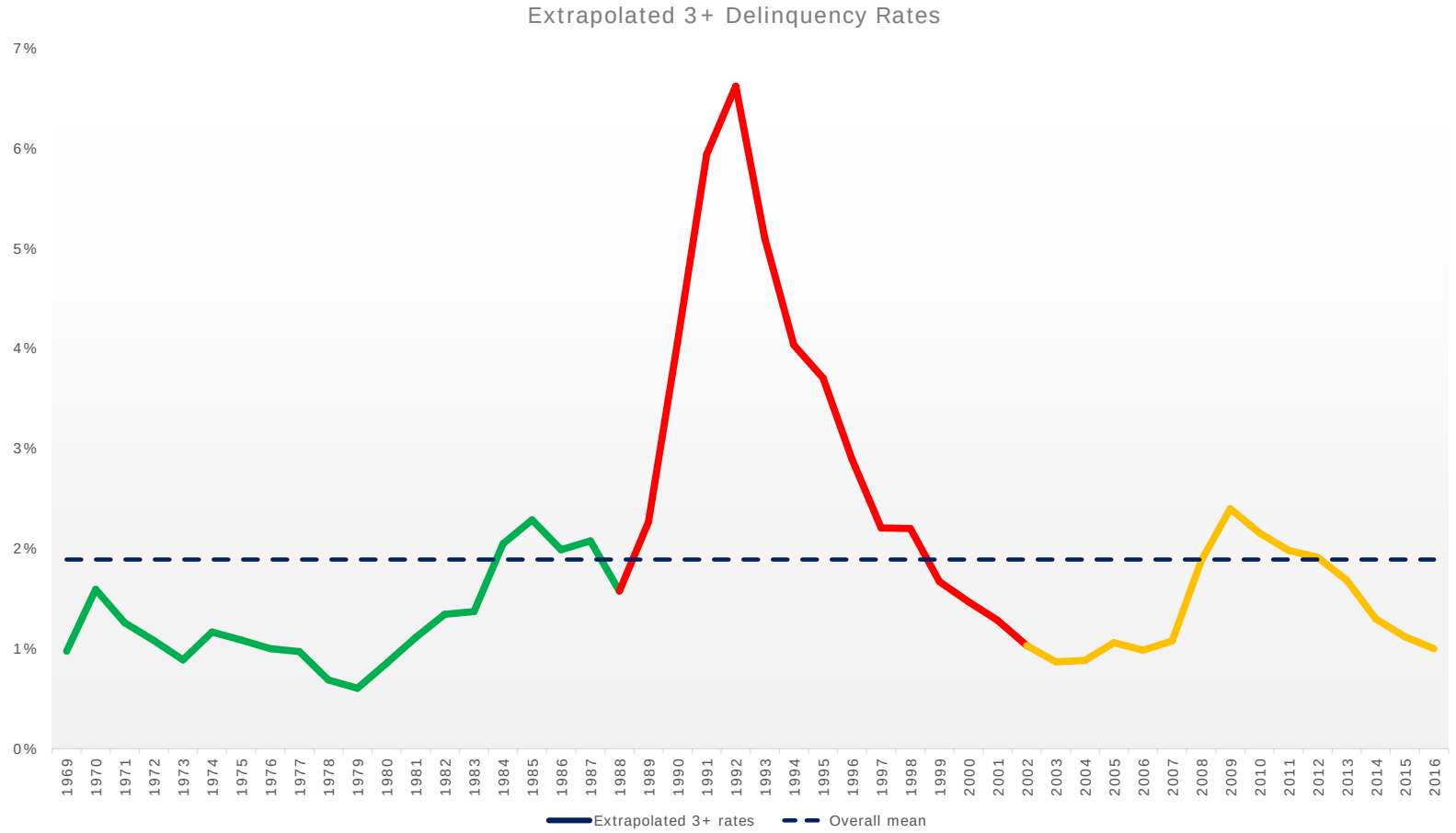
"***In the long run*** **we are all dead**. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is long past the ocean is flat again."



Credit: The Guardian

Challenge 3: Paradigm shifts

Based on 48 years of data, we may estimate the long-run 3+ arrears rate to be circa 1.9%;however, over the entire period, it is difficult to argue for any meaningful cyclical behaviour around this long-run value. The 3+ data appears to be so persistent that non-stationarity test often indicates that 3+ data is a random-walk.



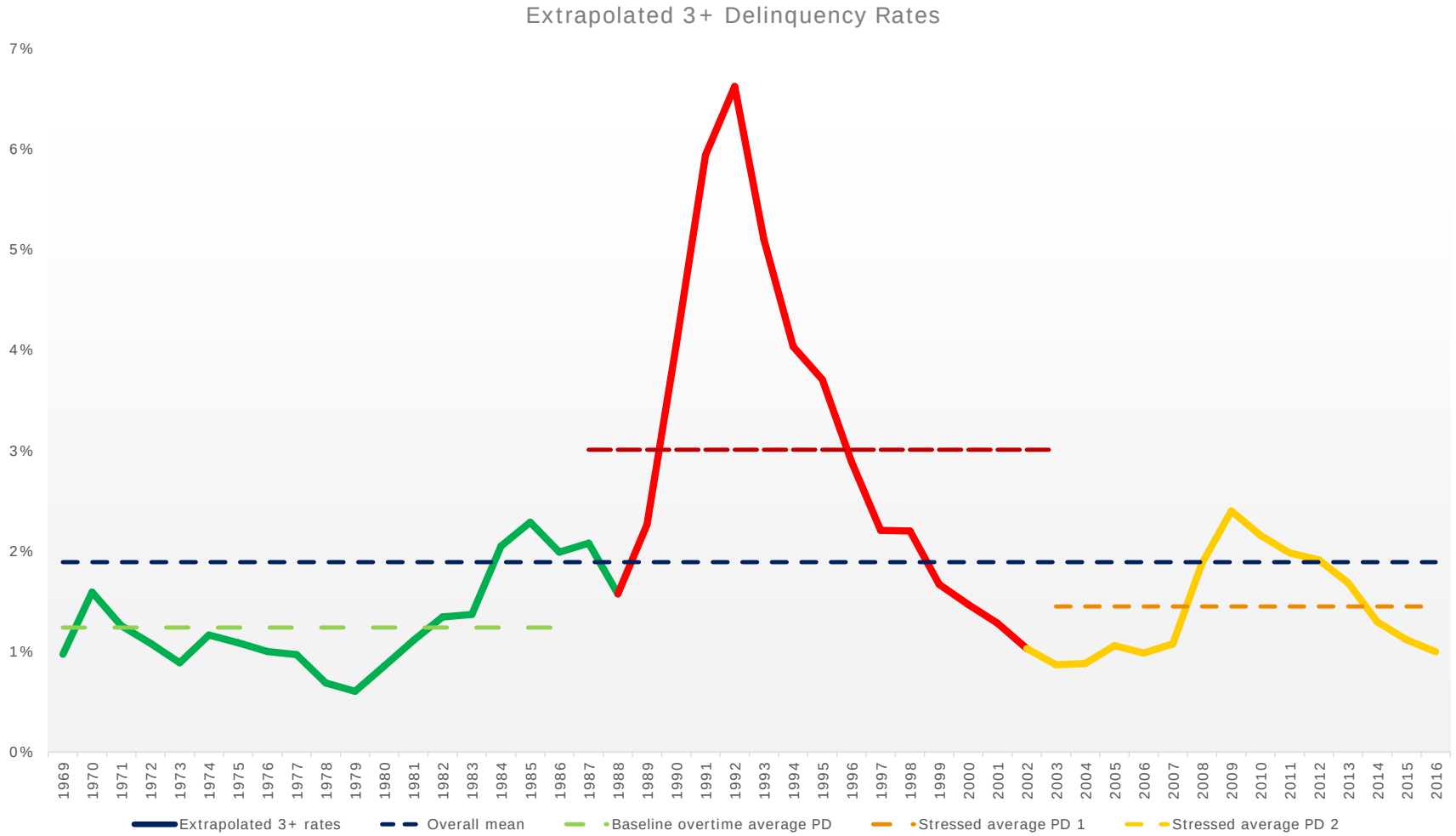
Source: CML 2017 and Deloitte Analysis

Paradigm shifts can lead to false non-stationarity test results.

48 years is a long time to have no paradigm shifts.

Challenge 3: Paradigm shift detection

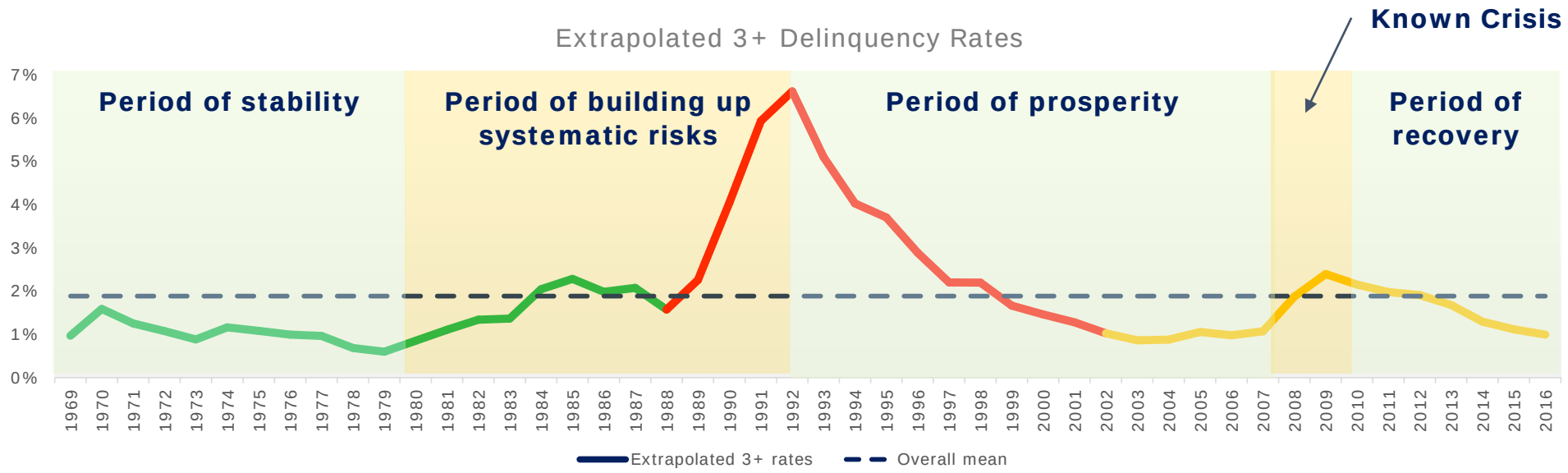
Visual inspection identifies three potential states of the mortgage market: Pre 90s crisis, period around the 90s crisis and periods around the 2008/9 crisis. The dividing line however can be arbitrary.



Source: CML 2017 and Deloitte Analysis

Challenge 3: Paradigm shift detection

Historical events may also provide some insights.



Pre 1980s

- Vast majority of mortgage funding came from building societies, which borrowed retail funds from the household sector and lent them to households with secure incomes, a savings history, and a significant deposit.
- It was arguably almost riskless to lenders because interest rates were adjusted to enable flows of funds to be balanced.
- Mortgagors bore all the interest risk.

Late 70s-late 1980s

- (Foreign) Banks and insurance companies started to enter the market.
- Bank of England (1980) lifted the Supplementary Special Deposits regulations ("Corset").
- 1984 changes in regulations meant building societies could then operate like banks.
- 1980s right to buy for council tenants, injecting 1 million households (lower income) into the mortgage market.
- Growth in use of mortgage backed securities by US banks.

1989-1992

- By 1989, institutions were lending at unprecedented income multiples and LTVs.
- Homeownership had spread down the income scale.
- 20% of new loans were at more than 100% LTV.
- Economy and housing market slowed down. Transactions halved by 1992.
- 2 million households faced negative equity and repossessions reached a peak in 1991.

1993-2007

- Great Moderation started to take effects.

2008-9

- Global Financial Crisis

2010 - ?

- Gradual recovery with low interest rates, more robust regulations and stronger bank balance sheets.

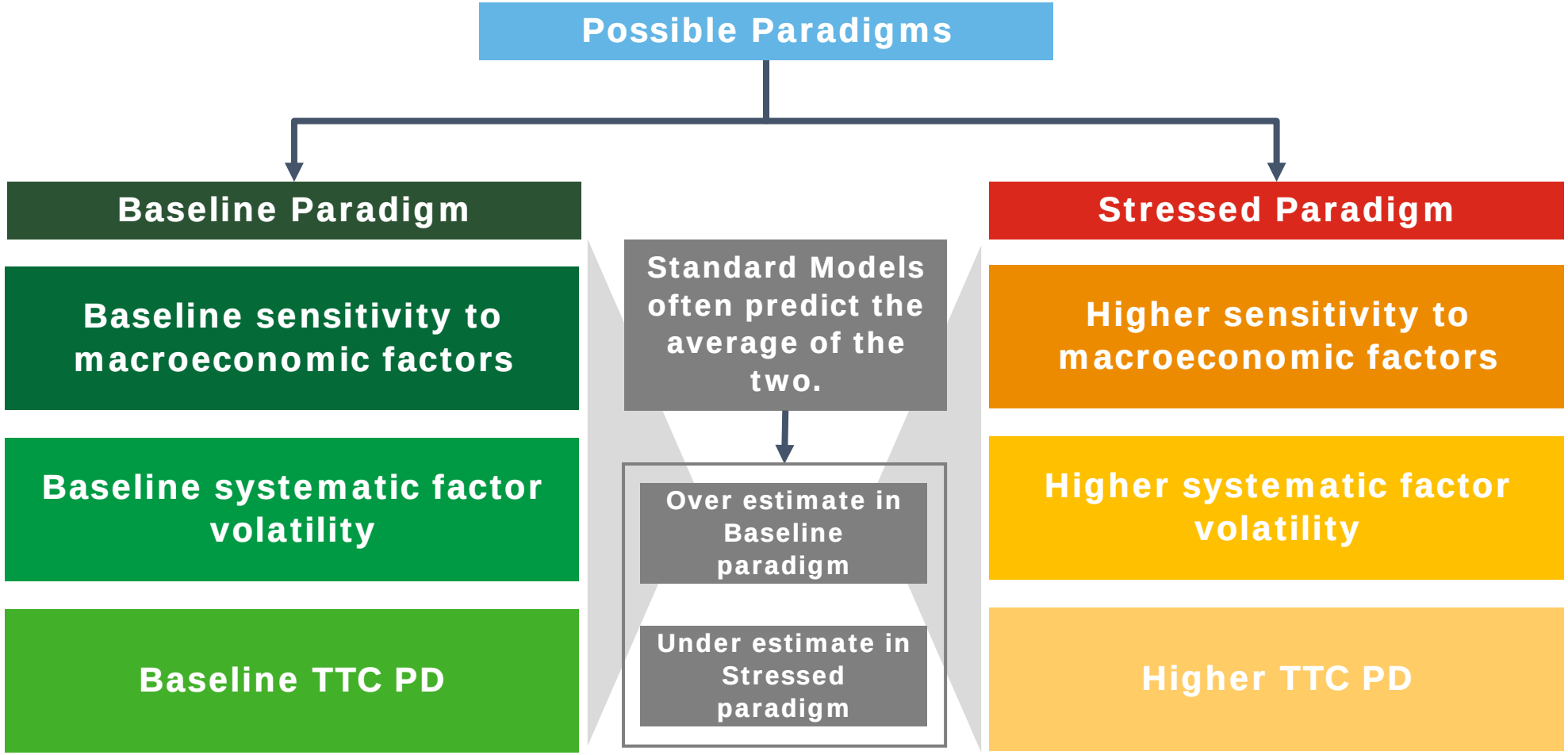
High volatility

Low volatility

Experimental Results

Challenge 3: Paradigm shifts and bias

For simplicity, if we only consider two possible paradigms: **Baseline** and **Stressed**, what can we say in general about each of these paradigms?



Challenge 3: Conventional approach to paradigm shifts

Dummy variables model the instability of time series in hindsight

- Step 1: Generate period dummies for high volatility periods (***stressed***), using low volatility period as baseline. Let:
  - $d_{stress} = \begin{cases} 1, \ for\ year\ from\ 1980\ to\ 1992,\ 2008\ to\ 2009 \\ 0, \ otherwise \end{cases}$
- Step 2: Run regression using both level and multiplicative dummies:

$$\Phi^{-1}(ODF_t) = y_t = \alpha + \sum_{k=1}^{m} \beta_k S_{kt} + \omega d_{stress} + \sum_{k=1}^{m} \delta_k S_{kt} * d_{stress} + v_t$$

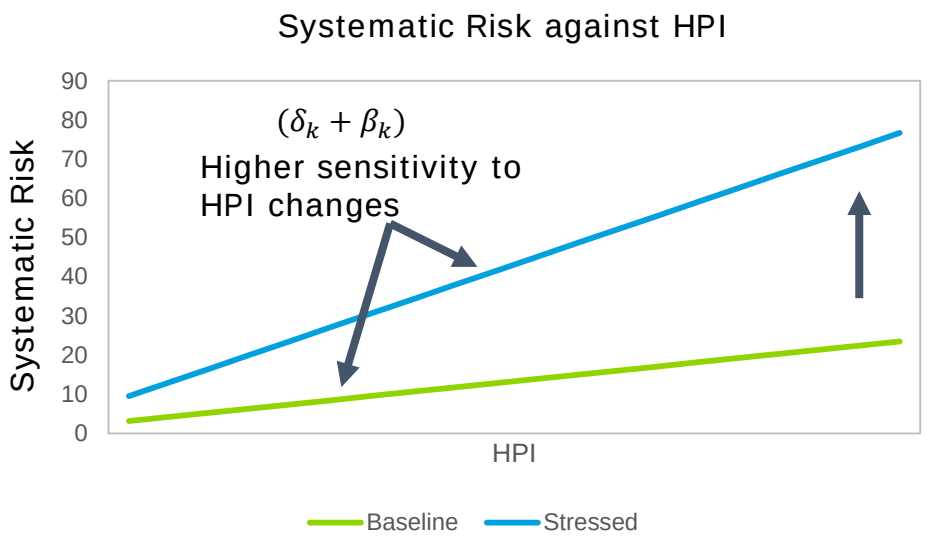
- Essentially we are estimating two mean models:

Baseline Model

$$y_t = \alpha + \sum_{k=1}^{m} \beta_k S_{kt} + v_t$$

Stressed Model

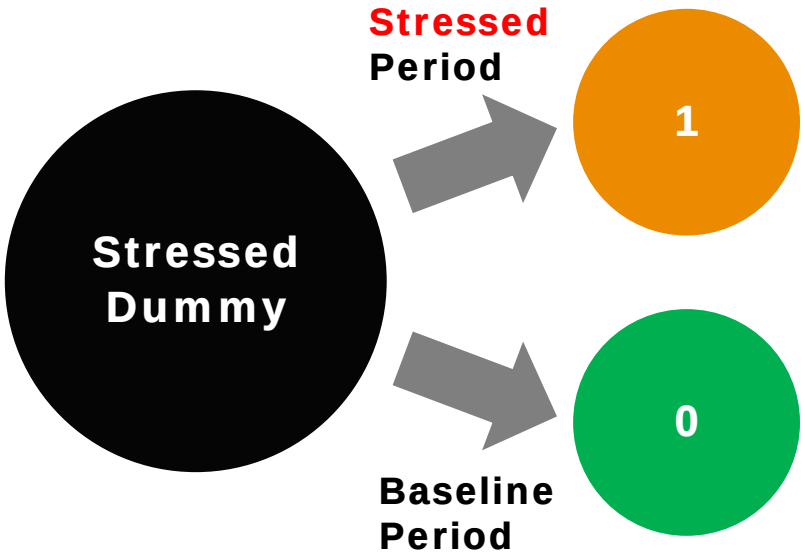
$$y_t = y_t = (\alpha + \omega) + \sum_{k=1}^{m} (\delta_k + \beta_k) S_{kt} + v_t$$

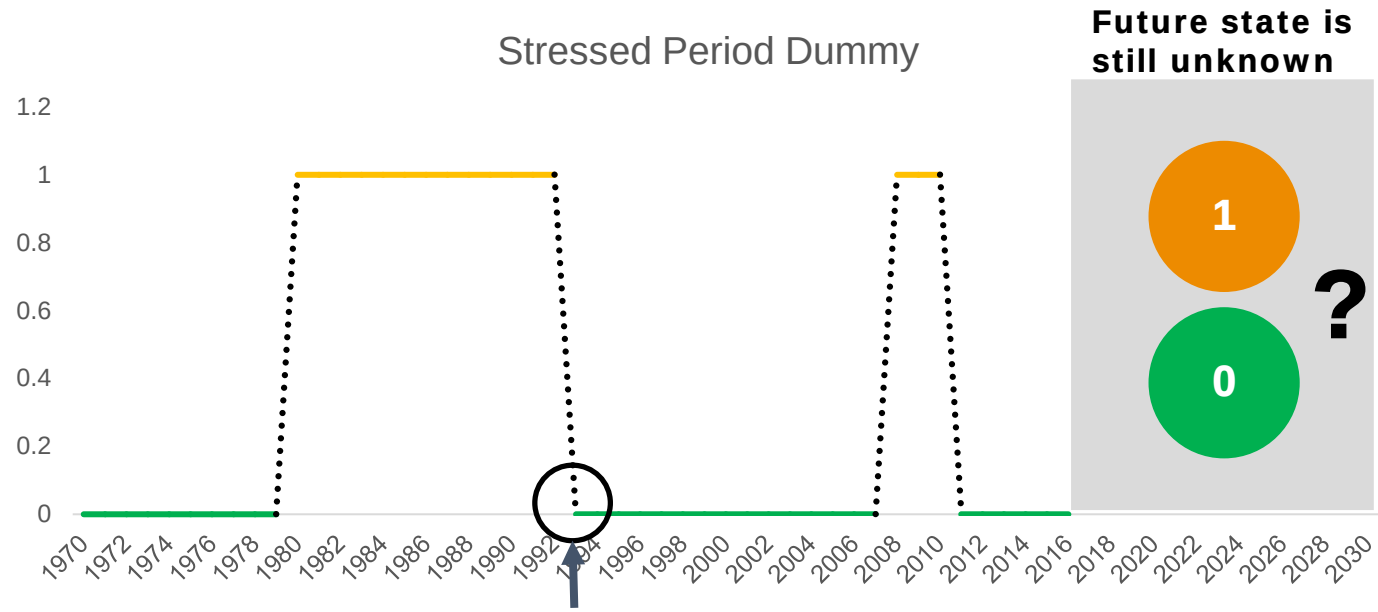


$(\alpha + \omega)$
Higher average default risk across all possible HPI values.

Challenge 3: Conventional approach to paradigm shifts

Dummy variables model only works in hindsight





In reality, it is hard to say when exactly the Great Moderation actually started.

Methodology issues

- This method is only useful in hindsight.
- This is a crude approach with abrupt arbitrary changing points.
- This method does not assign probabilistic weight to possible future paradigms.
- IFRS 9 requires banks to make scenario forecasts and so information on future paradigms (a form of scenario) is arguably essential.
- Assigning wrong future paradigms to forecasts may lead to bias.

"You only learn who has been swimming naked when the tide goes out,"

"And what we are witnessing at some of our largest financial institutions is an ugly sight."

Credit: Forbes.com

But perhaps we could assign some probabilities to this event happening?

Proposed approach

Introducing randomness in paradigm shifts

Proposed approach

Mortgage default in a Markov-Switching (MS) framework

MS-Model set up

- The dynamics of the CCI are modelled as a state-dependent process where the state(***Stressed*** or ***Baseline***) is unobserved by the modeller.
- Let y_t denote the CCI in period t and suppose that its mean and variance are governed by an unobserved state variable $S_t =$ (***Stressed***, ***Baseline***) in our simple two-state example:

$$y_t = \mu(S_t) + \sigma(S_t)v_t \quad where\ v_t \sim i.i.d.N(0,1)$$

Such that,

$$\begin{cases} y_t = \mu_s + \sigma_s v_t & if\ s_t = \textbf{\textit{Stressed}} \\ y_t = \mu_b + \sigma_b v_t & if\ s_t = Baseline \end{cases}$$

Note that the difference between this set up and the dummy-variable regression model is that the state-switching mechanism is a **random** process. Particularly, the state of the world is governed by an ergodic irreducible hidden Markov Process (mean-reverting without absorbing state):

$$\boldsymbol{P} = \begin{bmatrix} p_{ss} & p_{sb} \\ p_{bs} & p_{bb} \end{bmatrix}$$

Where for example $p_{bs} = P(S_t = Stressed | S_{t-1} = Base)$ is the probability that the process is in a ***Baseline*** state at time t given that it was in a ***Stressed*** state at time t-1.

Proposed approach

Mortgage default in a Markov-Switching framework

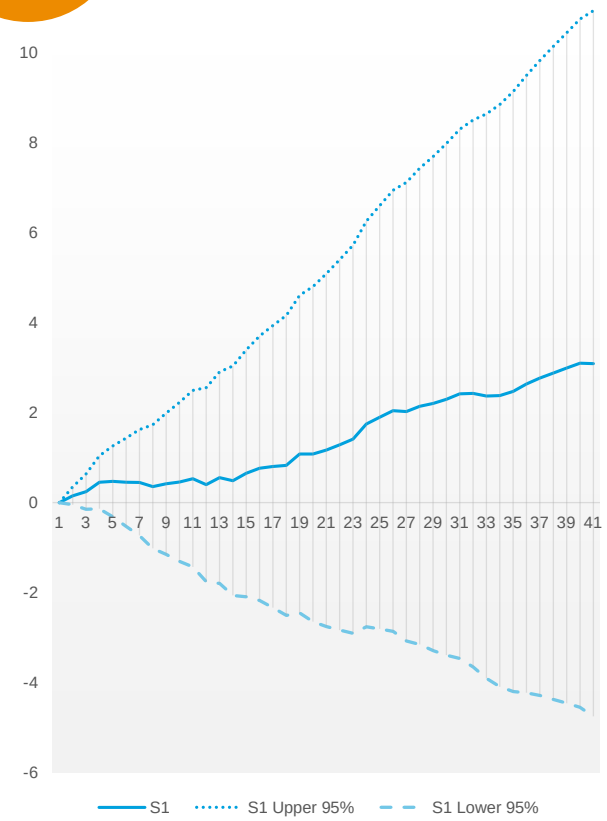
Forecasting with MS-Model

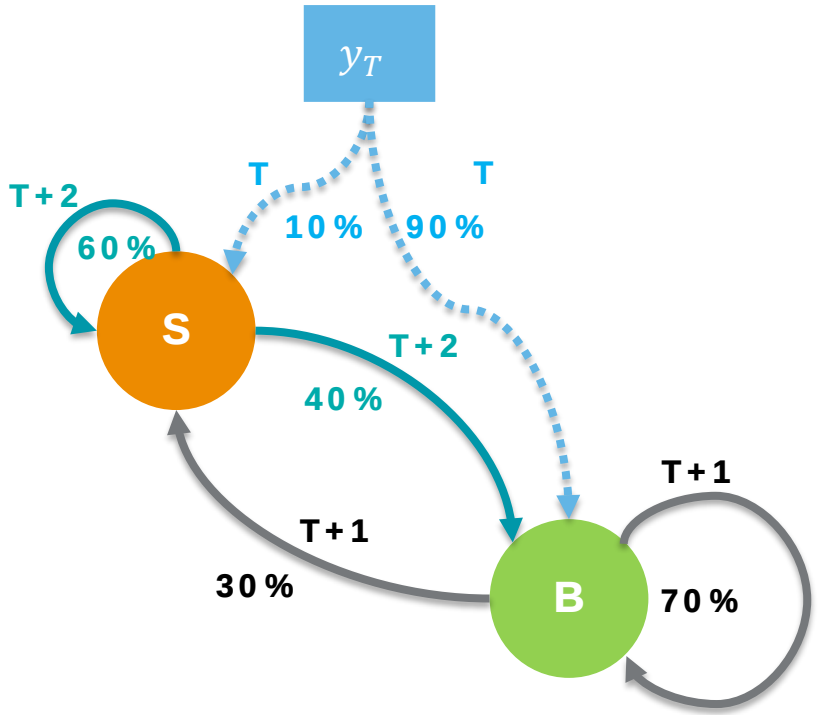
- Forecasts can be made using the key outputs of the MS-model. For a h-step ahead forecast based on information at time t,

$$E(y_{t+h}|I_t) = \hat{\xi}_{(t|t)} * \mathbf{P^h} * \hat{\boldsymbol{\mu}}$$

S

CCI @ State 1: Random Walk





CCI @ State 2: Persistent Auto-Regressive Process

B

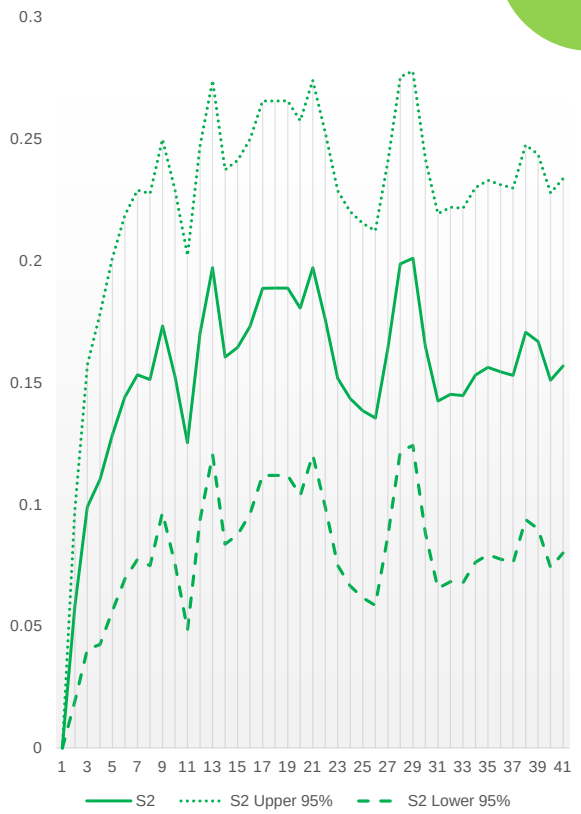


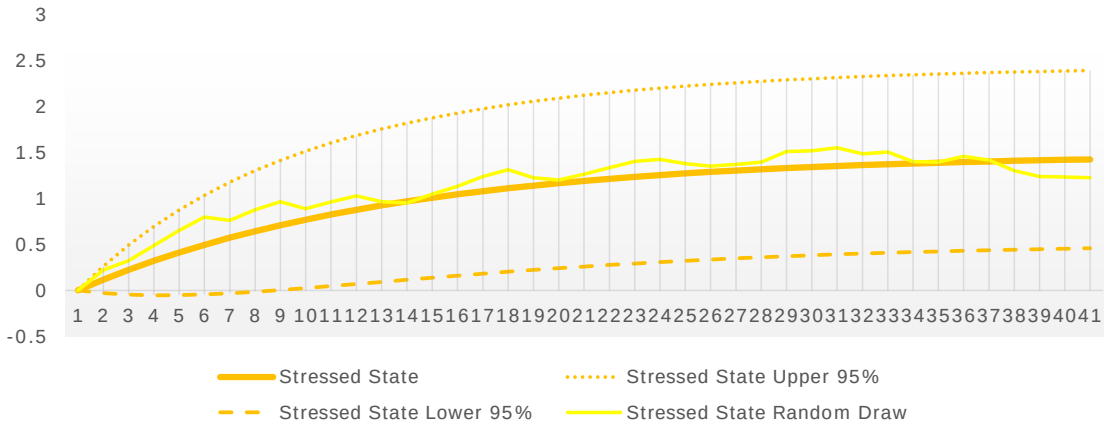
Illustration only

Application showcase
The UK mortgage market

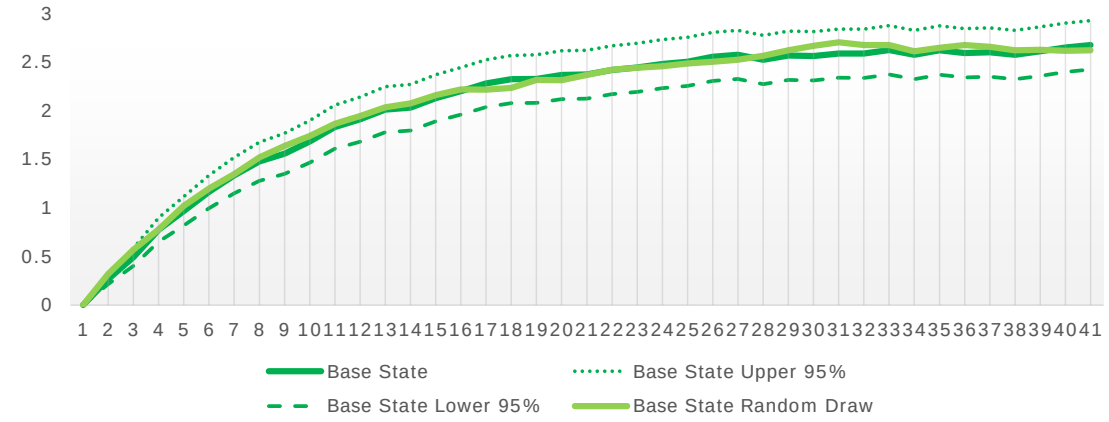
AR(1) MS-model estimation outcomes

CML 3+ Arrears data

Simulation for the Stressed state



Simulation for the Baseline state



	Stressed state
Sensitivity to HPI	**1%** fall in HPI growth -> **0.8%** fall in implied returns (R) (**4x** more sensitive)
Asymptotic TTC implied returns (R)	**1.4 (46% less)**
Asymptotic R volatility (σ_R^2)	**0.037 (>10x *Baseline*)**
Average duration (Forced uniform volatility)	**5 years** (3 years)

$$\boldsymbol{P} = \begin{bmatrix} P(S_t = Stressed | S_{t-1} = Stressed) & P(S_t = Stressed | S_{t-1} = Base) \\ P(S_t = Base | S_{t-1} = Stressed) & P(S_t = Base | S_{t-1} = Base) \end{bmatrix}$$

$$= \begin{bmatrix} \mathbf{0.80} & 0.20 \\ 0.27 & \mathbf{0.73} \end{bmatrix}$$

	Baseline state
Sensitivity to HPI	**1%** fall in HPI growth **-> 0.2%** fall in implied returns (R)
Asymptotic TTC implied returns (R)	**2.6**
Asymptotic R volatility (σ_R^2)	**0.003**
Average duration (Forced uniform volatility)	**4 years** (9 years)

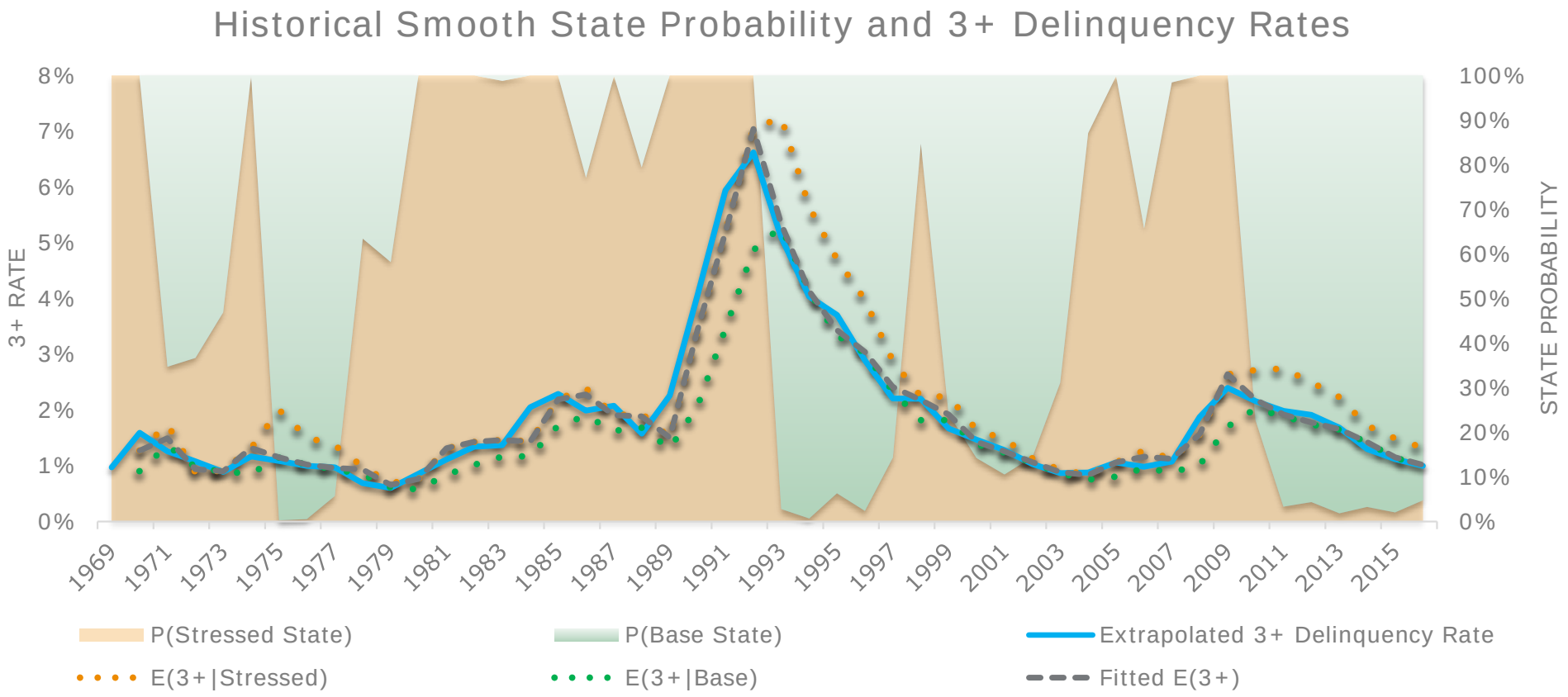
Experimental Results

In-sample assessment

How well does the model fit the data?

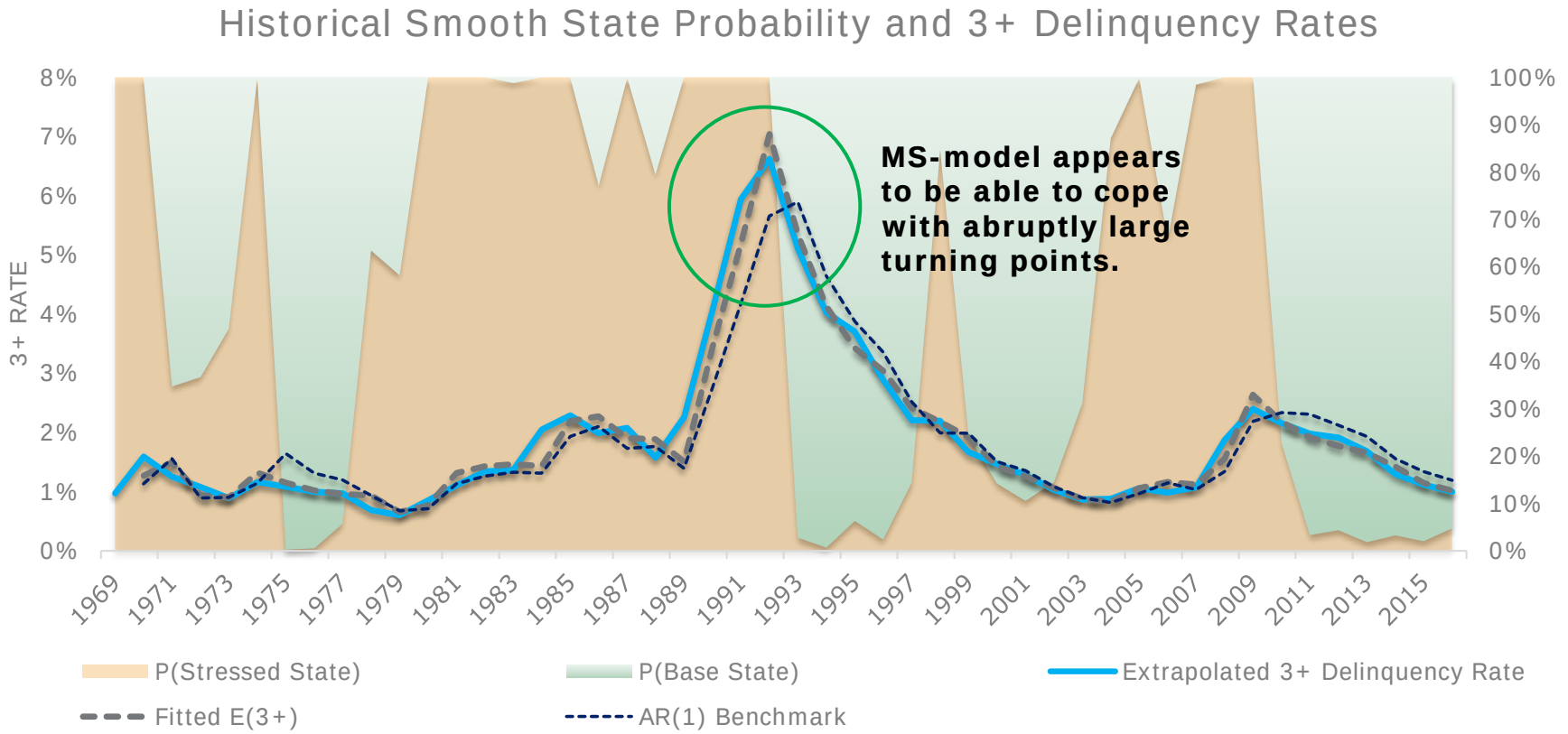
Assessment: actual vs. predicted

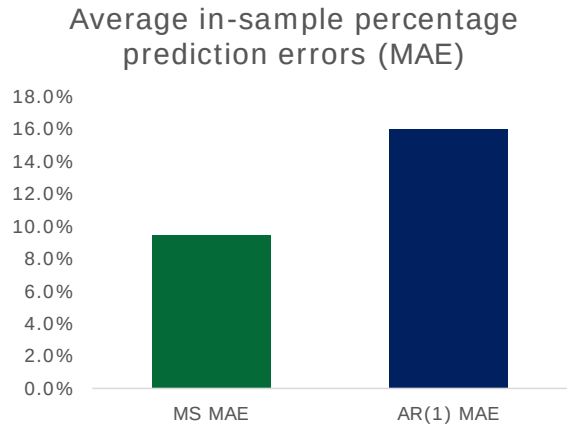
AR(1) MS-Model prediction is the average between the ***Baseline*** and ***Stressed*** state predictions, weighted by the probabilities of being a given state.

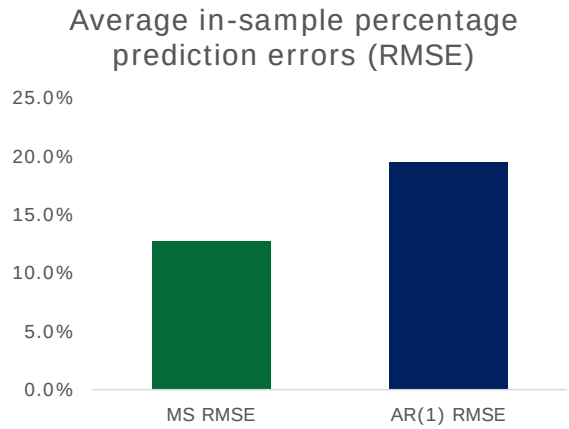


Assessment: In-sample fit comparison with next-best benchmark model

AR(1) MS-model appears to be able to cope with abrupt turning points (paradigm shifts) better than the benchmark AR(1) model, resulting in a significantly better in-sample fit.



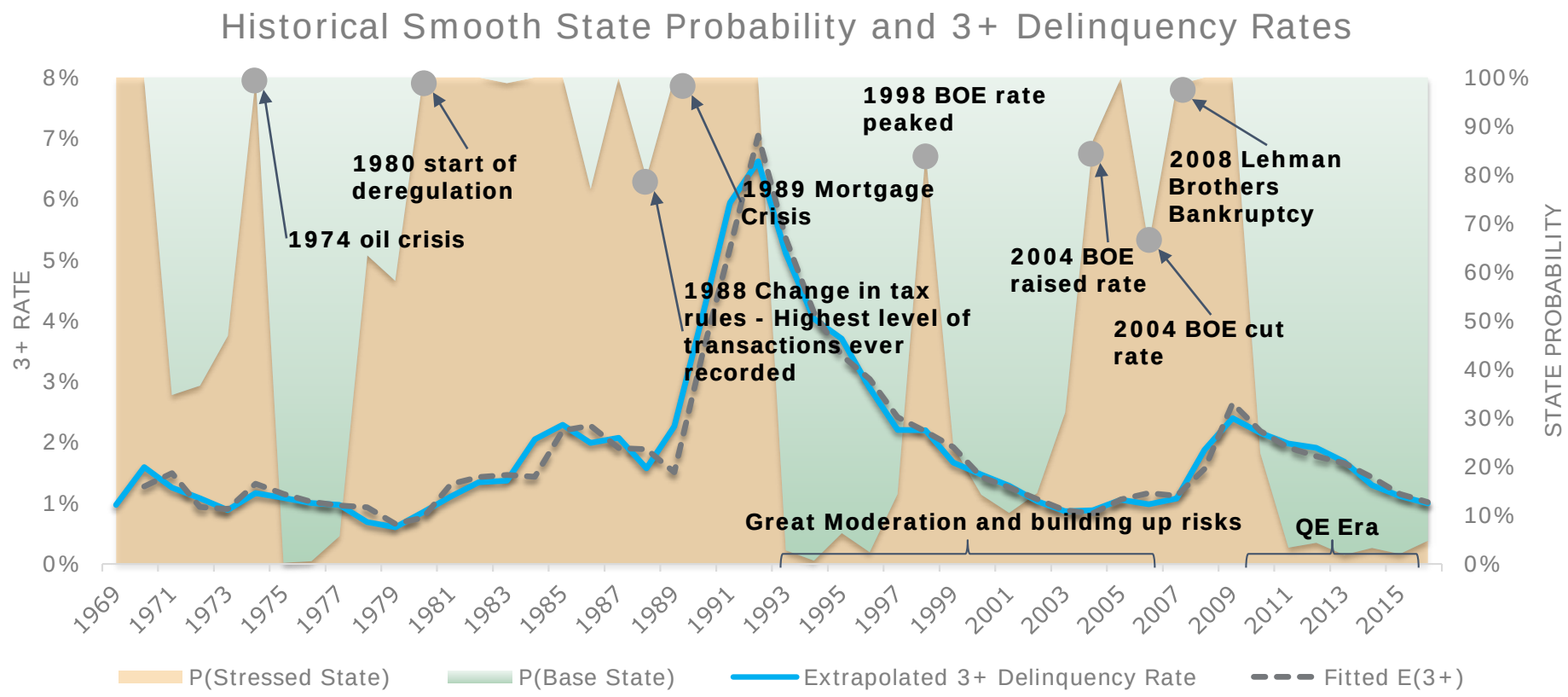




Experimental Results

Assessment: Sensitivity of state detection and sense-checking against real-life events

Our AR(1) MS-model appears to be able to capture a large number of major macroeconomic events that might have led to shifts in macro paradigms.

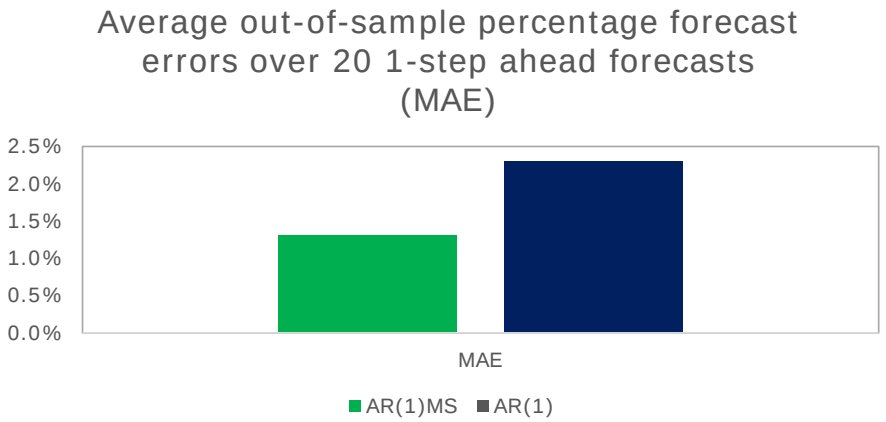


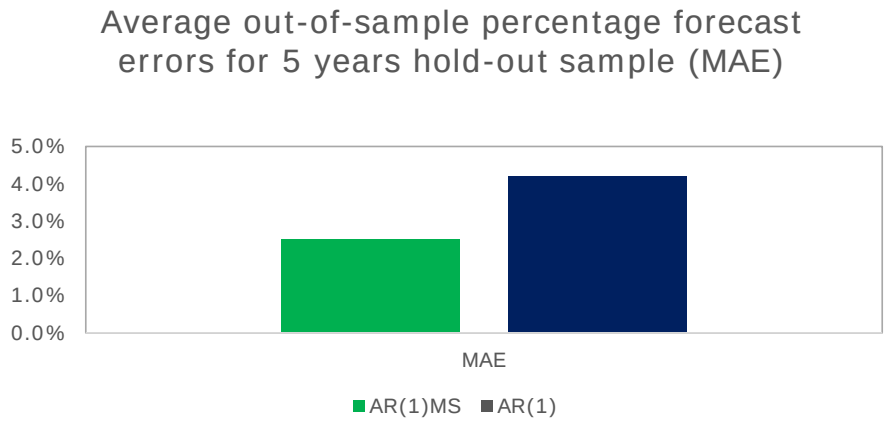
Forecast performance benchmarking

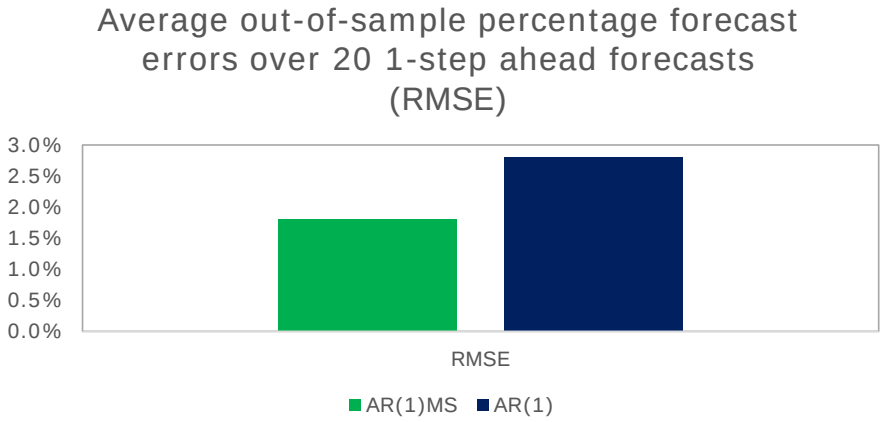
Does it forecast better than the next-best benchmark model?

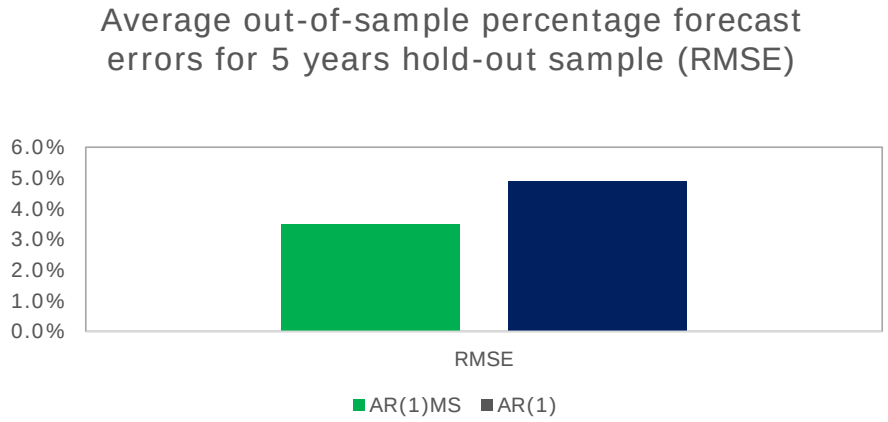
Performance benchmarking

For short-run forecasts, forward-chaining 1-step ahead cross-validation indicates that the AR(1)MS-Model outperforms a AR(1) model significantly. **For longer-run forecasts**, similar conclusion can be reached for a 5 year hold-out sample test.









Areas in further development

What’s next?

Areas in further development

Looking ahead

Development areas	Benefits	Drawbacks
Extend to VAR MS-model	• Capture interdependency among default risk and macro factors **Contagion dynamics** Key topic: *does default risk in one market/industry today affects another tomorrow?* • Capture shifts in paradigm of macro factors. • Self-sufficient forecasting system.	• Require even more data • More complex to implement • May not lead to improve forecast precision
Extend to provide interval forecasts	• Align with BOE stress-testing format with multiple scenarios under both baseline and stressed setting. • Provide a distributional perspective to forecast uncertainties allowing for deviations from normality assumptions.	• No close-form solutions and will require Monte Carlo simulation.

Questions?

Thank you!

Deloitte.