

COVID Scenarios for Treasury Risks: Integrating ALM & Liquidity Behavioural Models

Introduction & Speakers



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Agenda

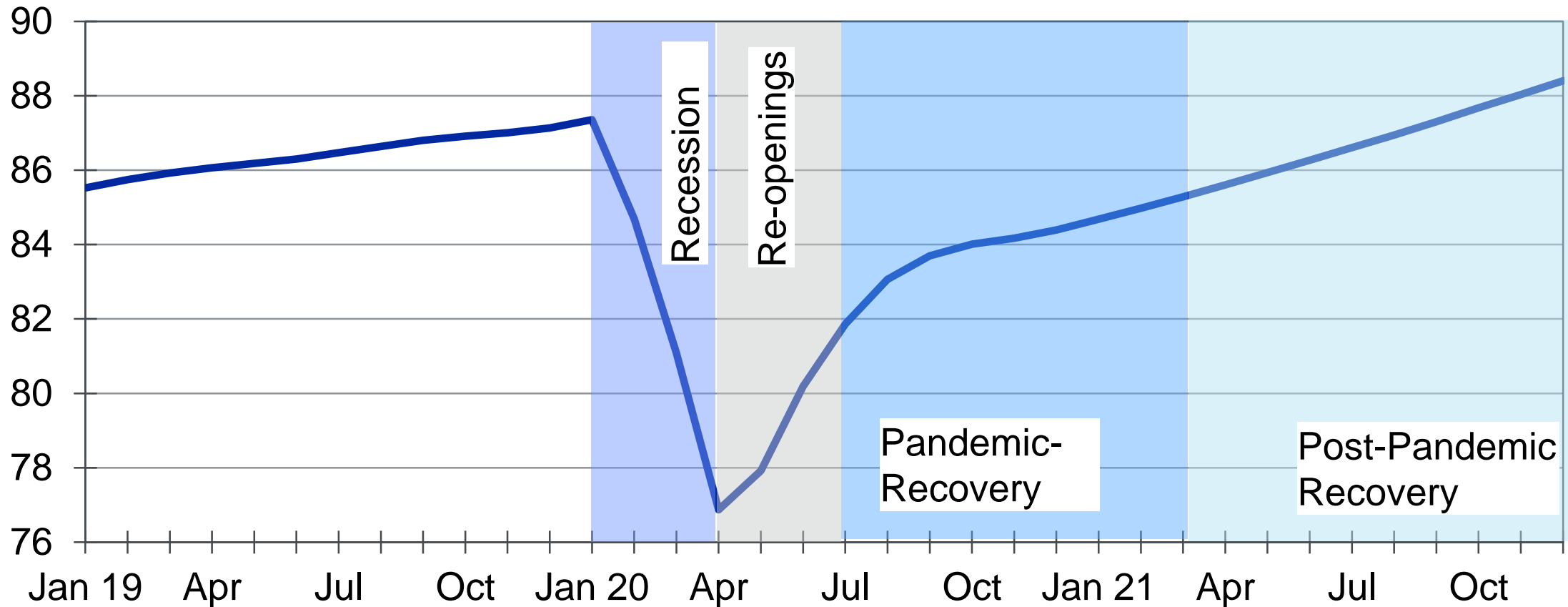
1. Economic and Interest Rate Outlook for the U.K.
2. Analytical Framework: Scenarios and Behavioral Models
3. Balance Sheet Impacts: The Pandemic and Beyond

1

Economic and Interest Rate
Outlook for the U.K.

Global Economy Struggles To Gain Traction

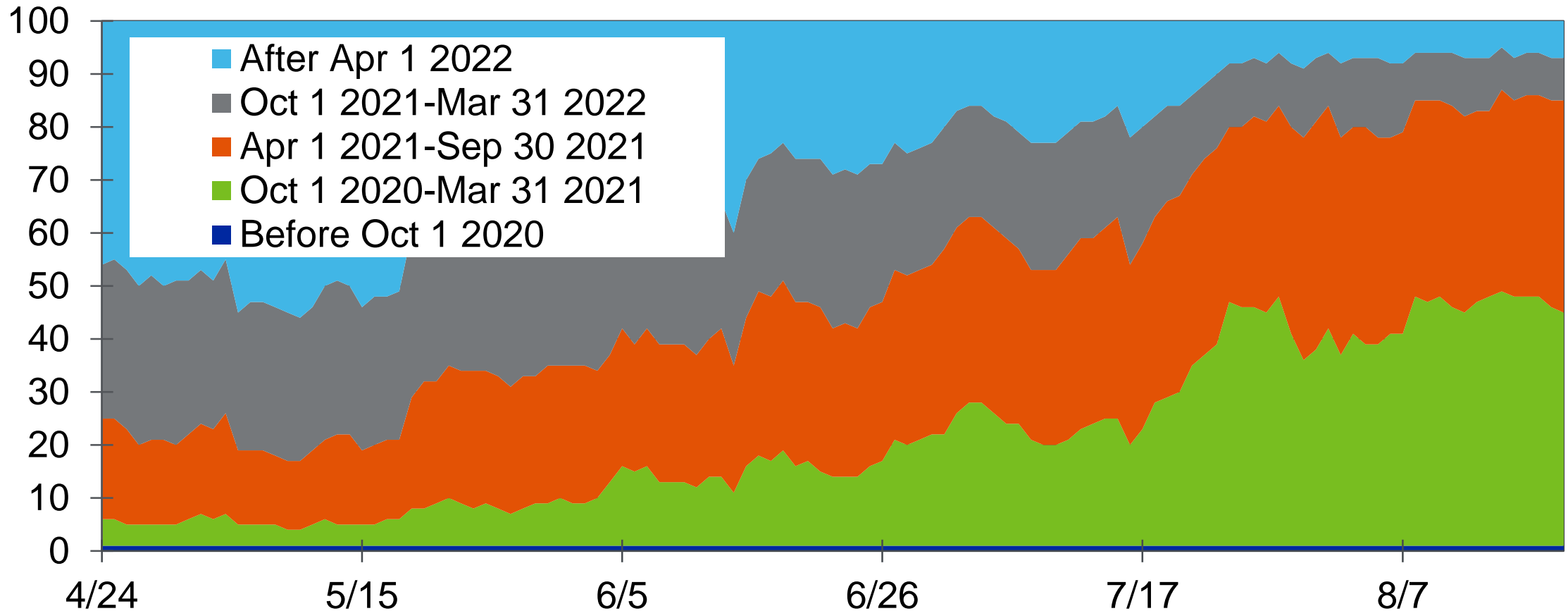
Global Real GDP, Trillions 2012\$



Sources: Government sources, Moody's Analytics

When Will There Be an Effective Vaccine

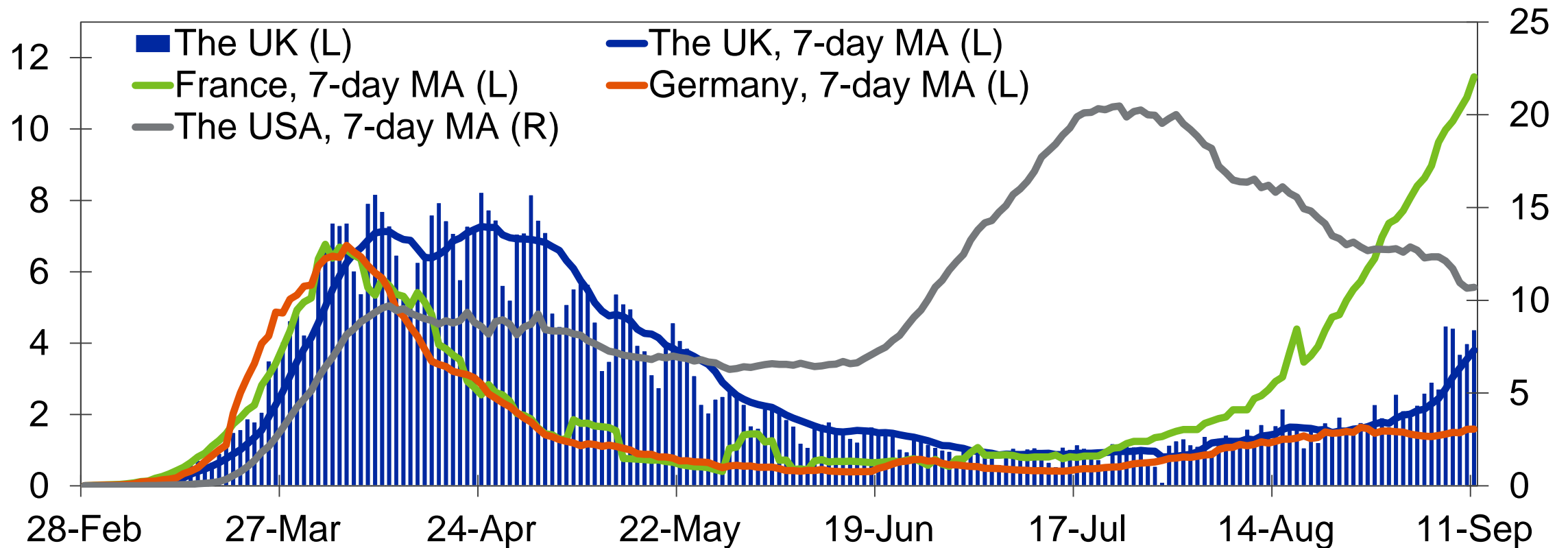
Probability, timeframe for 25 million inoculations in the U.S. (8/20)



Sources: Good Judgment Project, Moody's Analytics

Rising Number of Infections

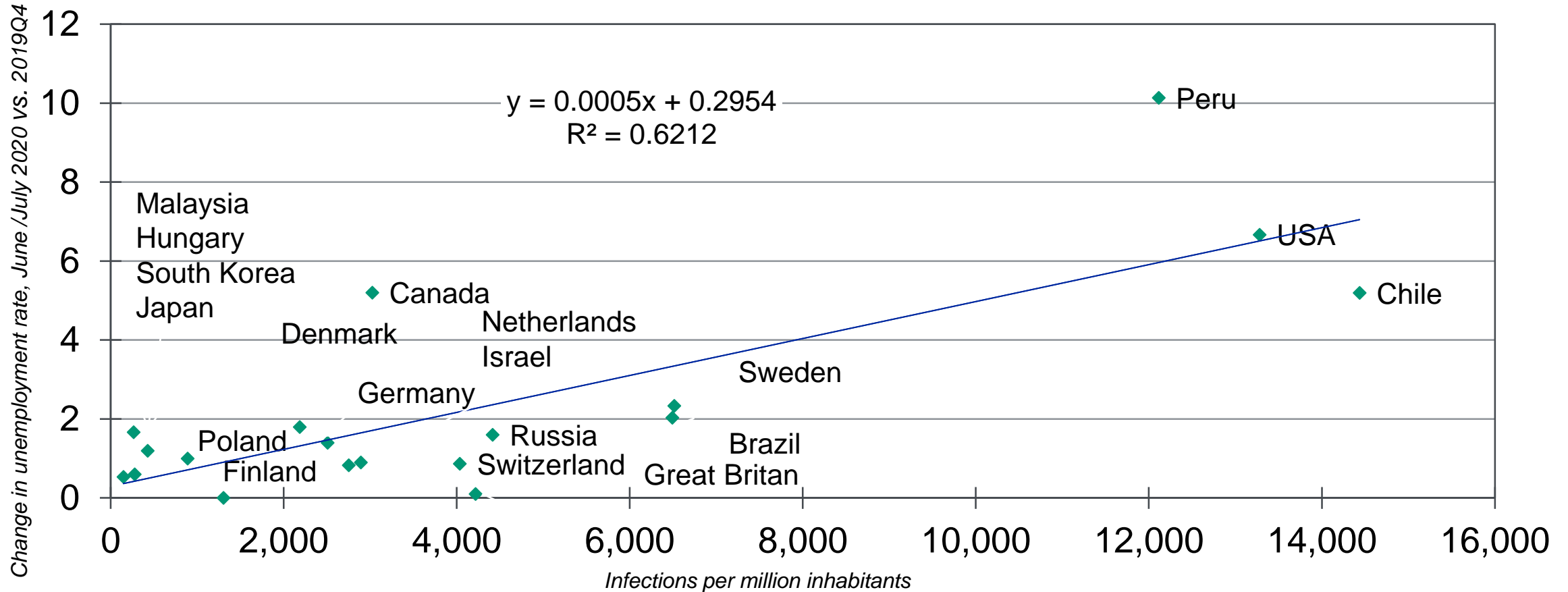
Coronavirus reported cases per 100,000 population



Sources: WHO, Moody's Analytics

More Infections...Weaker Economy

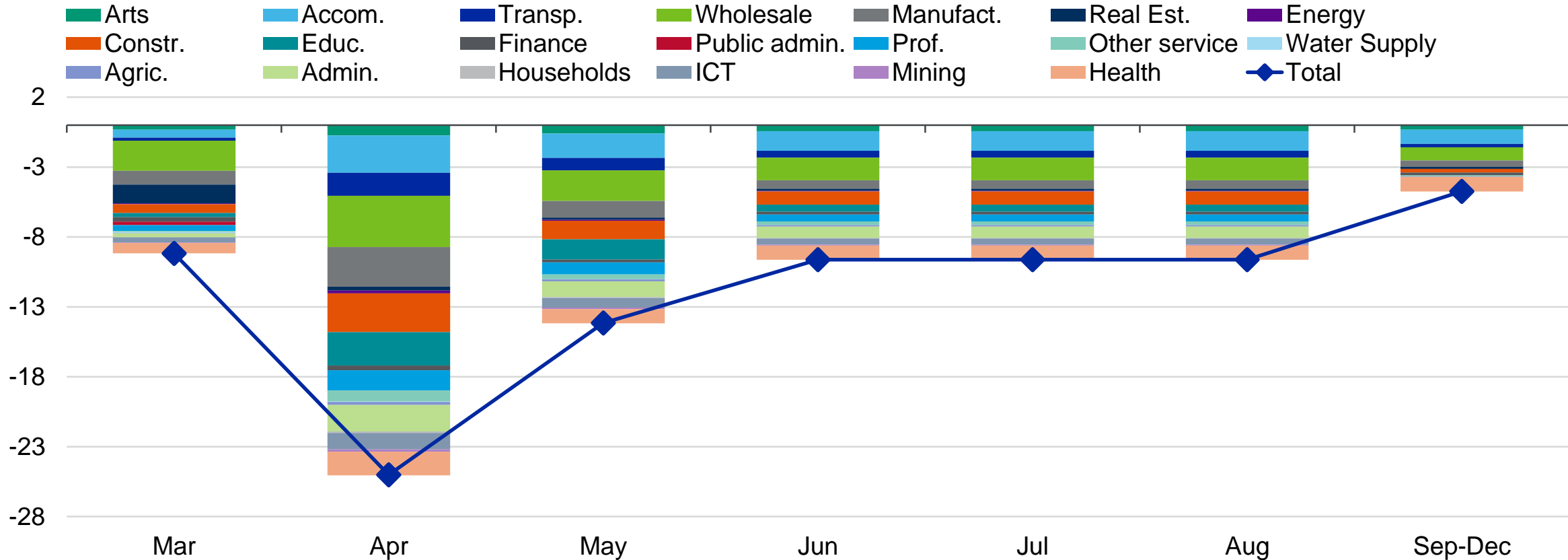
Confirmed infections vs. change in unemployment



Sources: WHO, Government sources, Moody's Analytics

Output Declines Dramatically in Q2

Deviation from normal level of activity, ppts, by industry



Sources: Moody's Analytics calculated

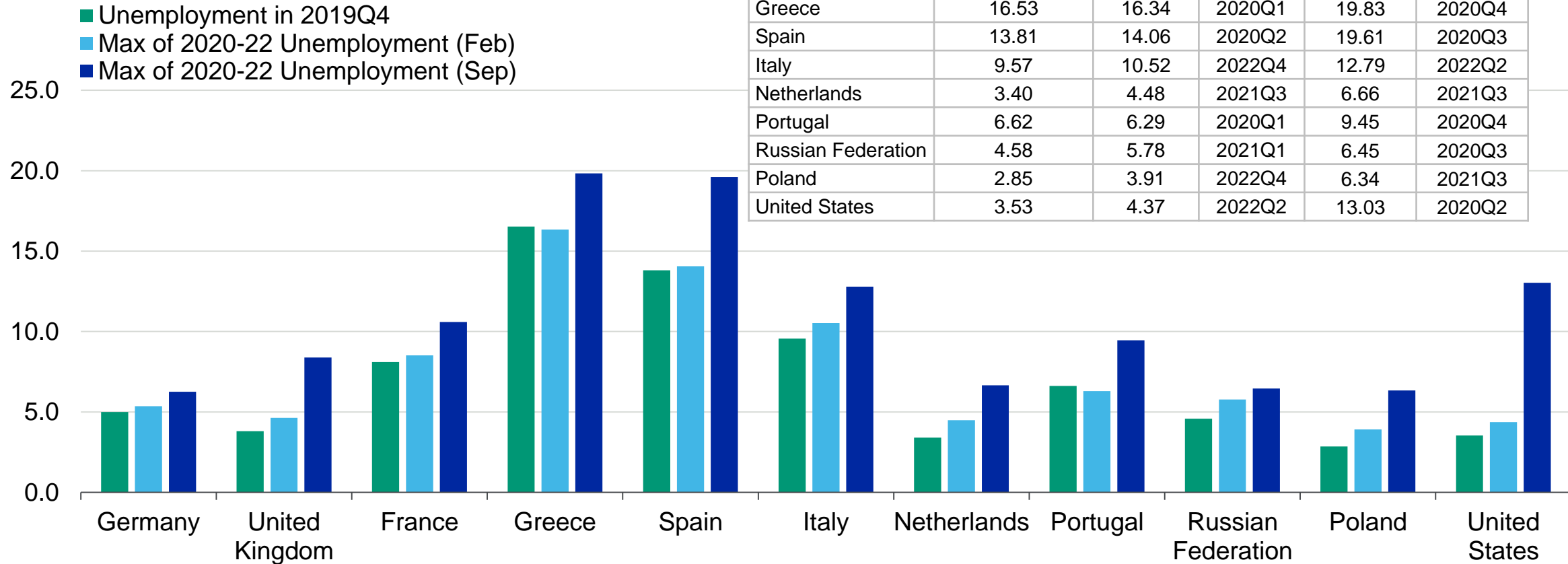
Global Economic Body Blow

Real GDP growth, % change, baseline scenario

		2020Q1	2020Q2	2020Q3	2020Q4	2019	2020
United States	February	0.3	0.5	0.5	0.4	2.3	1.7
	May	-1.2	-9.4	3.8	0.2	2.3	-5.7
	September	-1.3	-9.1	6.1	0.7	2.2	-4.3
Euro Zone	February	0.4	0.4	0.4	0.4	1.2	1.3
	May	-3.8	-12.4	12.7	0.5	1.2	-7.0
	September	-3.7	-12.3	9.8	1.0	1.2	-8.0
UK	February	0.3	0.3	0.3	0.3	1.3	1
	May	-2.3	-14.2	10.9	2.2	1.4	-7.4
	September	-2.2	-20.4	17.3	1.8	1.4	-9.8
Italy	February	0.2	0.2	0.2	0.2	0.2	0.4
	May	-4.8	-16.4	18.0	1.7	0.3	-9.0
	September	-5.5	-12.8	11.6	1.8	-0.3	-9.5
Spain	February	0.4	0.4	0.5	0.5	2.0	1.8
	May	-3.4	-15.7	18.4	0.4	2.0	-6.7
	September	-5.2	-18.5	13.7	2.6	2.0	-12.0
Ireland	February	2.1	1.2	0.5	-0.3	5.6	4.0
	May	-2	-15.9	11.8	1.2	5.5	-6.5
	September	1.17	-19.87	11.56	-0.11	5.54	-7.26
Global Output	February	0.4	0.9	0.8	0.7	2.5	2.4
	May	-3.1	-6.7	5.2	1.6	2.4	-4.5
	September	-2.93	-7.58	6.10	1.94	2.38	-4.63

Unemployment Increases

Shift of baseline scenarios



Policy Response

Baseline Assumptions

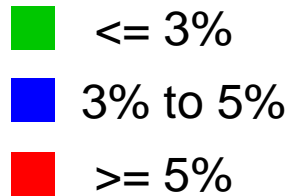
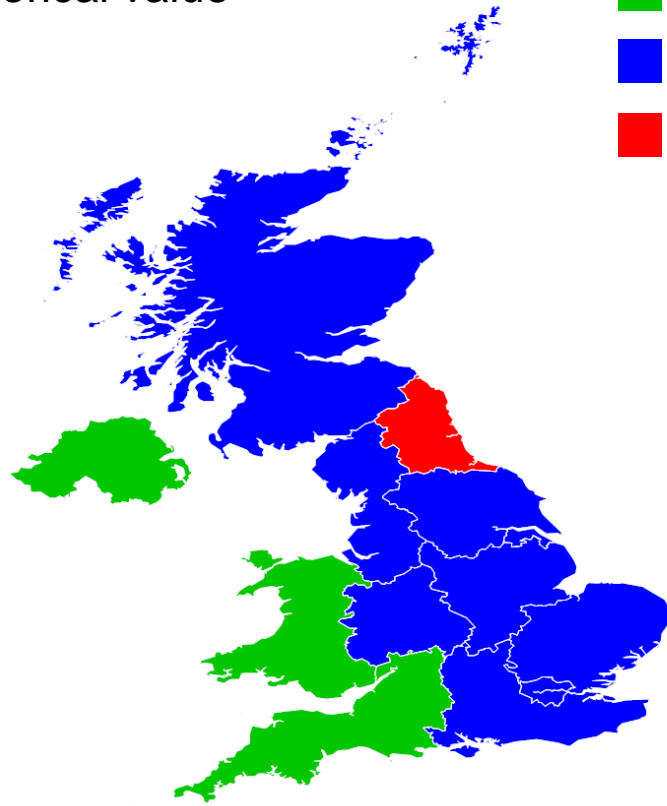
- » The catalysts are the COVID-19 crisis, turmoil in equity markets, and the plunge in global oil prices
- » In June and May, the decline is driven almost entirely by the government's lockdown measures in a bid to contain the virus, with the tourism and entertainment sectors taking the hardest hit.
- » The lockdown is lifted by summer and the supply side of the economy starts to recover
- » Real estate sector will produce 20% less output in the second quarter of 2020 compared to the period prior to the crisis.
- » The U.K. economy should rebound in 2021 following the resolution of the coronavirus crisis and signing of the trade deal

Country	Fiscal policy	Monetary policy
United Kingdom	<ul style="list-style-type: none"> » Coronavirus Job Retention Scheme & Self-employment Income Support Scheme » State-backed loans £330bn » £7bn to support the self-employed, businesses and vulnerable people; £5bn emergency response fund to help the National Health Service (NHS) and other public services; £18 billion of “fiscal loosening” to support the economy this year » Deferring VAT and Income Tax payments; Statutory Sick Pay relief package for small and medium sized businesses (SMEs); » 12-month business rates holiday for all retail, hospitality, leisure and nursery businesses in England; Small business grant funding of £10,000 for all business in receipt of small business rate relief or rural rate relief; The Coronavirus Business Interruption Loan Scheme offering loans of up to £5 million for SMEs through the British Business Bank » June - Increase capital spending to 3% of GDP, speed up £5 billion of repairs on roads, schools, hospitals. » June – additional £50 borrowing plans (2.5% of GDP) 	<p>BoE:</p> <ul style="list-style-type: none"> » Monetary policy rate at 0.1% » Reduced capital (banks shall not pay dividends in 2020) – release lending up to £190 billion » Covid Corporate Financing Facility will provide a quick and cost-effective way to raise working capital for those large firms who need it » Quantitative Easing (March 2020) – the target holding of government bonds is £645 billion » QE (June) – expand by £100 billion

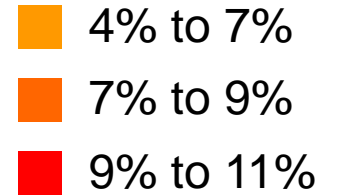
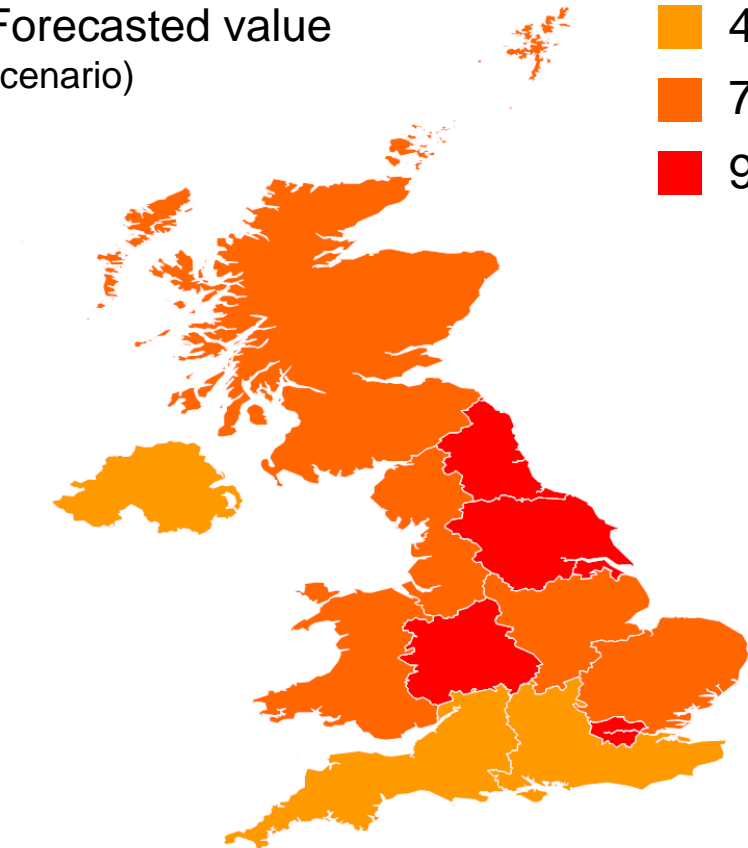
Regional Shocks to Unemployment Rate (NUTS3)

UK regions: level 2019 vs. 2020 (baseline forecast)

2019Q4 Historical value

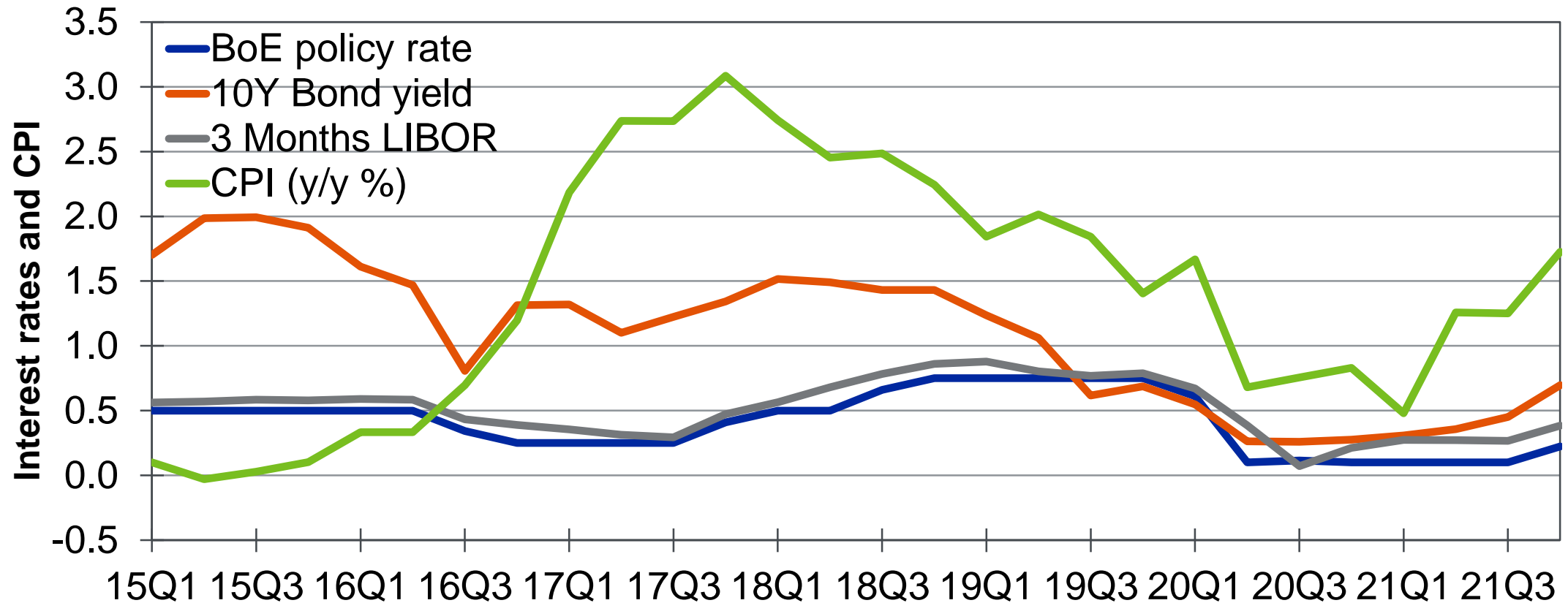


2020Q4 Forecasted value
(Baseline Scenario)



UK Interest Rates Remain Low

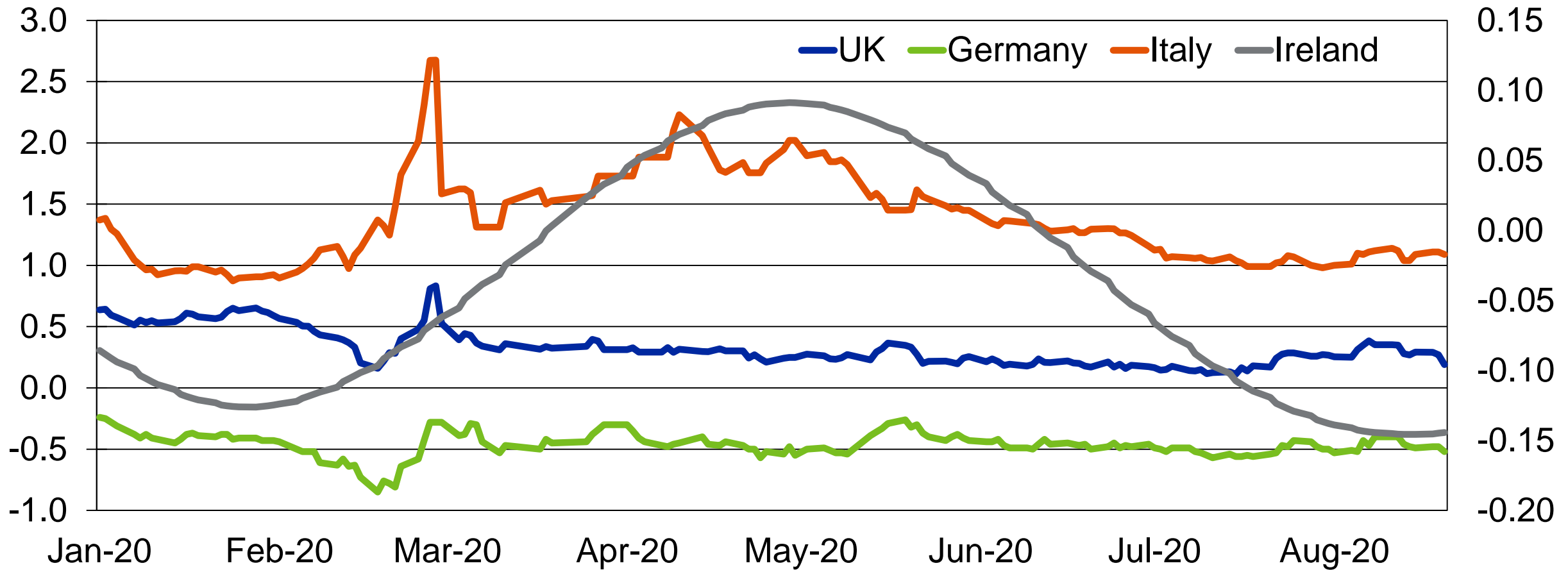
Key interest rates and Inflation



Sources: BoE, ONS, Moody's Analytics

Yields Drifting Sideways

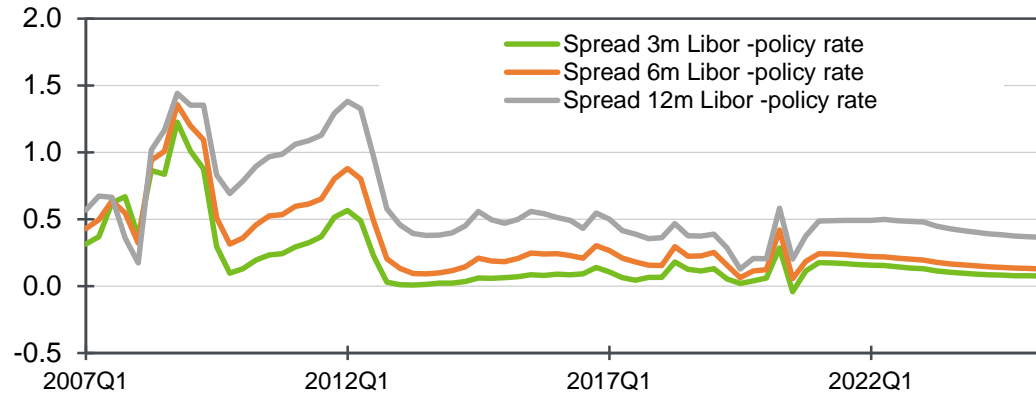
10-year Sovereign Bond Yields, %



Sources: Bank of England, Deutsche Bundesbank, Central Bank of Italy, Moody's Analytics

Spread: Libor – Policy Rate

Spreads, %



Dependent Variable: D(FRILIBOR12M_IGBR-FRMP_IGBR)

Method: Least Squares

Date: 10/03/19 Time: 04:51

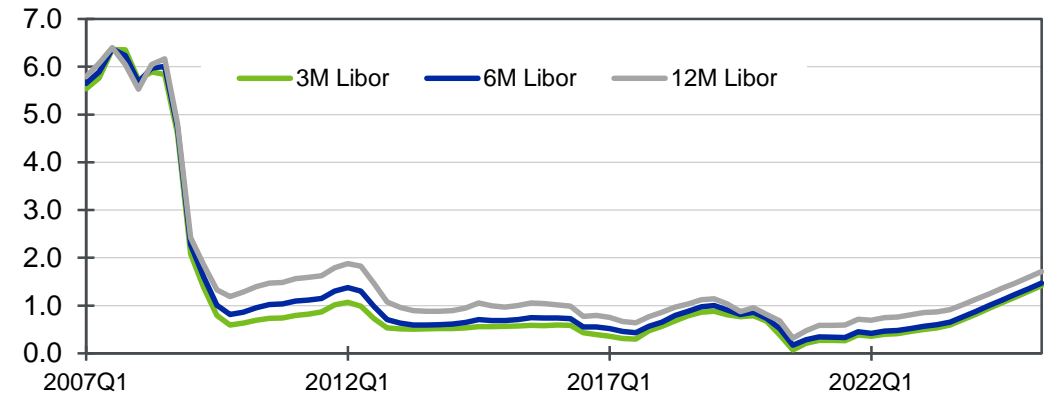
Sample (adjusted): 1987Q2 2019Q2

Included observations: 129 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FRILIBOR12M_IGBR(-1)-FRMP_IGBR(-1)	-0.4533943237373811	0.102	-2.777	0.006
D(FRILIBOR3M_IGBR-FRMP_IGBR)	1.374	0.121	11.397	0.000
D(FRILIBOR12M_US-FRFD_US)	0.161	0.056	2.859	0.005
R-squared	0.619	Mean dependent	0.004	
Adjusted R-squared	0.613	S.D. dependent	0.317	
S.E. of regression	0.197	Akaike info criter	-0.386	
Sum squared resid	4.903	Schwarz criterion	-0.319	
Log likelihood	27.865	Hannan-Quinn cr	-0.358	
Durbin-Watson stat	1.716			

Sources: Central banks, Moody's Analytics

Level, %

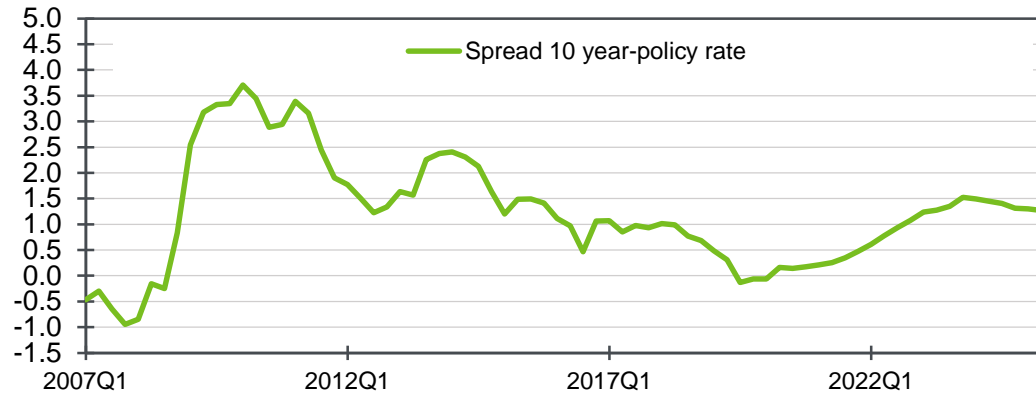


Key drivers of the spread of 12M Libor from the policy rate are the following factors:

- Spread of the US 12M Libor from the Fed policy rate
- Spread of the UK 3M Libor from the BoE policy rate
- As the spread is increasing in the USA Libor, the spread in the UK Libor will be increasing too

Spread: 10-year Bond Yield – Policy Rate

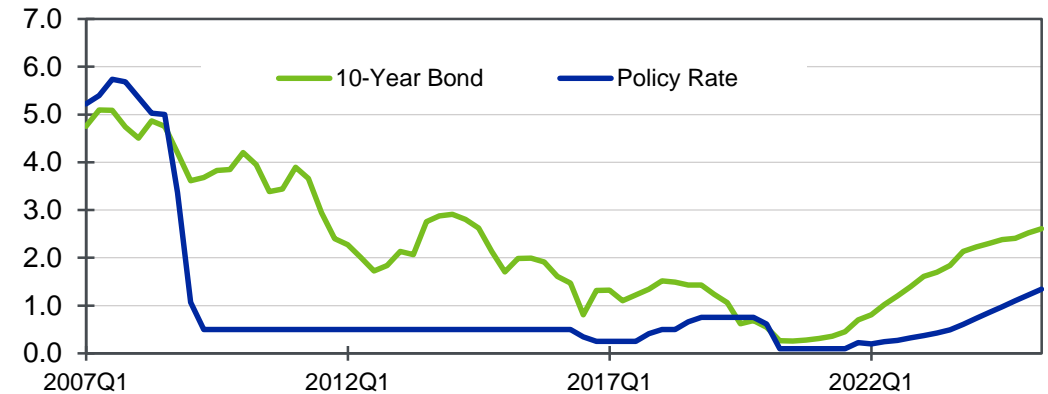
Spreads, %



Dependent Variable: D(FRGT10Y_IGBR-FRMP_IGBR)
 Method: Least Squares
 Date: 10/03/19 Time: 04:51
 Sample (adjusted): 1999Q2 2017Q3
 Included observations: 74 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FRGT10Y_US-FRFD_US)	0.171	0.075	2.285	0.03
D(FRGT10Y_IDEU-FRMP_IDEUN)	0.657	0.091	7.221	0.00
FRGT10Y_IGBR(-1)-FRGT3M_IGBR(-1)	-0.033	0.017	-1.916	0.06
FRGT10Y_IGBR(-1)-@PCY(FGDP_POT_IGBR(-1))	-0.018	0.020	-0.914	0.36
DUM_FINCRISIS_IGBR(-1)	0.388	0.094	4.132	0.00
R-squared	0.753	Mean dependent var		0.030606
Adjusted R-squared	0.739	S.D. dependent var		0.430213
S.E. of regression	0.220	Akaike info criterion		-0.126691
Sum squared resid	3.335	Schwarz criterion		0.028989
Log likelihood	9.688	Hannan-Quinn criter.		-0.064589
Durbin-Watson stat	1.952			

Level, %



Key drivers of the spread of 10 year bond from the policy rate are the following factors:

- Spread of the US 10 year bond from the Fed policy rate
- Spread of German 10 year bond from the ECB policy rate
- As the spread is increasing in the USA and Germany, the spread in the UK will be increasing too

Sources: Central banks, Moody's Analytics

Risks: Epidemiological U.K. Assumptions

COVID-19: Upside S1 Scenario

- » 450K confirmed infections
- » 4,5mil total cases
- » 63K total deaths
- » Infections abate by Feb 2021

COVID-19 Baseline Forecast

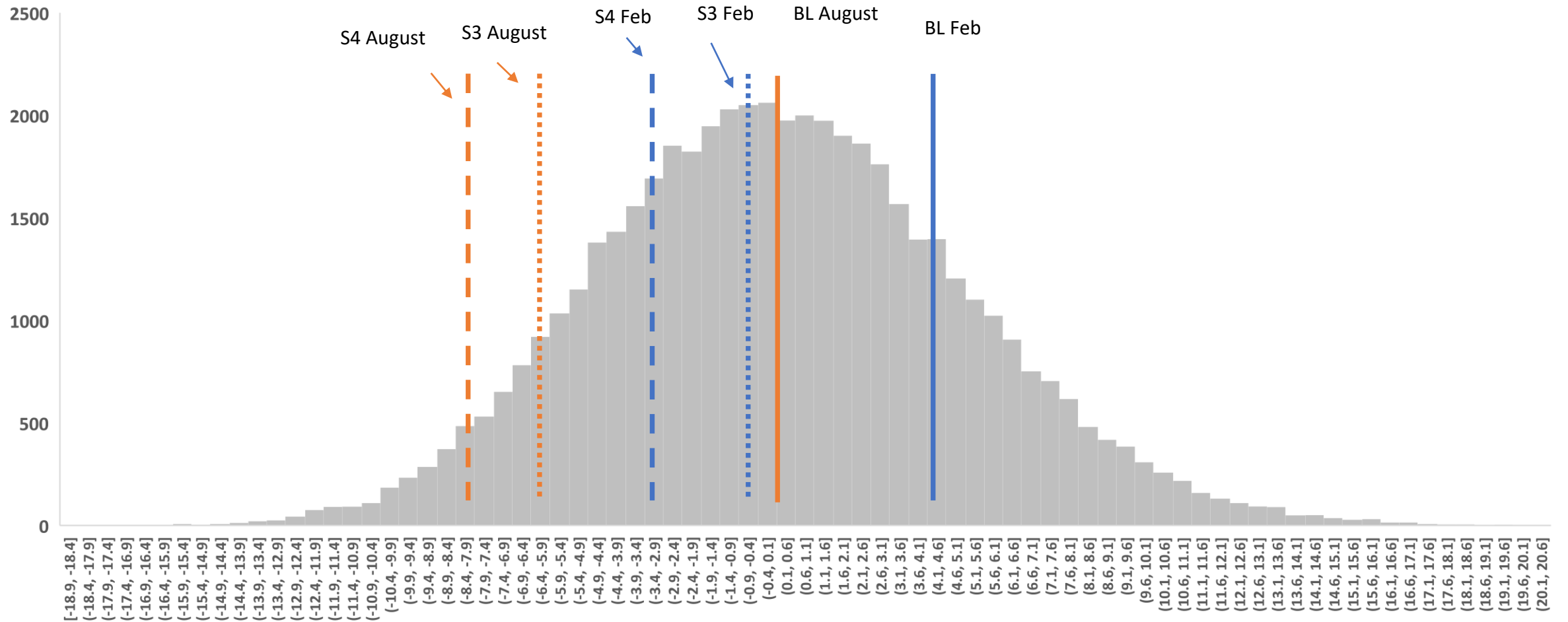
- » 500K confirmed infections
- » 5mil total cases
- » 75K total deaths
- » Infections abate by May 21

COVID-19: Downside S3 Scenario

- » 660K confirmed infections
- » 5.7mil total cases
- » 138K total deaths
- » Infections abate by Oct 2021

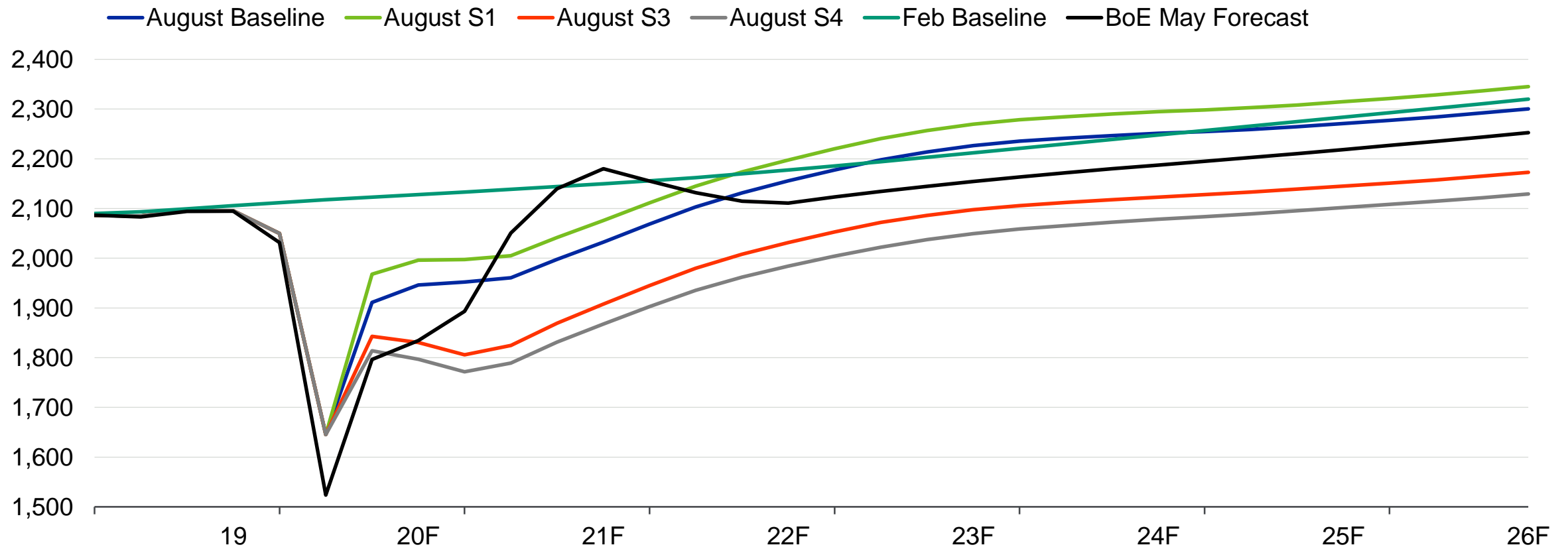
Severity, avg. deviations from baseline, %

Deviations from baseline (Standard deviation=4.9)



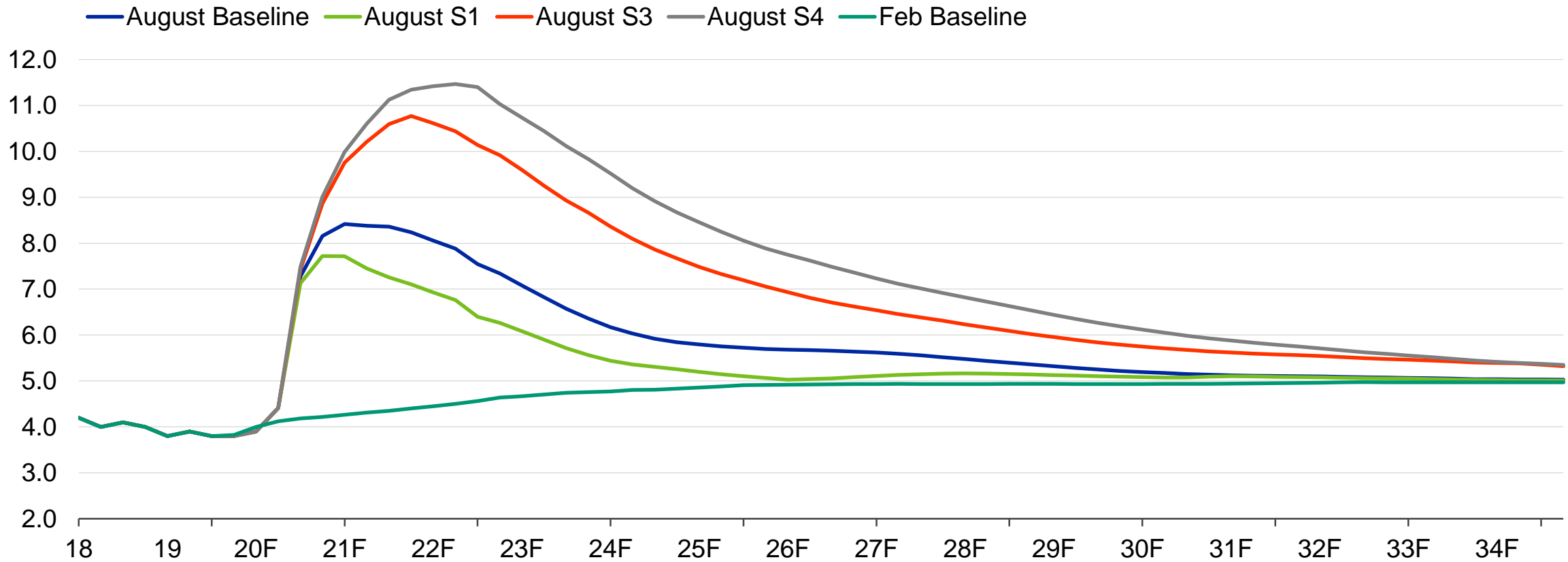
GDP Declines

UK Real GDP level



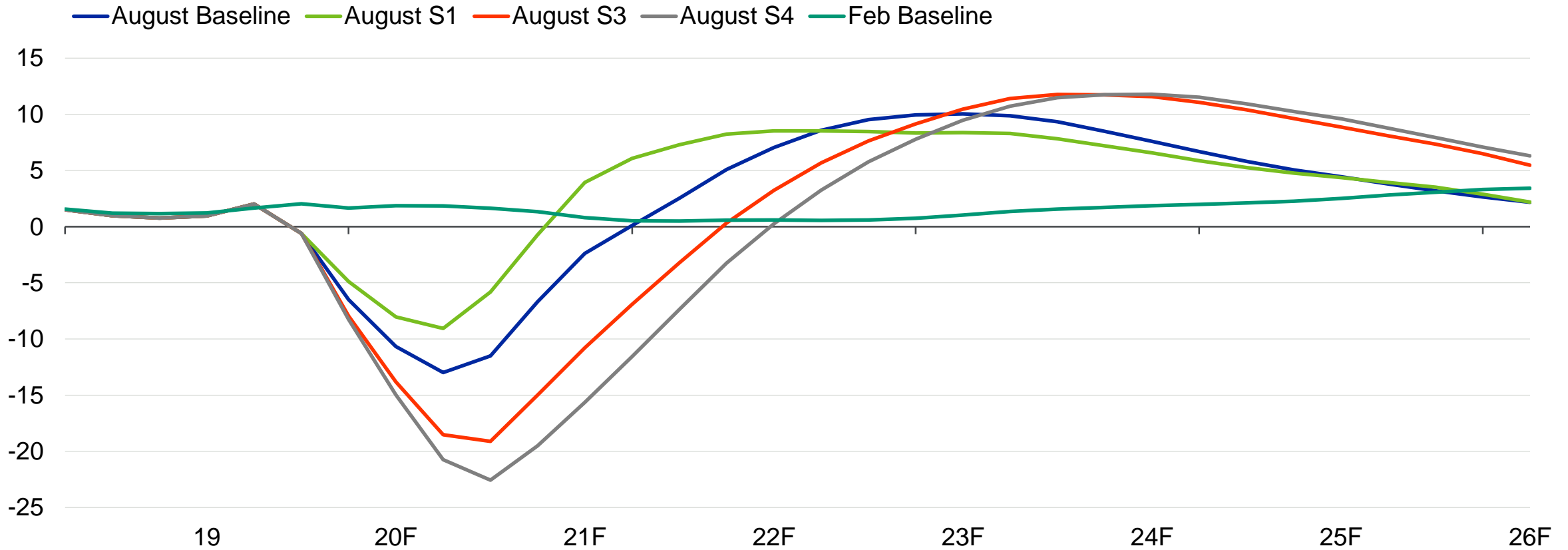
Unemployment Rises

Unemployment rate



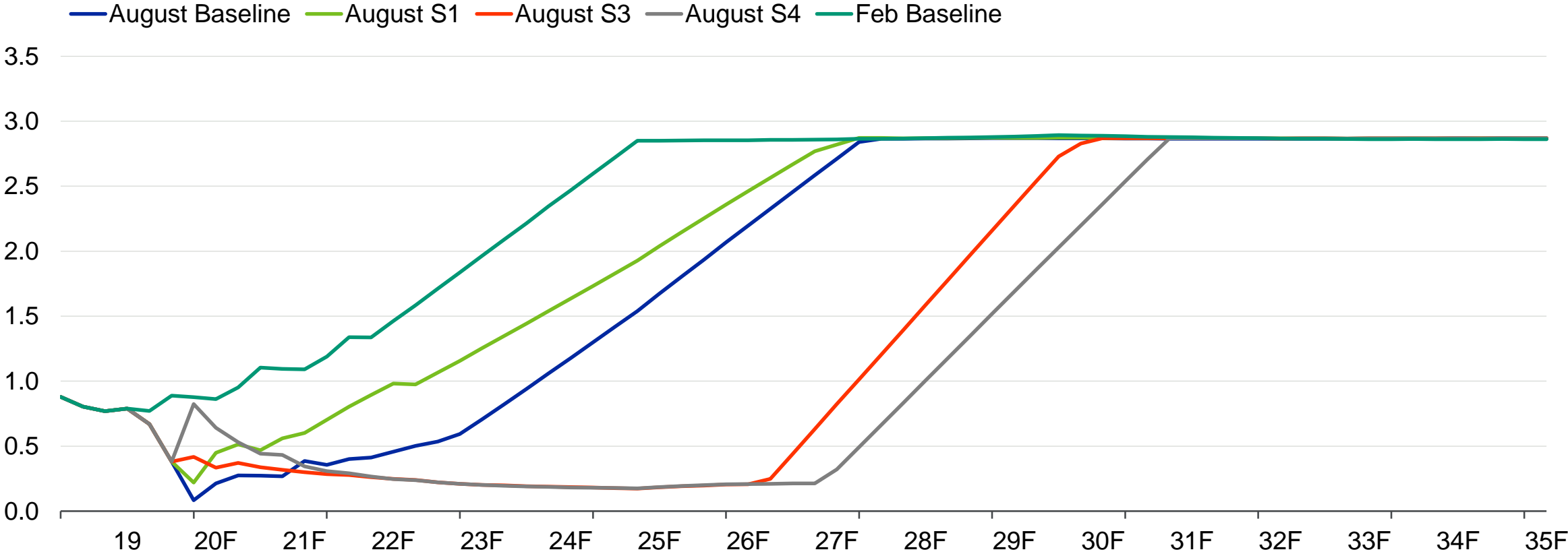
House Prices Decrease

House price growth, % change yr ago



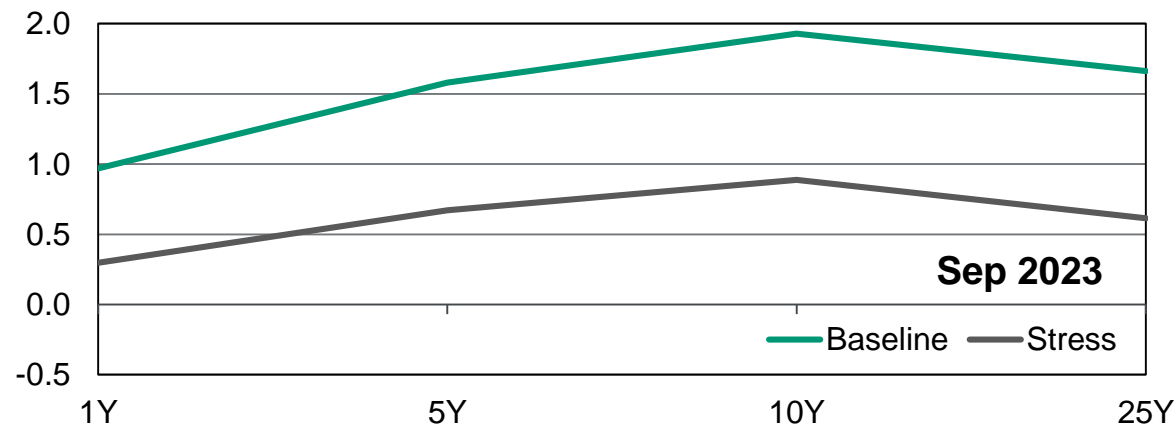
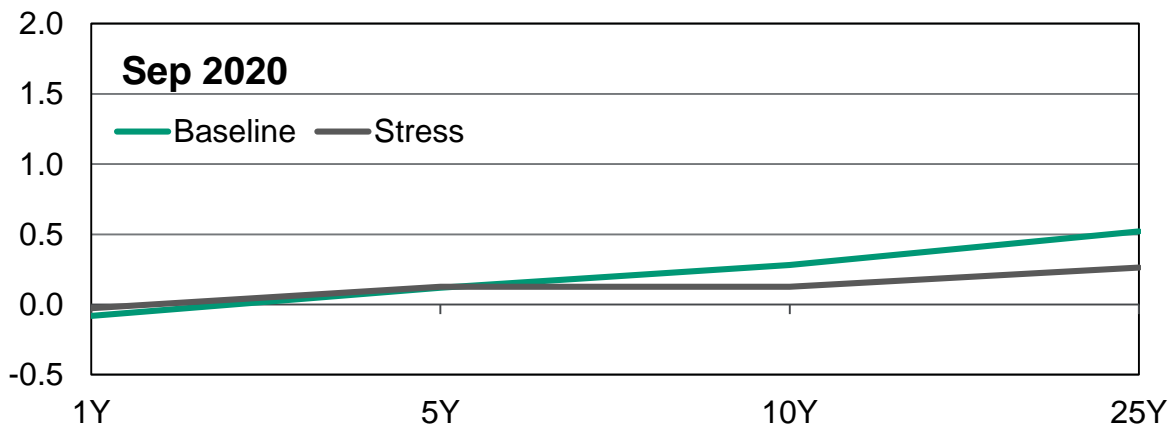
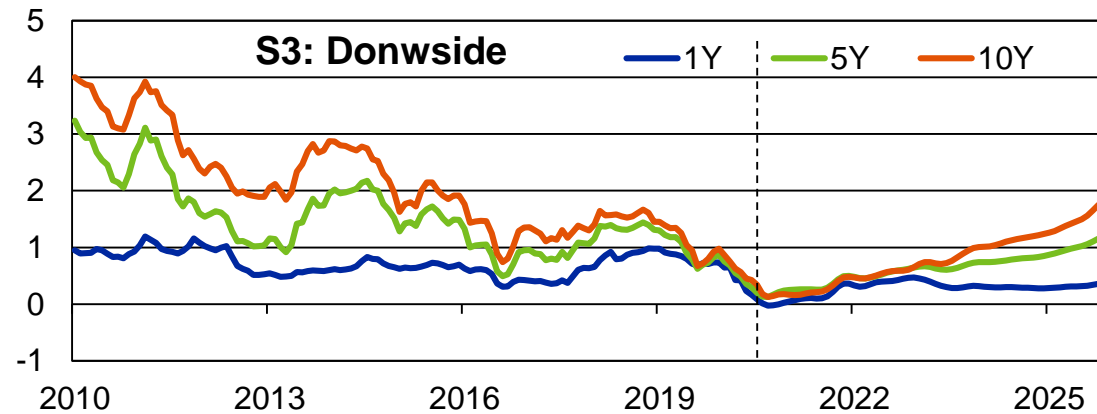
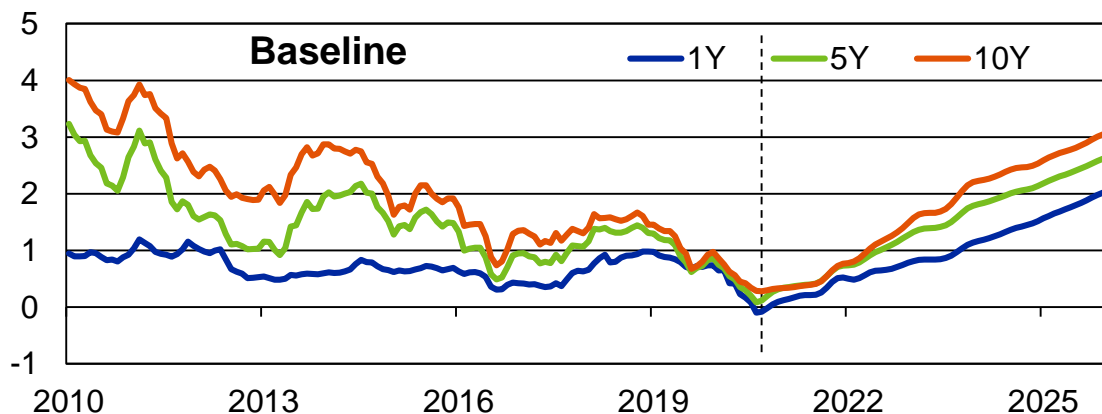
3-months LIBOR

3-months Libor level



Impact on the Yield Curve

Swap Rates: UK Pound Sterling Interest Rate Swap, Month average, (% p.a., NSA)



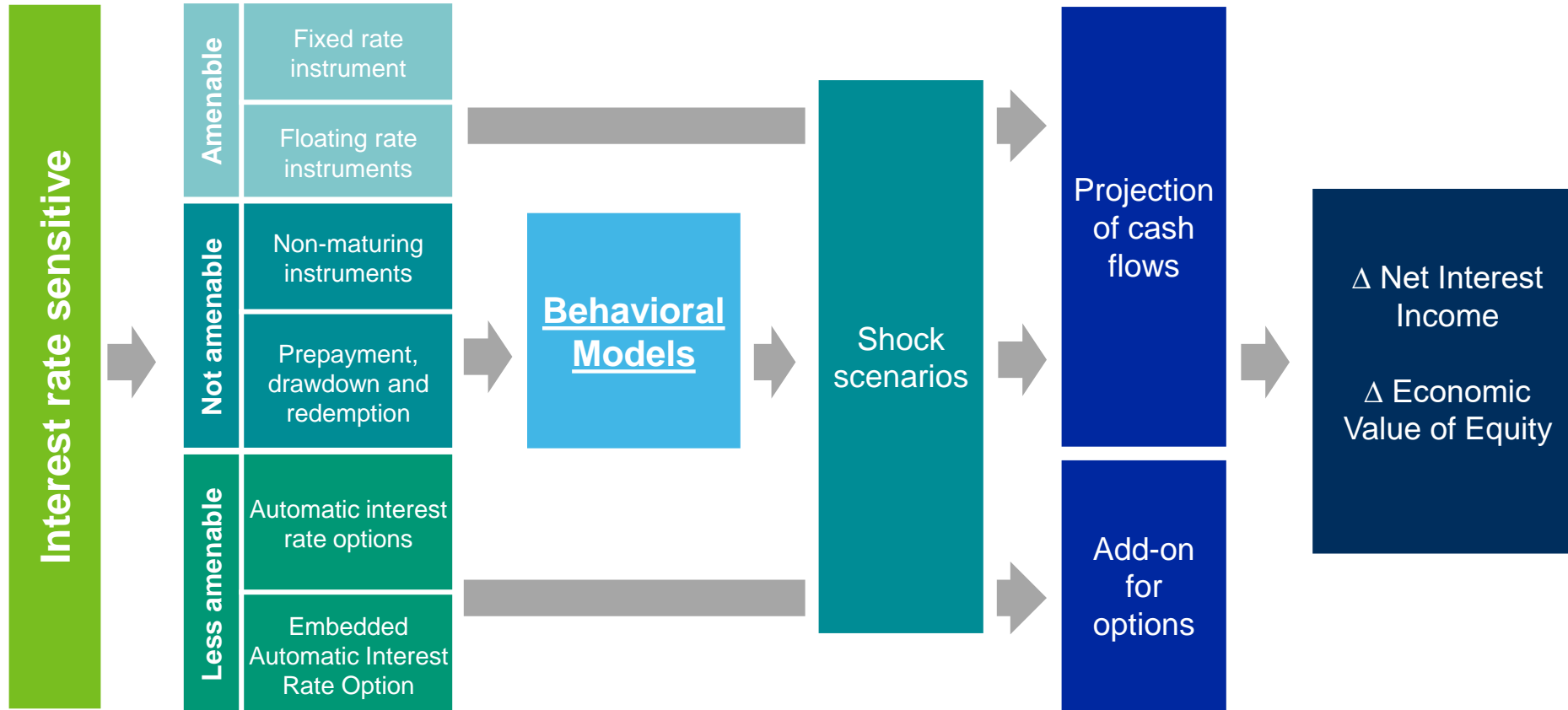
Sources: Refinitiv; Moody's Analytics Calculated and Forecasted

2

Analytical Framework: Scenarios and Behavioral Models

Analytics: Behavioral Models and Scenarios

Satisfy regulation and make results more credible for IRRBB



Challenges of Behaviour Models and Scenarios

For interest rate risk in the banking book, liquidity and credit metrics

Data Availability

- Granularity, frequency, consistency, completeness, and quality
- Limitations can put constraints on the type of modeling techniques
- Macroeconomic scenarios historical data and forecast.

Framework Integrity

- Single view of risk across the bank
- Enforce consistency of results by establishing and common modeling framework
- Model governance, re-calibration updates, monitoring, use test



Model Design

- Building robust models using relevant quantitative methods
- Finding appropriate model specification using variable search algorithms
- Detailed documentation and knowledge transfer

Model Implementation

- Implementation into key interest rate risk and liquidity metric calculations
- Implementation into credit risk metric calculation
- Ensuring continuity through detailed user manuals

Approach to Link Scenarios with Models

Critical for forward-looking planning

1 Macroeconomic Indicators

- Baseline scenario forecast
- Alternative stress scenarios
- Alternative upside scenarios
- Event-driven scenarios
- Regulatory stress testing scenarios

2 Risk Models

- Interest rate term structure
- Customer behavior
- Liquidity risk
- Credit risk and provisioning for regulatory capital, IFRS9
- Early warning indicators

3 Key Measures

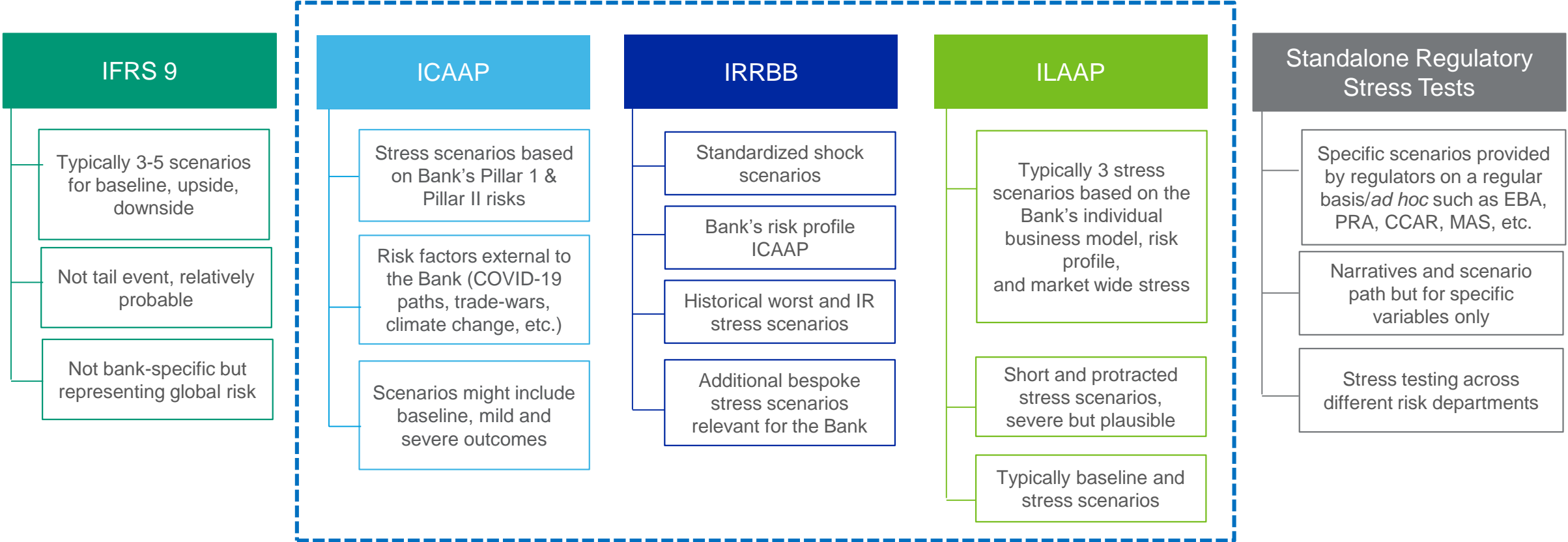
- Liquidity risk gaps, survival period
- Interest risk gaps
- Net interest income
- Economic value of equity
- Balance sheet, P&L, RWA projections
- Expected credit loss
- Internal and regulatory capital requirement

2.1

Scenario Generation for Behavioural Factors

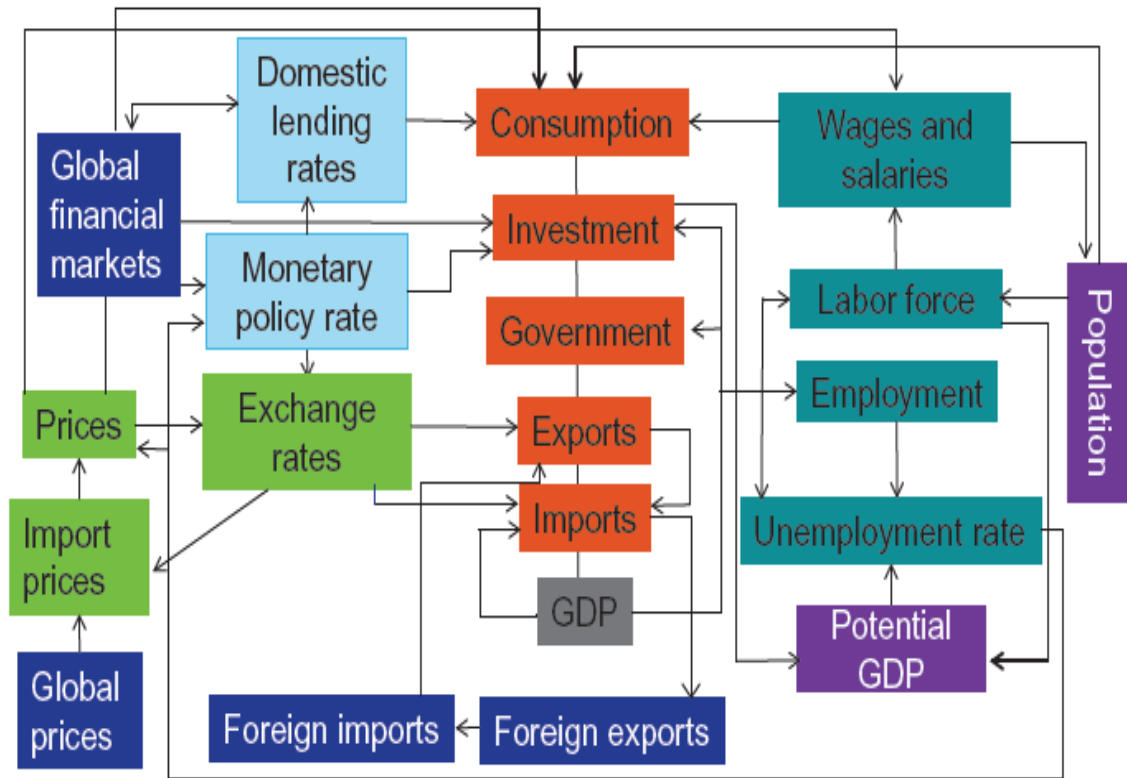
Achieving an Integrated Balance Sheet View

Cross-discipline scenario alignment



Scenario Generation Framework

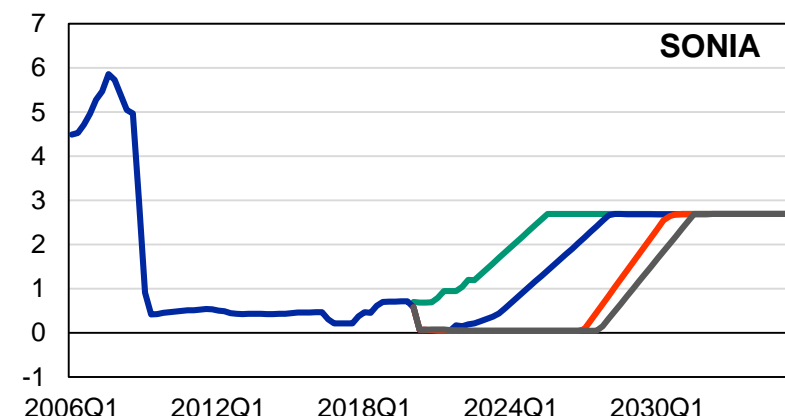
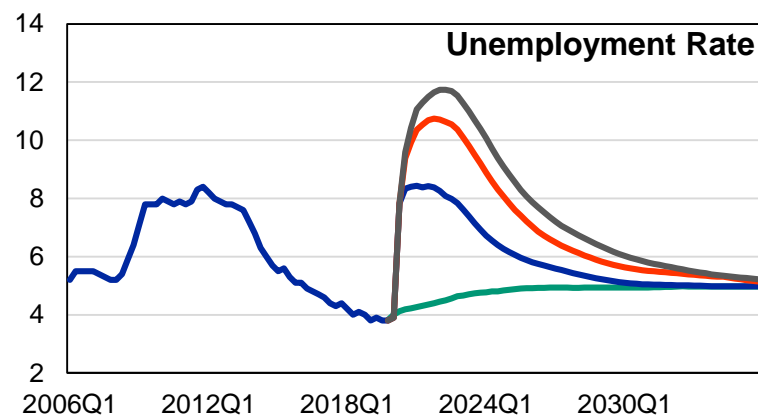
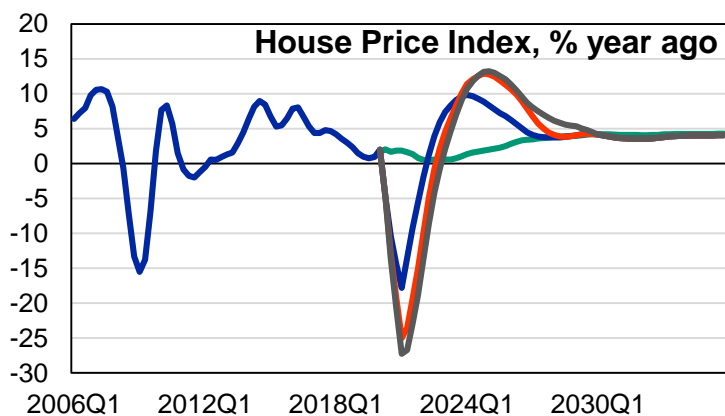
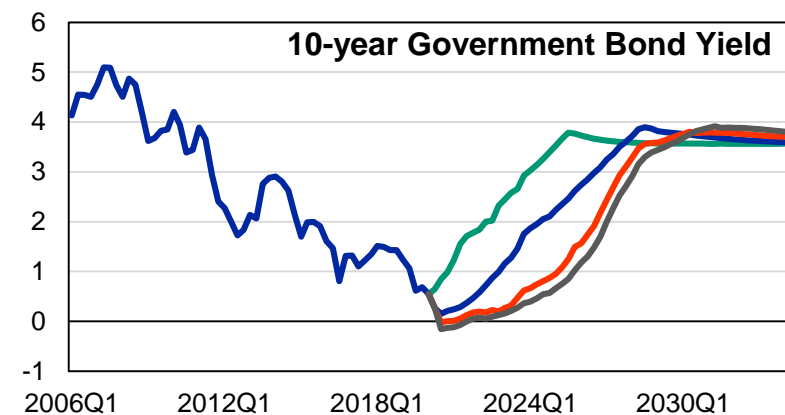
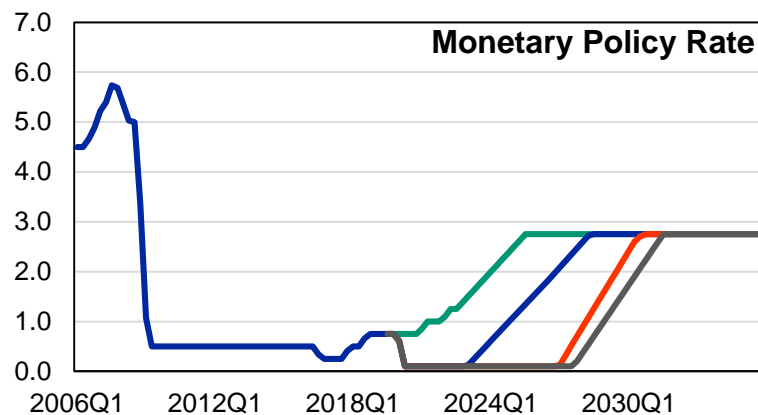
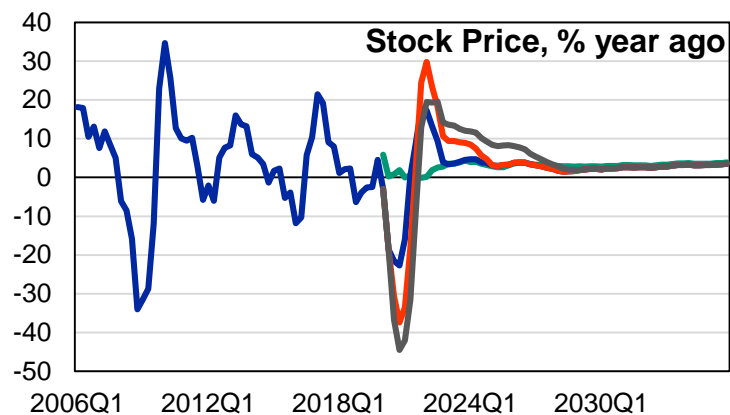
Transmitting shocks through economy to forecast behavioral factors



Core Economic Concepts	Market Risk Indicators
<p>National Accounts Balance of Payments Government Finance Industrial Production Price Indices Key Interest Rates Labor Markets Home Price Indices and many more...</p>	<p>Swap Rates Curves Sovereign Bond Yield Curves Stock Market Indices Implied Market Volatilities Asset-backed Securities Mortgage-backed Securities Corporate and Sovereign CDS by Sector and Rating Corporate and Sovereign Credit Migrations and many more...</p>

Forecast of Selected Behavioural Factors

Severity shift for baseline and two alternative scenarios, examples



— Baseline

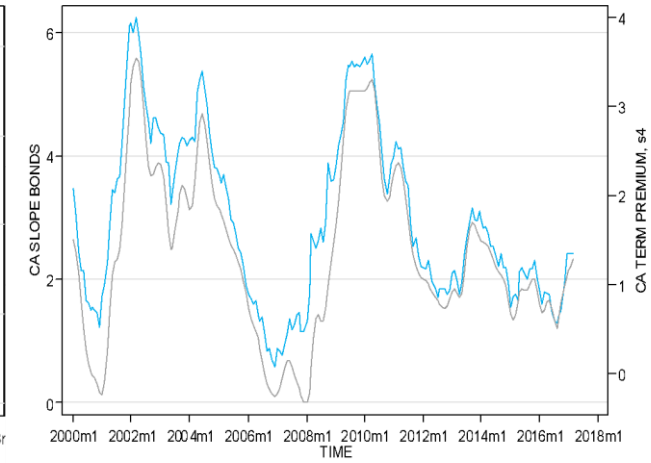
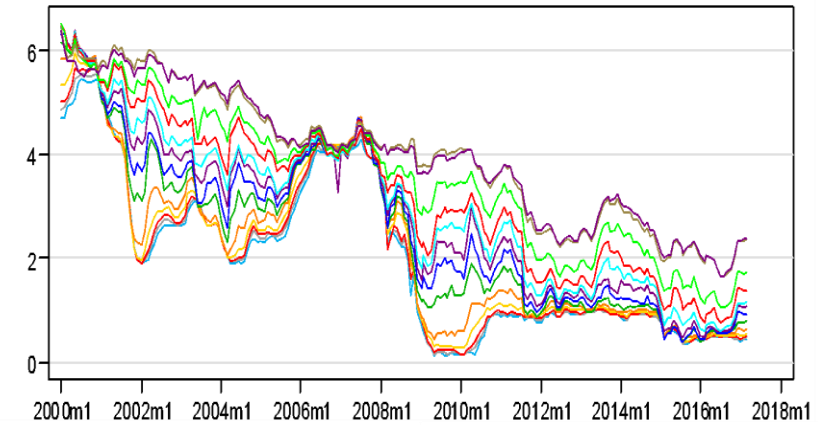
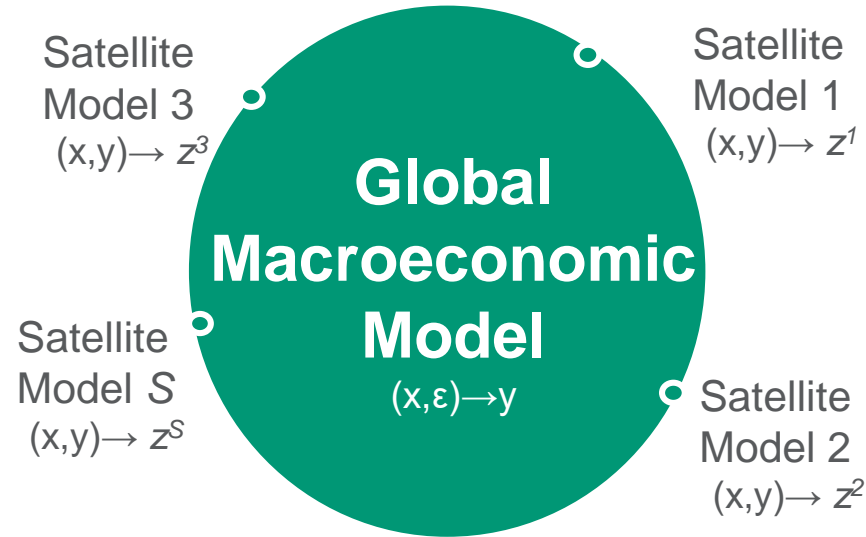
— S3: Downside

— S4: Severe downside

— Baseline pre-pandemic

Modelling Term Structure of Interest Rates

Modified Nelson-Siegel methodology



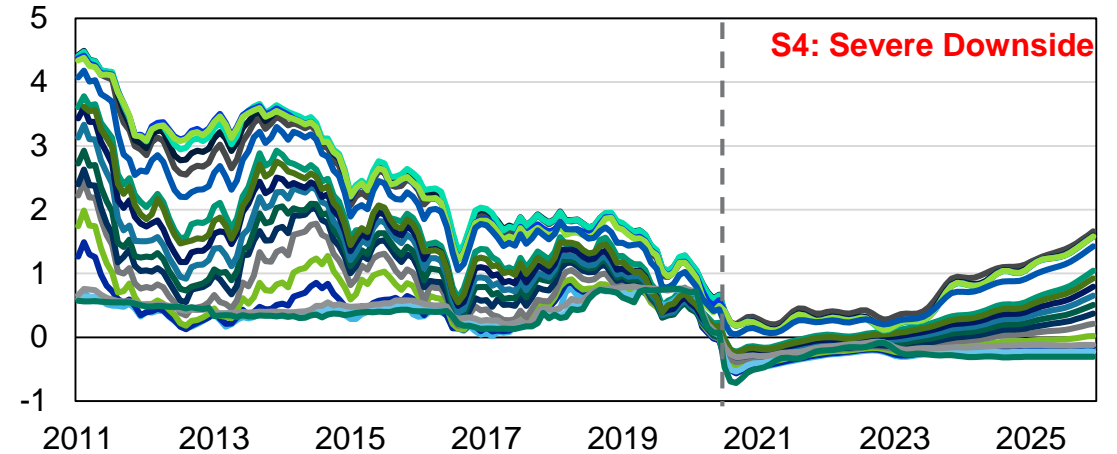
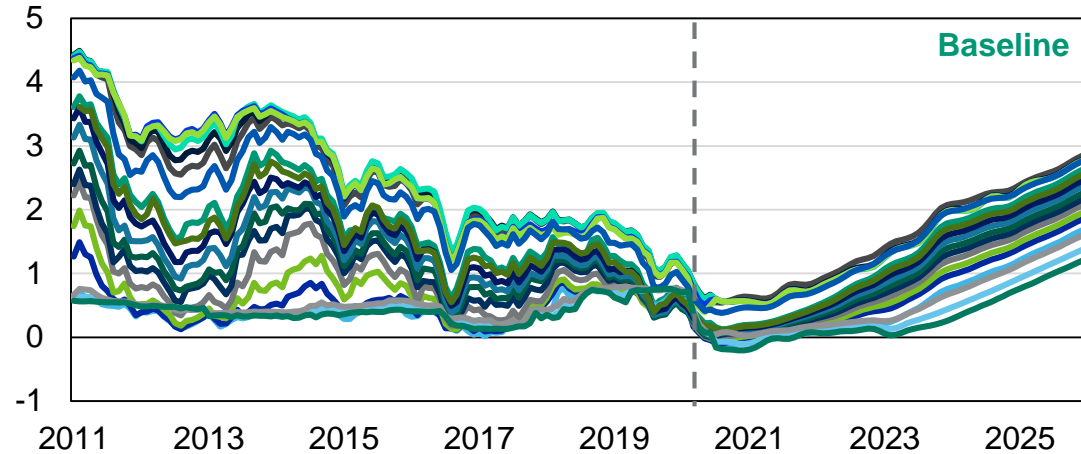
— CA LEVEL BONDS — CA MPOL, s4
— ff_ca_gb10y_s4

— CA SLOPE BONDS — CA TERM PREMIUM, s4

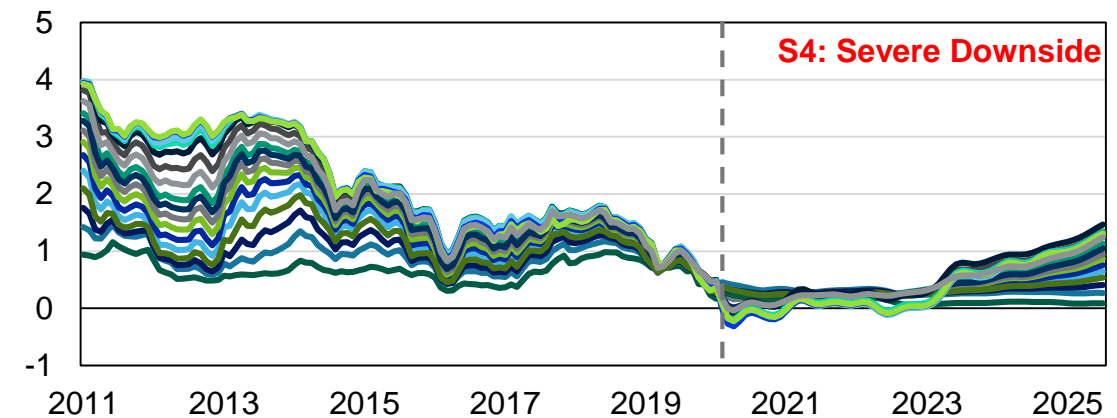
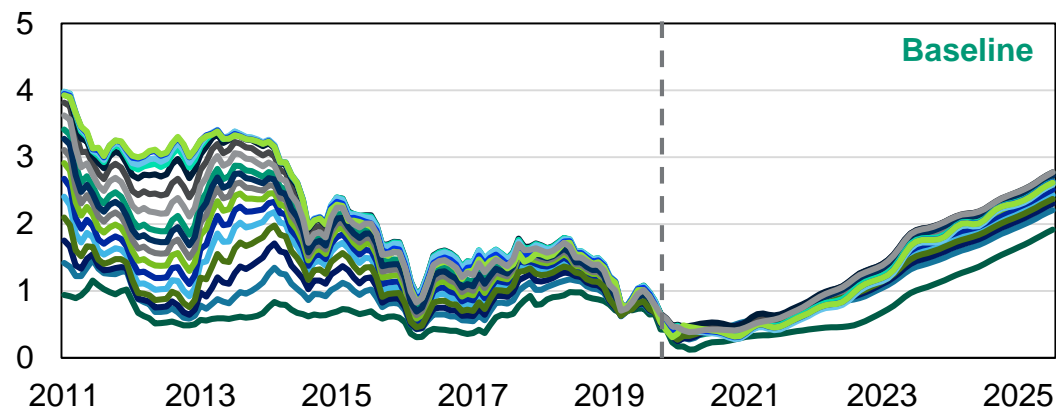
Forecast of Selected Key Behavioural Factors

Government bonds & swaps scenario examples

Government bonds, 1-month to 50-year maturities



Interest rate swaps, 1-year to 50-year maturities

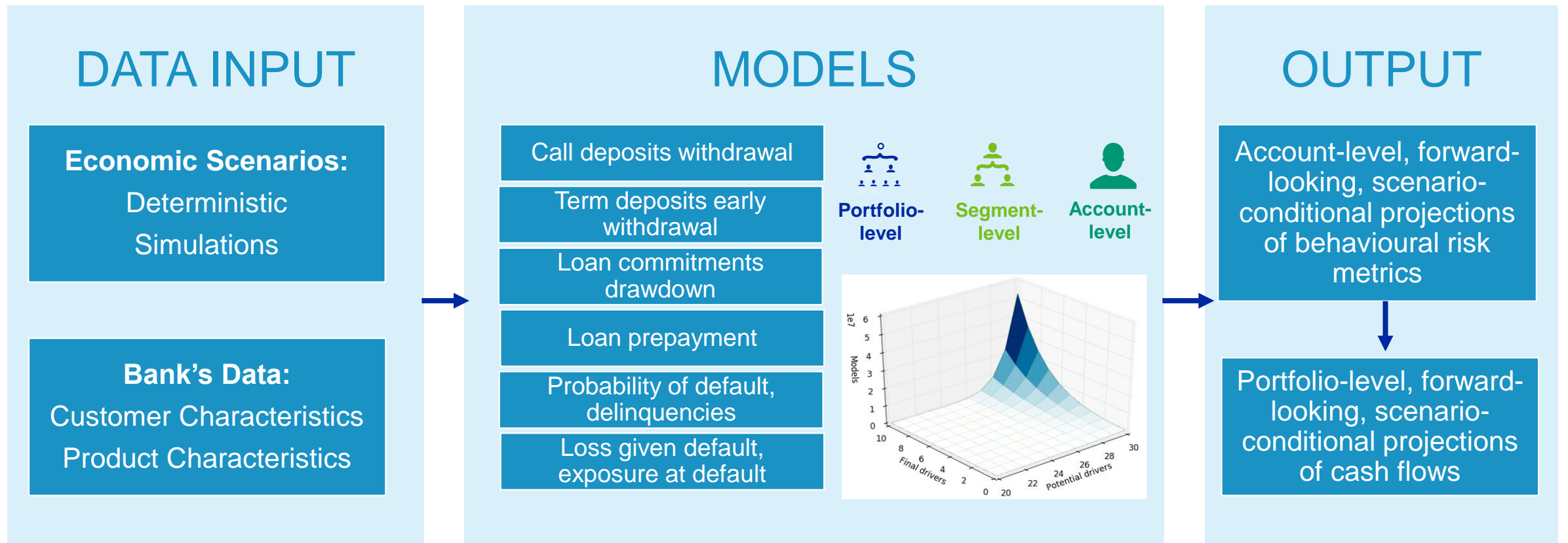


2.2

Forward-looking Behavioural Models

Modelling Expected Behaviours

Linking scenarios with net cash-flows from assets and liabilities



Example Factors for Different Behavioural Models

For interest rate risk in banking book, liquidity and credit risks

Loans subject to prepayment risk

- Loan size, LTV
- Borrower characteristics
- Contractual and current interest rates
- Geographical location
- Demography
- Taxes
- Changes in family composition
- Original and remaining maturity
- Seasoning
- **Macroeconomic variables (e.g. stock price index, unemployment rates, inflation and HPI)**

Loan commitments drawdowns

- Borrower characteristics
- Geographical location, including competitive environment and local premium conventions
- Customer relationship with bank
- Remaining maturity of the commitment
- Seasoning and remaining term
- **Macroeconomic variables**

Term deposits subject to early withdrawal risk

- Deposit size, depositor characteristics
- Funding channel
- Contractual interest rates
- Seasonal factors, geographical location and competitive environment
- Remaining maturity and other historical factors
- Insurance coverage
- Bank's reputation
- **Macroeconomic variables**

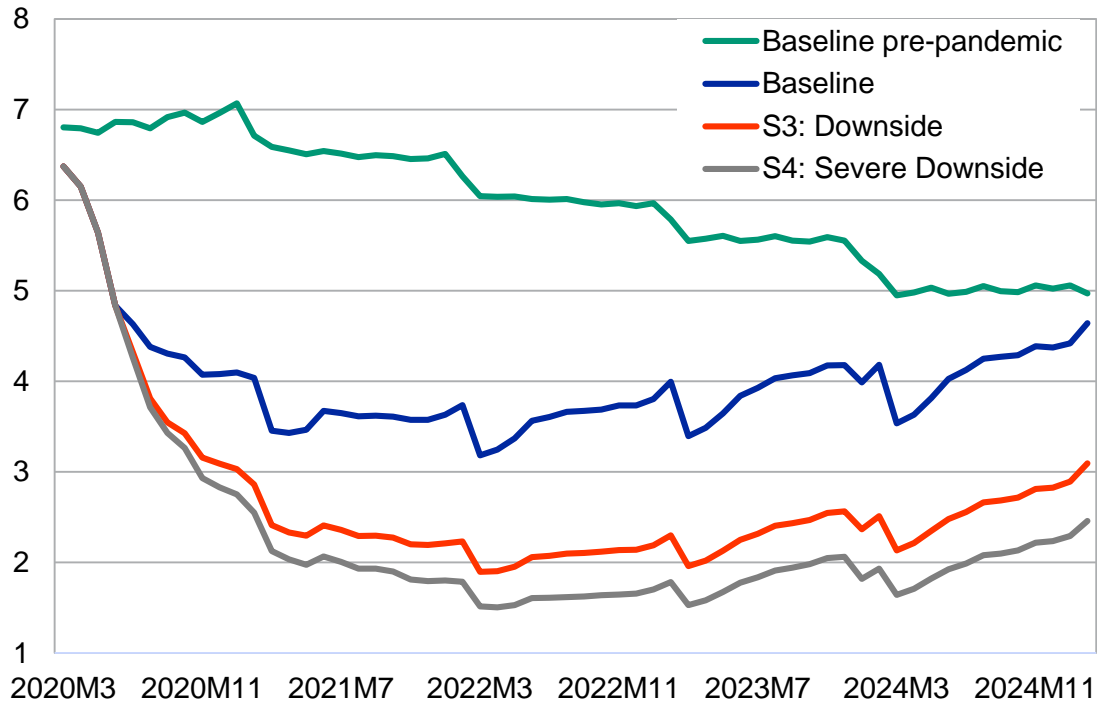
Call deposits

- Responsiveness of product rates to changes in market interest rates
- Current level of interest rates
- Spread between a bank's offer rate and market rate
- Competition from other banks
- Bank's reputation, geographical location and demographic characteristics of customer base
- Insurance coverage
- **Macroeconomic variables**

Prepayment Risk Modelling Example

Capturing incentives for early amortization

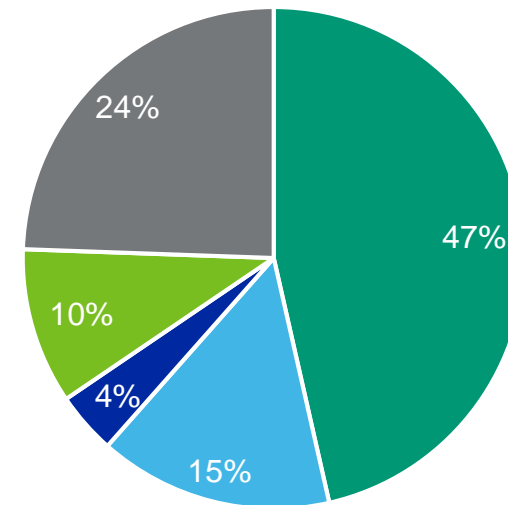
Prepayment Rate, %



Sources: UK Mortgage Portfolio Analyzer, Moody's Analytics

Driver Composition

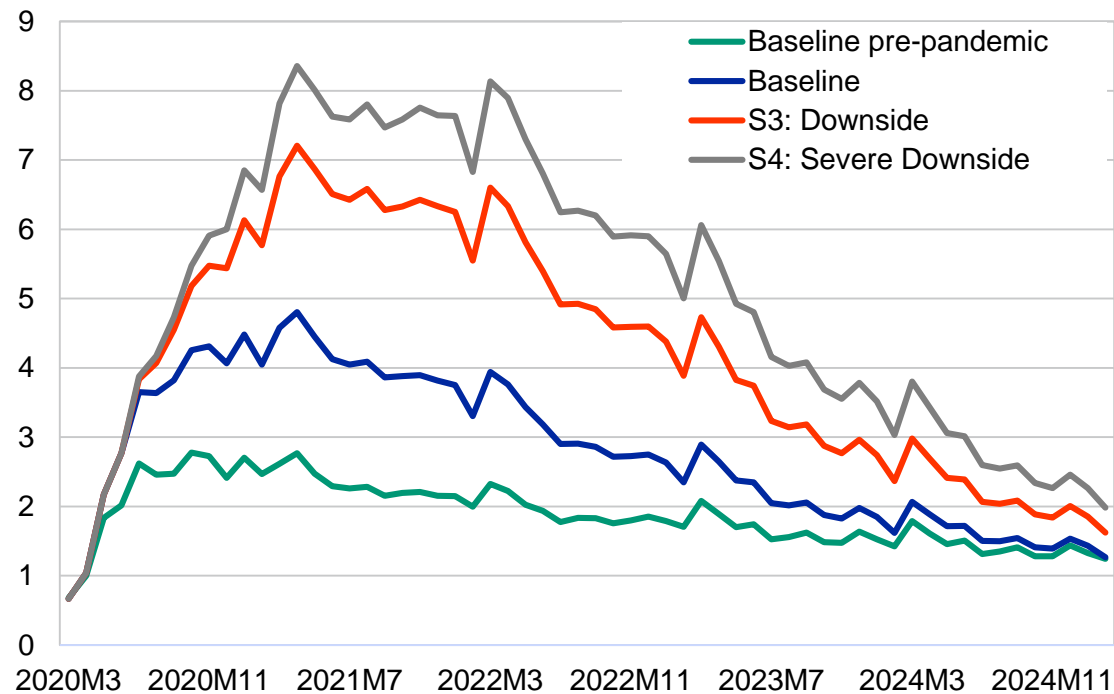
- Loan lifecycle
- Customer characteristics
- Updated LTV with HPI
- Other loan characteristics



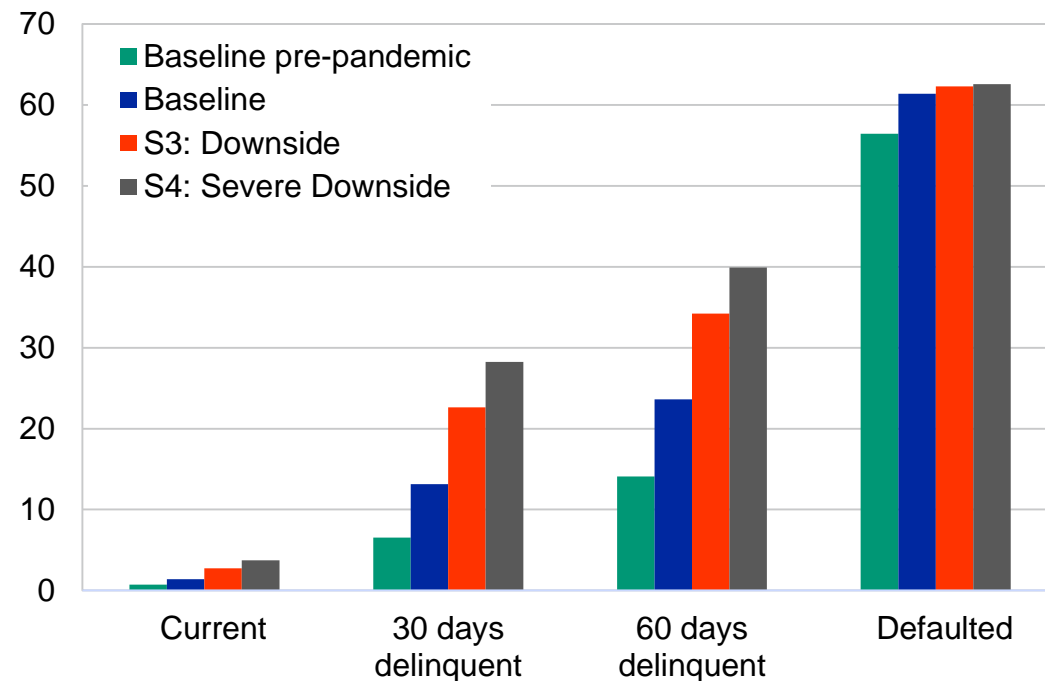
Delinquency and Credit Loss Modelling Example

Capturing borrowers' ability to repay and corresponding losses

Probability of Default, %



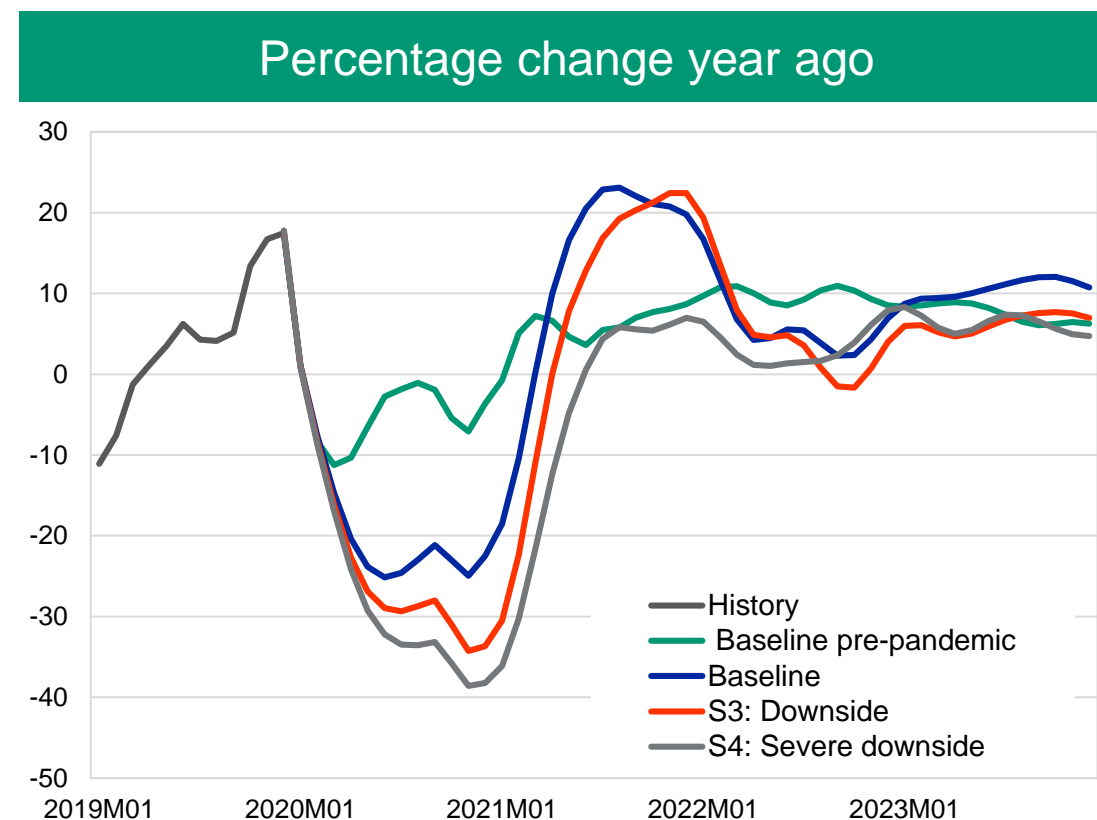
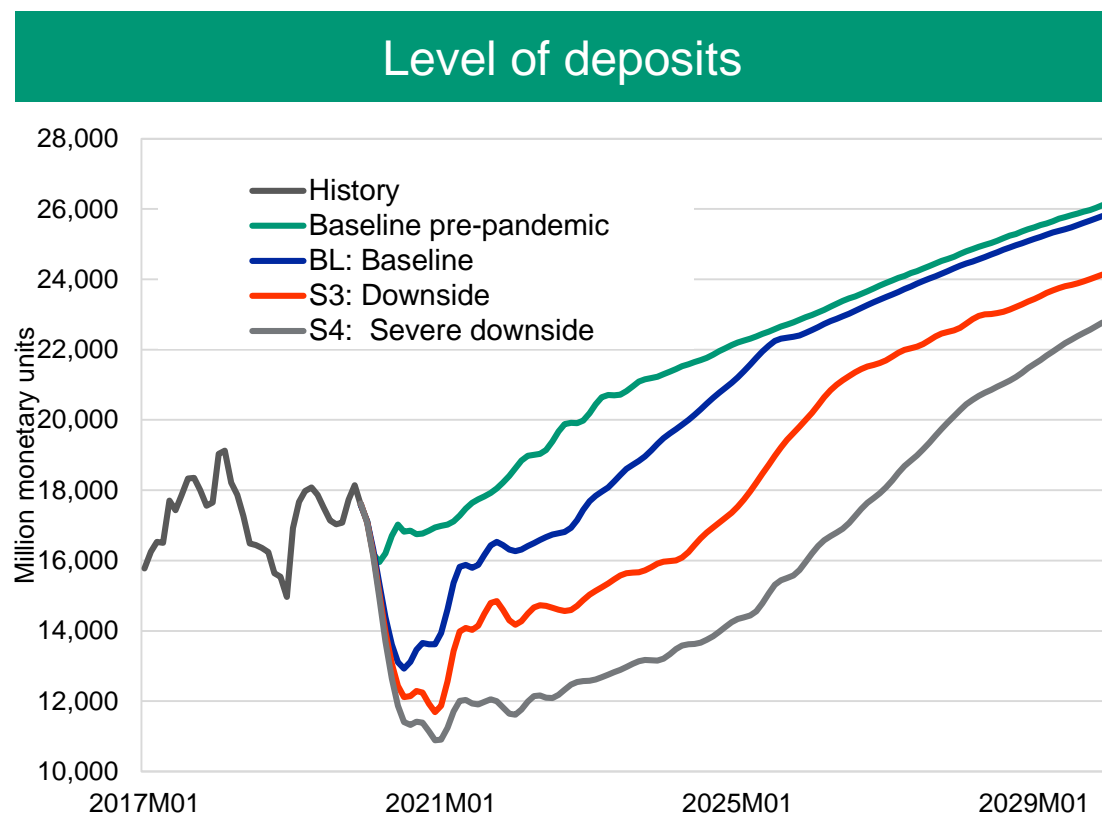
Expected Credit Loss, %



Sources: UK Mortgage Portfolio Analyzer, Moody's Analytics

Propensity to Withdraw Modelling Example

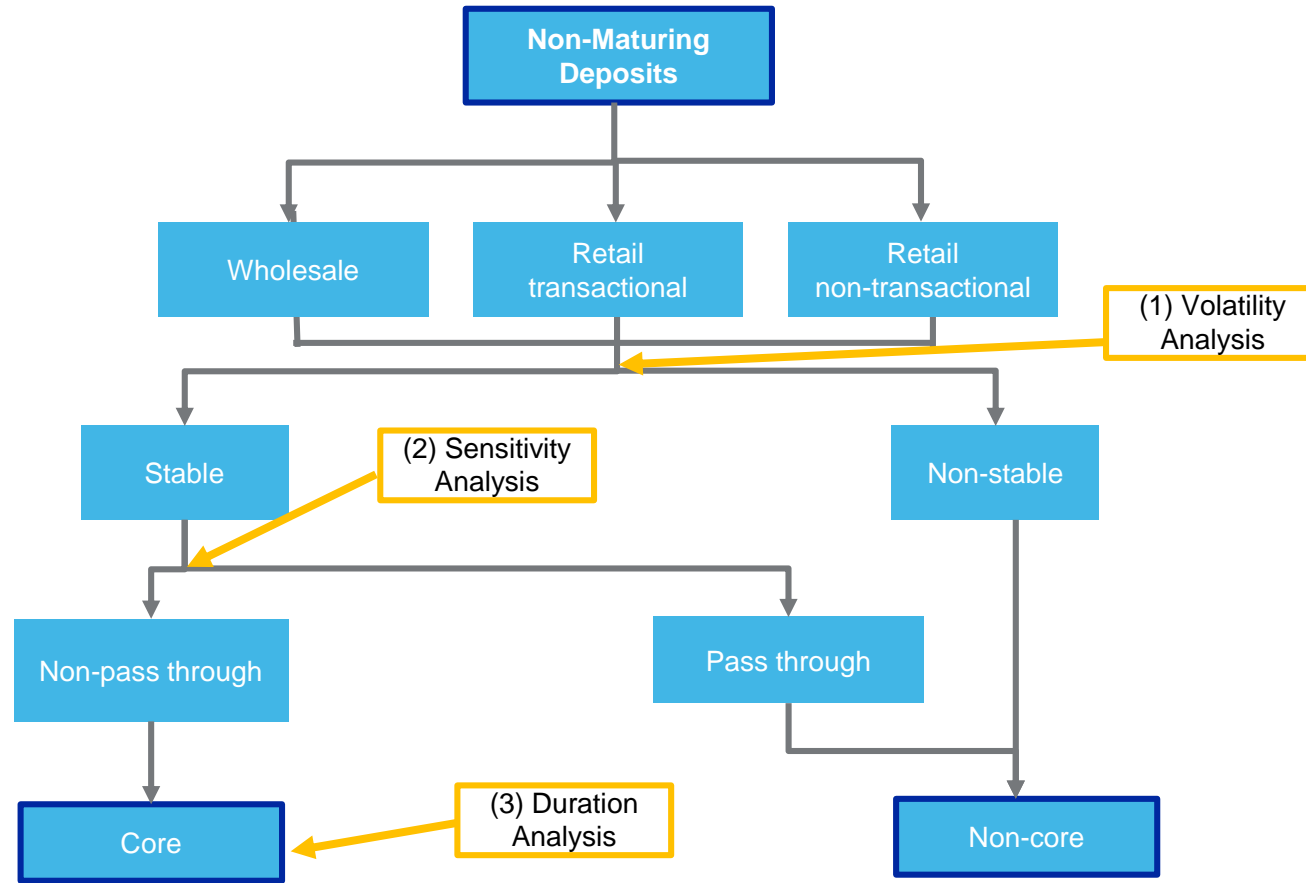
Capturing motives for willingness to withdraw and place funds



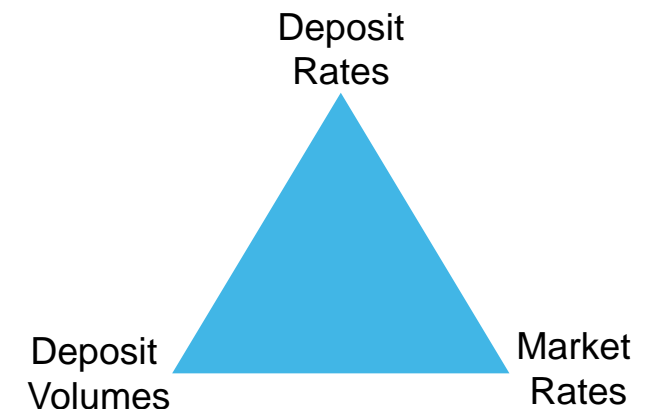
*Assuming complete pass-through

Non-maturing Deposits Modeling Example

Product-specific approach for IRRBB



- (1) Examine the distribution of **Stable Deposit Rate** across observation windows
- (2) Analyze the relationship between market rates, deposit rates and deposit volumes to determine **Core Deposit Rate**
- (3) Determine the optimal **Behavioral Duration**



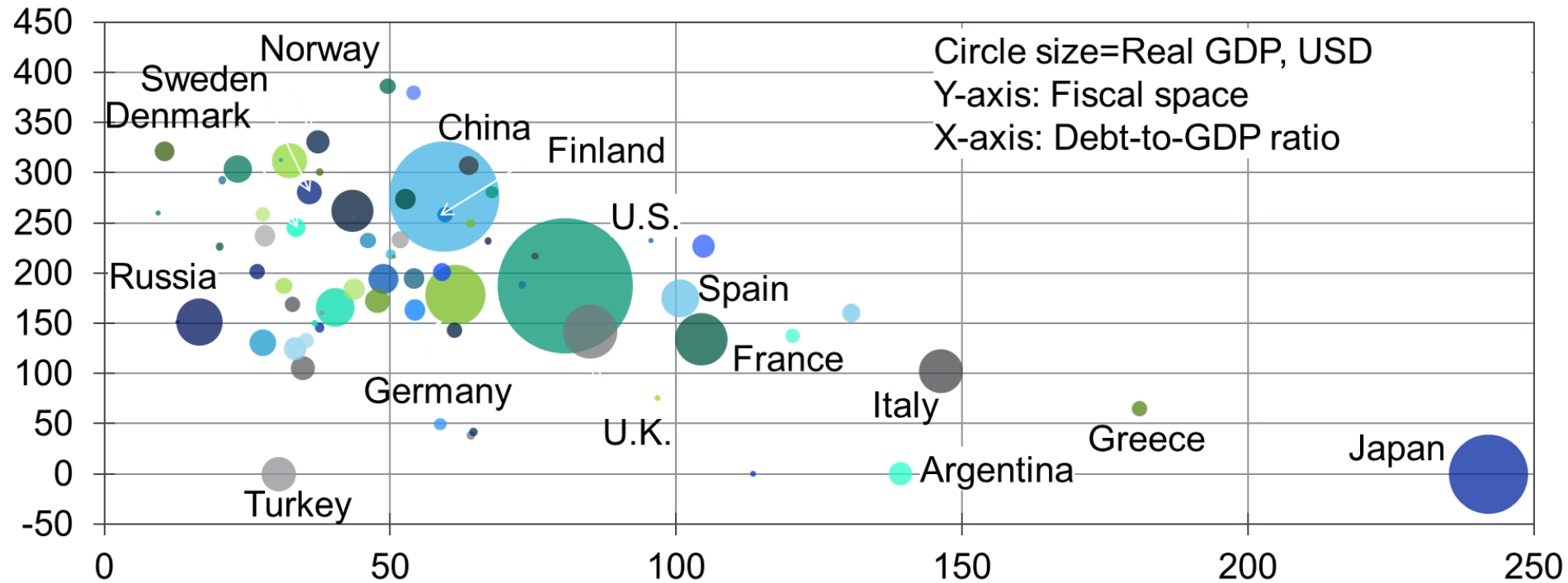
3

Balance Sheet Impacts: The Pandemic and Beyond

Balance sheet impacts of the Pandemic

Defined by intervention

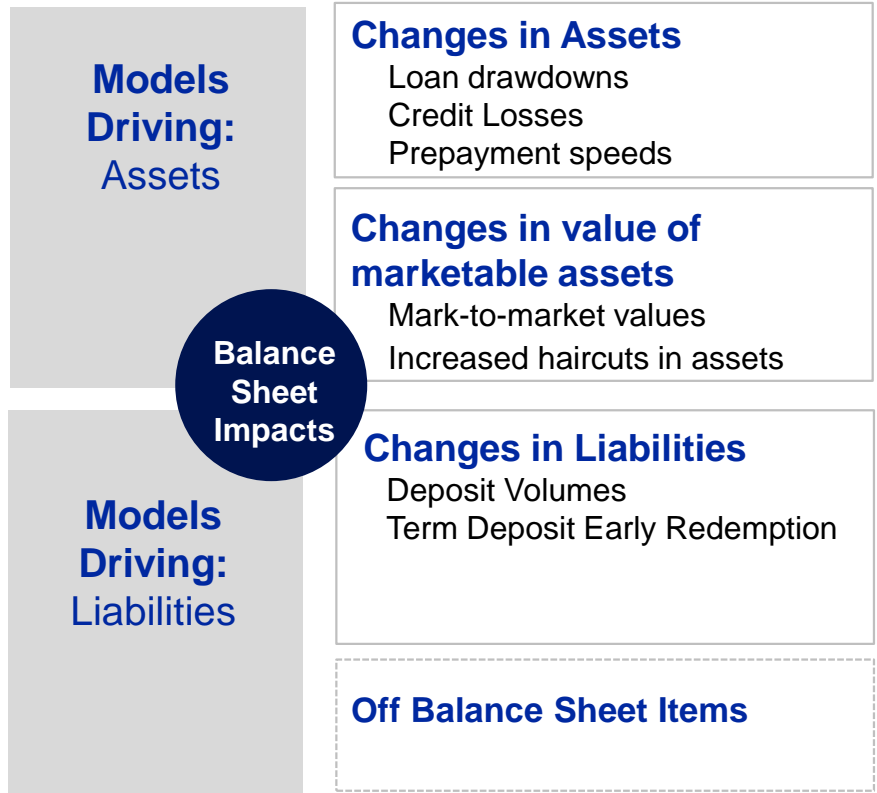
Sovereign borrowing capacity (given current yields, proj. output growth and primary bal)



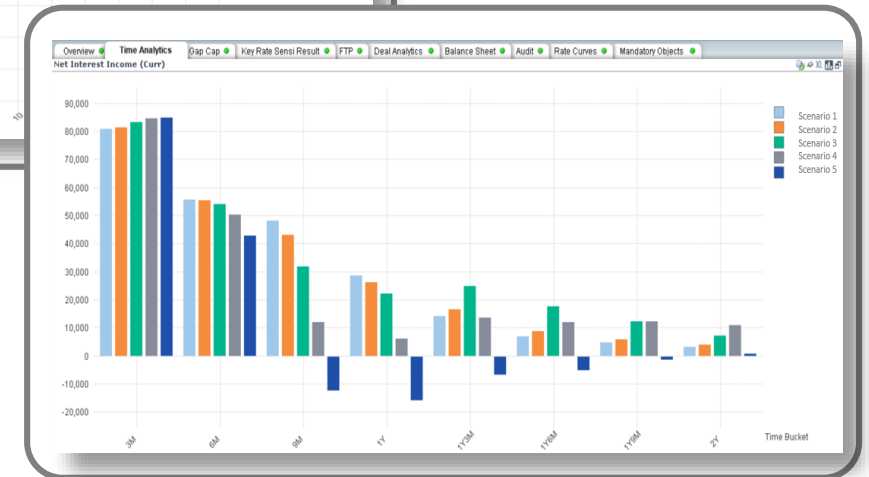
Source: Moody's Analytics, as at 2020Q1 (excludes announced COVID-19 policies)

Balance sheet impacts of the Pandemic

Inputs into stress tests and metrics should be reviewed



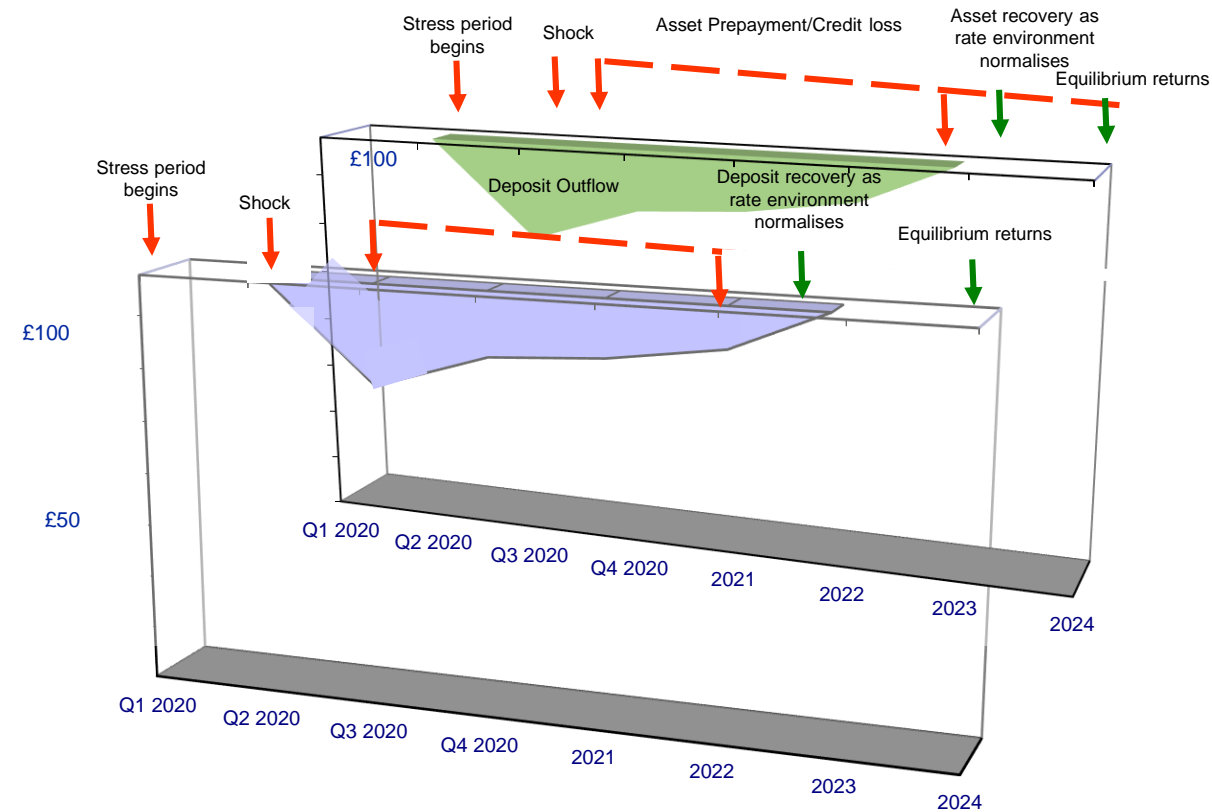
Interest Rate Risk, Credit & Liquidity Results to Influence Decision-Making



Balance sheet impacts of the Pandemic

What will happen next?

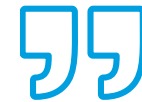
Modelling Impact on balance sheet



The ECB said it was:



..particularly concerned that insufficiently stressful scenarios, an absence of ad hoc stress-testing capabilities and a failure to put in place management action strategies based on test outcomes put lenders at risk of succumbing to financial calamity.

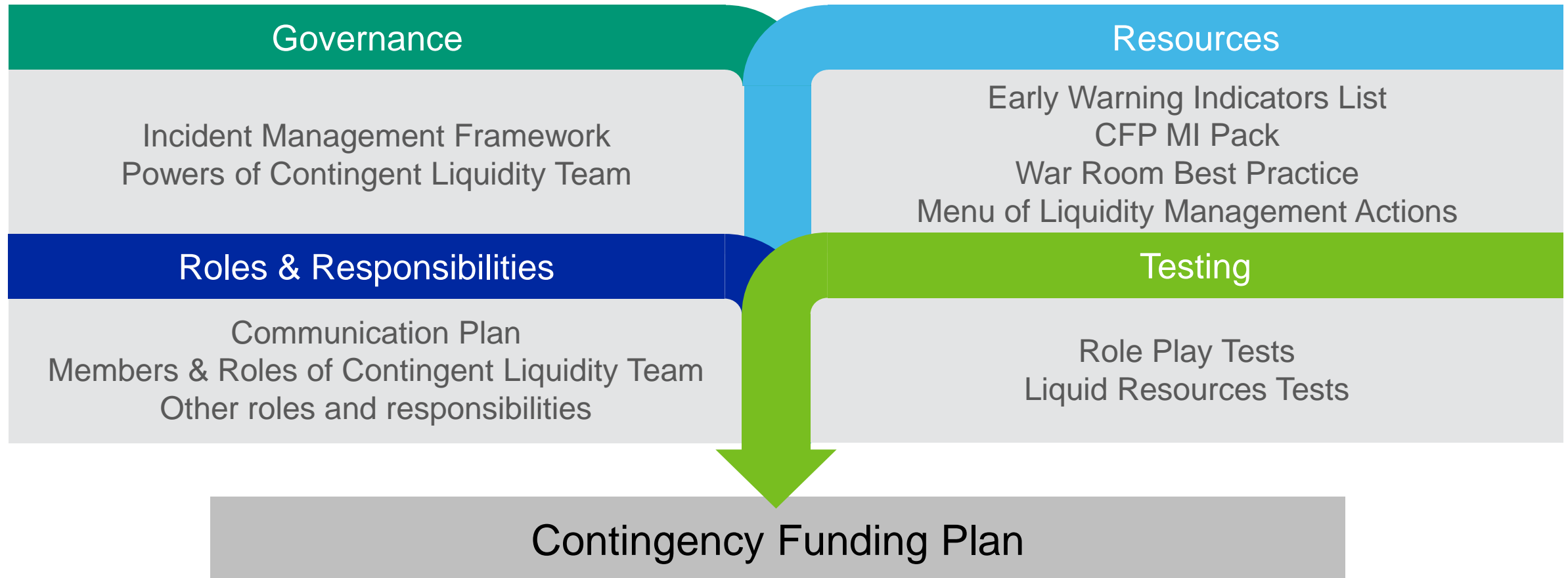


Source: Risk.Net, *Internal stress tests of EU banks not up to scratch*, 11Aug, 2020



Pre-Preparation Measures

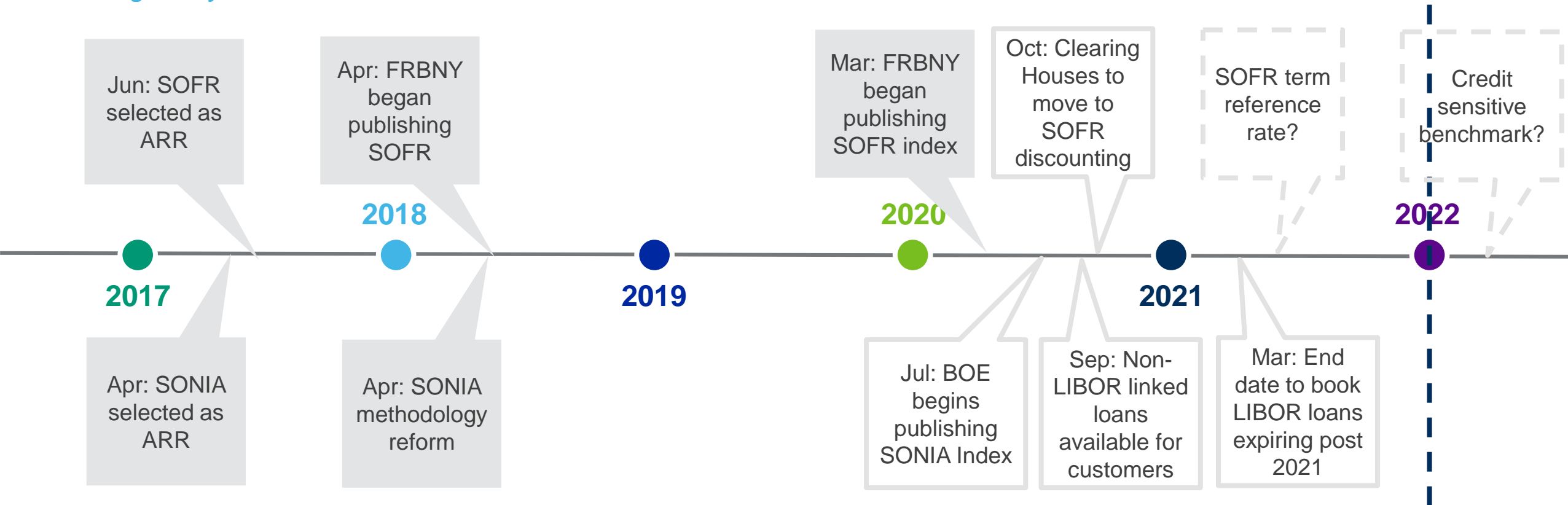
Contingency measures should be tested and reviewed



Other Headwinds

How near is the end of LIBOR?

US Regulatory Timeline



UK Regulatory Timeline

LIBOR panel no longer required to submit quotes

Other Headwinds

The market is moving to align.. but slowly...

ASSET	ESTIMATE OF LIQUIDITY		COMMENTS
	SOFR	SONIA	
SWAPS			<ul style="list-style-type: none"> • Low uptake of SOFR swap volumes so far (<0.5 percent of LIBOR volume¹) • High volume of SONIA swaps (~40 percent of total volume²), due to the pre-existing short-dated OIS market, but low liquidity in longer tenors
Futures & forwards			<ul style="list-style-type: none"> • Significant progress on SOFR futures in past few months, now ~1 percent of US Dollar rates futures cleared by CME³ • SONIA futures also growing, e.g. SONIA now constitutes 4 percent of listed British Pound interest rate figures²
Bonds			<ul style="list-style-type: none"> • SOFR volume is increasing (>80 deals in Q1 2019 accounting for 24 percent of all USD FRN proceeds) but still 90 percent agency-driven⁴ • SONIA volume is robust (>40 deals done and, in Q1 2019, 77 percent of British Pound FRN proceeds), and with more participation by the private sector⁴
Loans			<ul style="list-style-type: none"> • No banks are regularly offering SOFR and SONIA loans to corporate clients

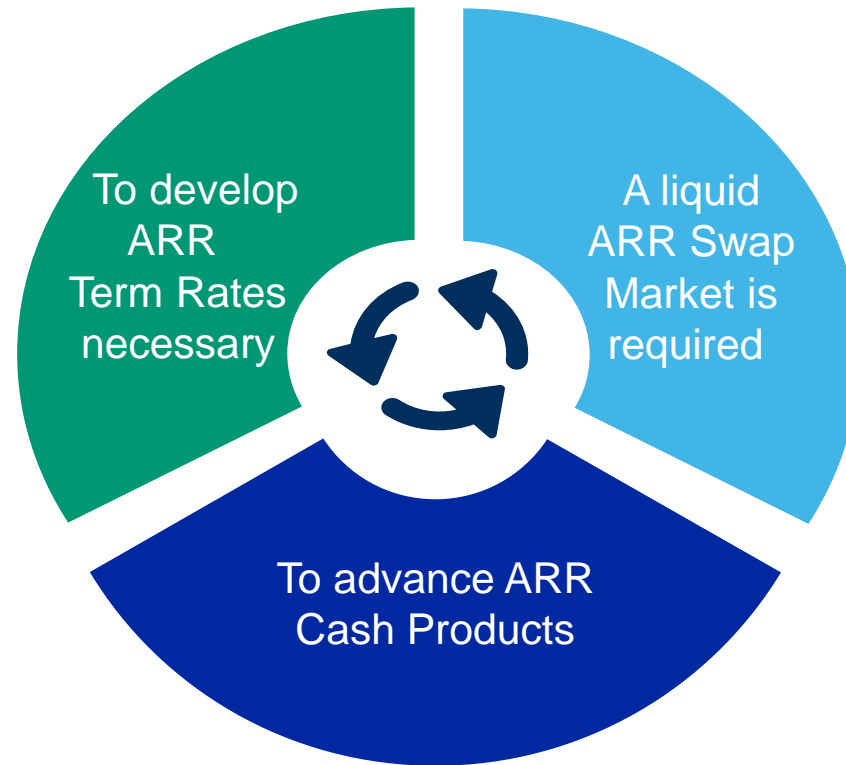
No liquidity in RFR markets
 Sufficient liquidity for all activity to take place in RFR market

Sources: 1. ICH volume statistics; 2. Sterling Risk Free Working Group newsletter; 3. CME monthly volume reports; 4. Eikon by Refinitiv, Oliver Wyman analysis

Source: Time to switch rates, Jun 2019, Oliver Wyman

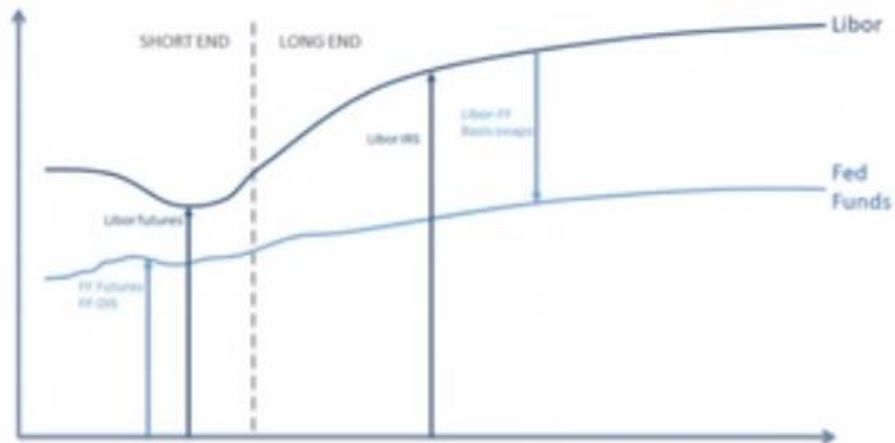
Development of ARR Term Rates

Will impact forward rates used for balance sheet forecasting



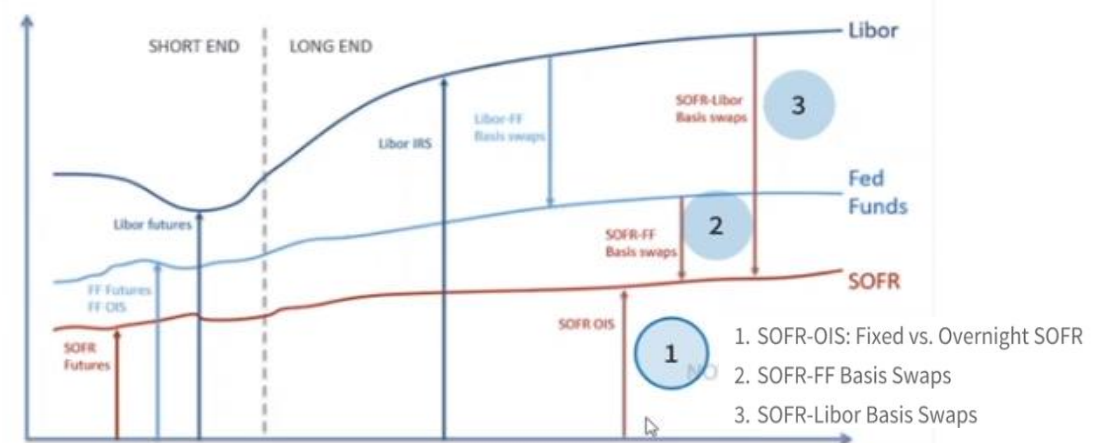
Development of ARR Term Rates

ARRs must sit alongside other rates in stress tests and forecasts



Building IBOR curves

- » IBOR Futures at short end
- » IRS swaps or Fed Funds Basis Swaps at long end



Building ARR curves

- » ARR Futures at short end
- » OIS at long end- Liquidity is low! FF or LIBOR Basis swaps as an alternative?

Source: FINCAD

Key Takeaways

1. Despite the current recovery phase, the U.K. economy is forecast to contract 9.7% in 2020.
2. QE and schemes to support the customer franchise helped to both dissipate any wholesale market stress and contain a surge in impairments, but have impacted banks' balance sheets.
3. With the end of intervention (including the end of the payment holiday scheme in October), banks should expect a tsunami effect on their provisions.
4. Modelling this in a balance sheet context, as well as taking account of other headwinds, such as IBOR transition, are the next challenges for those dealing with Treasury risks.

Q&A

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