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What's Happening to Interest Rates?

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Presentation Overview

- Interest rate history: long term and the recent past
- Arguments for lower bounds
- Interpreting prices of interest rate options
- Drivers for recent behaviour
- Implications for Investment
- Conclusions & lessons learnt

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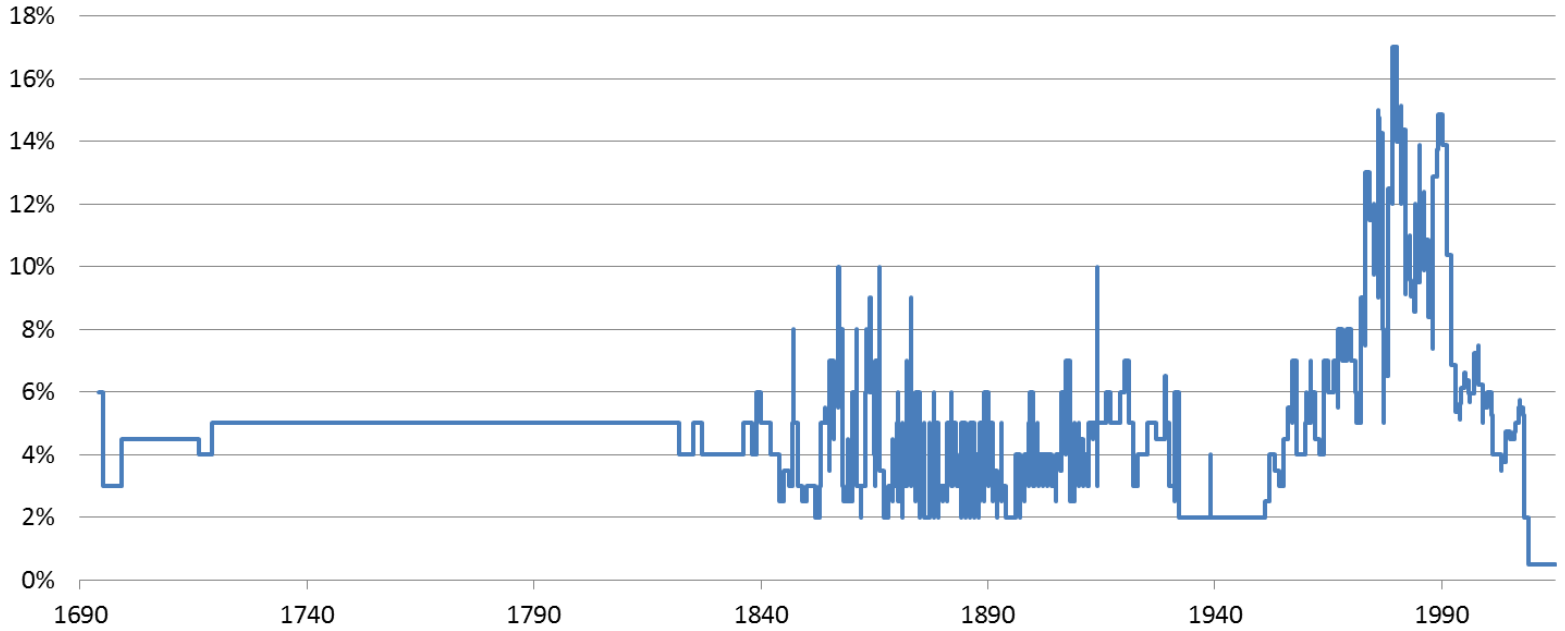
History of Interest Rates

UK Base Rates since 1694

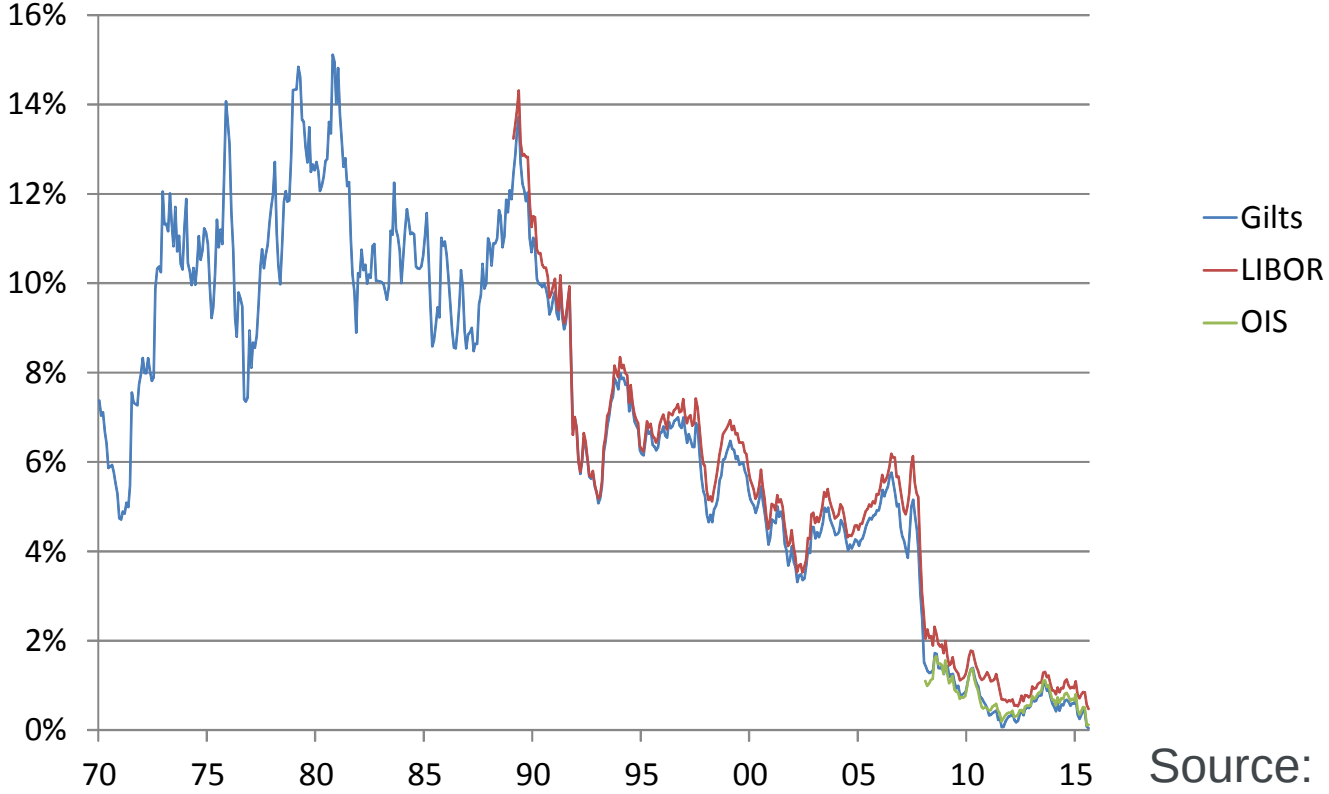


Source Bank of England

Why Interest Rates Matter for Investors?

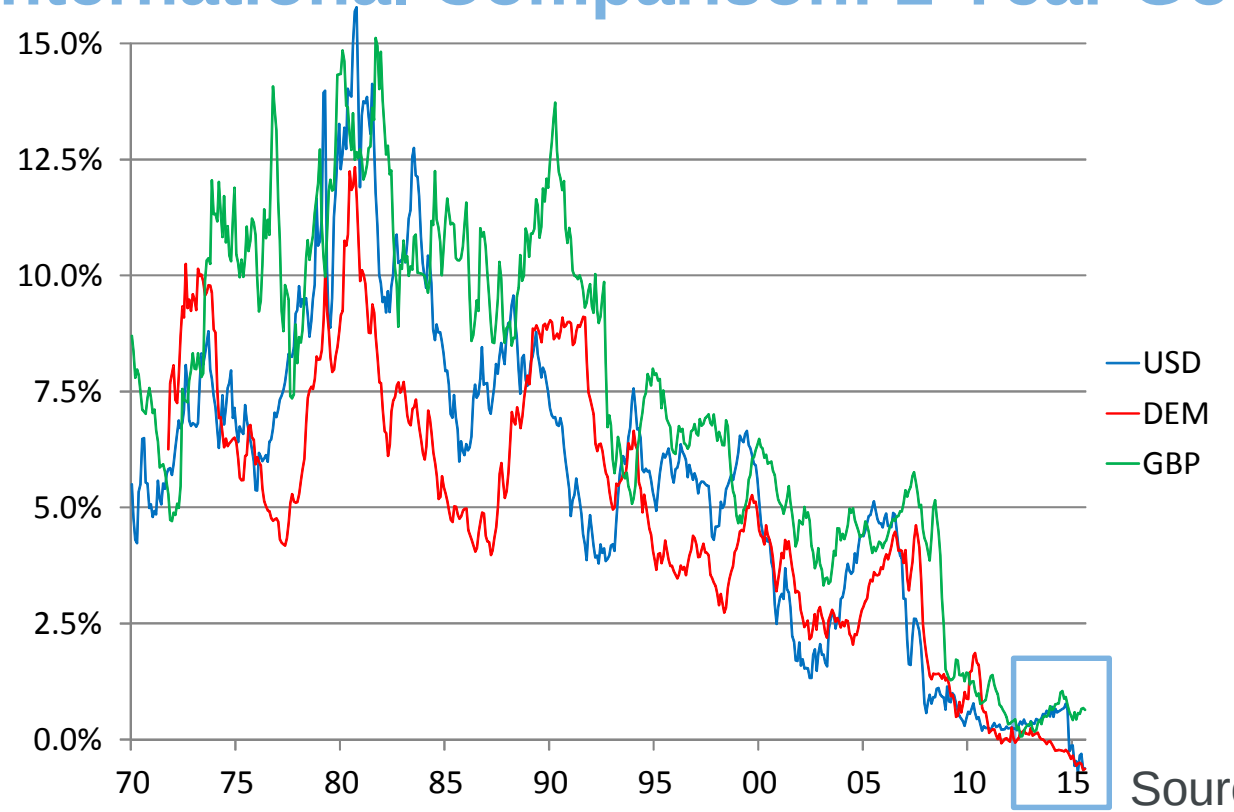
- Interest rates explain market prices of fixed income instruments
- Key factor in calculating the value of liabilities for pension schemes and insurance companies
- At the heart of any building block framework for explaining asset returns (e.g. equity returns expressed as risk-free + risk premium)
- A policy instrument that may be used to target inflation or the general level of economic growth
- At a corporate level - rate for lending and borrowing for companies
- Infrastructure and development - Hurdle rates for project investments

UK Market Rates (2 Year Term)



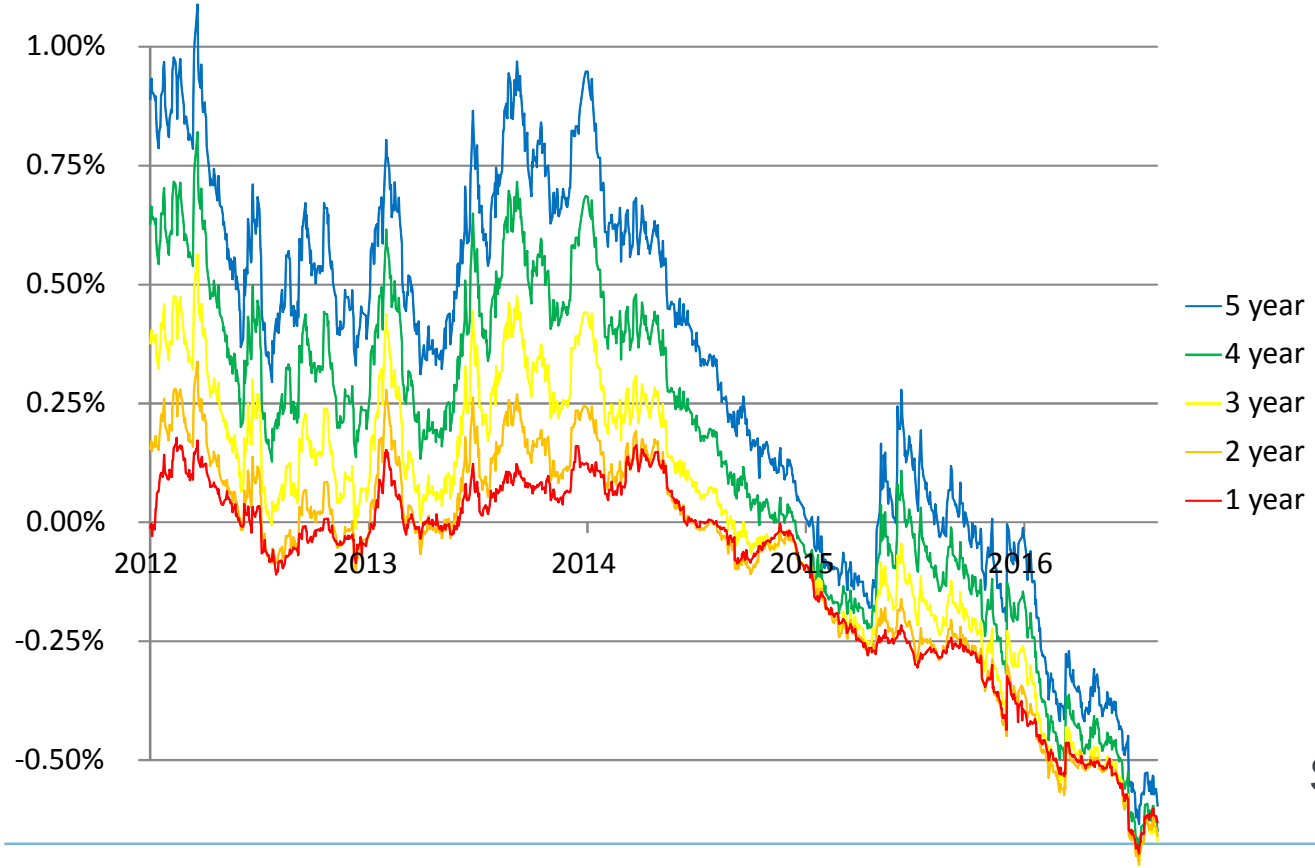
Source: Bank of England

International Comparison: 2 Year Gov Yields



Source: Fed, BoE, Buba

Recent Yields on German Bonds



Source: Buba

What do the Examiners Say? (CT8, Apr 2012, Q 6)

(i) Write down a stochastic differential equation for the short rate r_t for the Vasiček model. [1]

(ii) State the type of process of which the Vasiček model is a particular example. [1]

(iii) Solve the stochastic differential equation in (i). [5]

(iv) State the distribution of r_t for t given. [1]

(v) Derive the expected value and the second moment of r_t for t given. [3]

(vi) Outline the main drawback of the Vasiček model. [1]

Examiners' Model Solution to part (vi):

"The process may become negative which is undesirable in a nominal interest rate model"

What does EIOPA say about negative rates?

- QIS 5 – there was a minimum down stress of 1% but a floor on the stressed (down) rates of 0%
- Current basis from EIOPA:
  - Negative rates are a feature of EIOPA Term Structure
    - credit default adjustment increases likelihood of negative rates
  - Downward Interest Rate stress in the Standard Formula
    - If the pre-stressed rate is negative there is no further stress down
    - If the pre-stressed rate is positive then the proportionate EIOPA Down stress ensures the Downward Interest Rate is also positive

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What is the lower bound for interest rates?

Supply and Demand Considerations

Could Interbank Rates become Negative?

- Short government bond yields have become negative in several currencies
- LIBOR (inter-bank unsecured borrowing) has remained positive
- Typically settled as two cash flows (deposit, followed by redemption + interest)
- No particular administrative issues with the interest rate becoming negative – it would mean banks had to pay other banks to look after their money.
- Negative swap rates have occurred – currently CHF & SEK
- What about negative perpetuity yields?

Are Negative Interest Rates Logical?

- Investors can choose to hold physical banknotes.
- It could be argued that the option to hold banknotes should keep market interest rates above zero.
- But this ignores:
  - Cost of storage
  - Risk of theft
  - Damage from floods, fire
  - Cost of moving cash, especially across borders
  - Various other issues, e.g. legal tender

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Interest Rate Option Pricing Models

Diffusion models

Black, Bachelier and Related Models

Random Walk Models for interest rates

- Brownian Motion is the building block of choice when modelling asset classes and time series. Equivalent to random walks in discreet time.
- Two main extensions commonly used:
  - **Geometric Brownian Motion** - The default model for positive economic series (such as share prices or foreign exchange rates)
  - **Mean reversion** – Incorporated by the Ornstein Uhlenbeck expansion (effectively assuming that a mean exists, and has a certain magnetic force)
- Interest rates have an additional complexity in terms of at least two dimensions of time, which results in a large range of potential models.

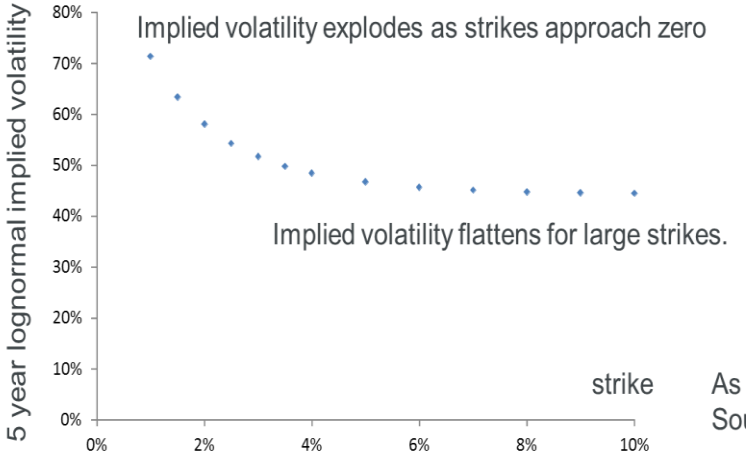
What is the Lower Bound for Interest Rates?

- The lower bound is an artefact of the model we choose.

Model / Family of models	Interest Rate Lower Bound
Vasicek family of models	No lower bound
Hull-White family of models	No lower bound
Bachelier (normal implied volatility); Johnson curves	No lower bound
Displaced geometric random walk (Piterbarg DDSV LMM)	-3.48% or other estimated constant
Cox, Ingersoll and Ross (CIR) models	Theoretically no lower bound, but fitting to a term structure can result in a negative lower bound
Black-Karasinski models	Zero
LIBOR Market Models	Zero
Bank of England (Shimko method of extrapolating Black / LogNormal implied volatility)	Zero

Challenging the Market Conventions used for Volatilities

- Black volatilities is the market standard convention for interest rate volatility data.
- Under the Black model, the evolution of the forward swap rate $F_{[T_0,T_n]}(t)$ for a swap with term T_0 and tenor $T_n - T_0$ is modelled through the following stochastic differential equation.
  - $\frac{dF_{[T_0,T_n]}(t)}{F_{[T_0,T_n]}(t)} = \sigma_{LN} dW(t)$
- The forward swap rate is assumed to evolve according to geometric Brownian motion with a Black volatility σ_{LN}.
- However, this valuation formula breaks down technically as it contains terms such as log(F/K) that are only defined for positive forward swap rates, F.
- The negative interest environment results in the need for an alternative to Black volatilities e.g. Normal volatilities.



As at 29 May 2015
Source: Bloomberg

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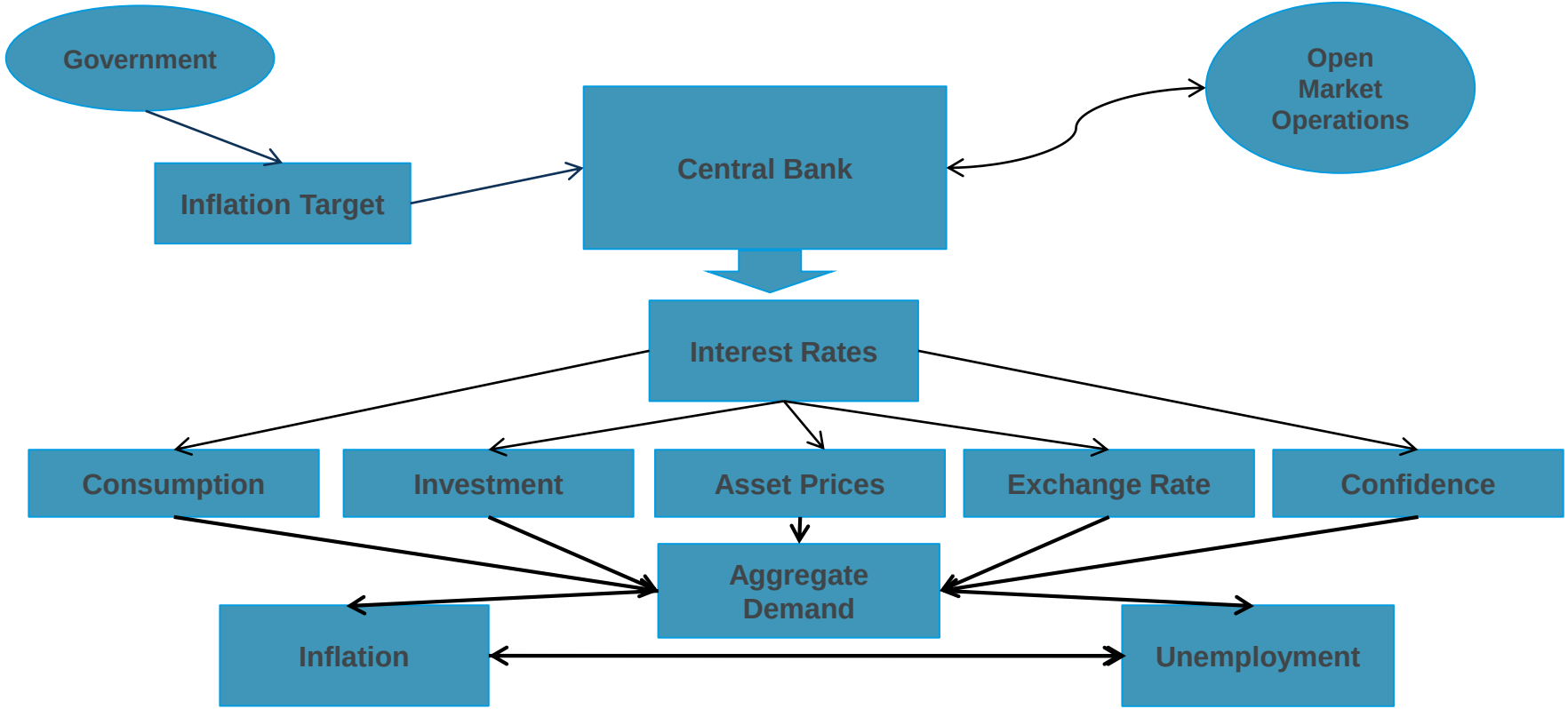
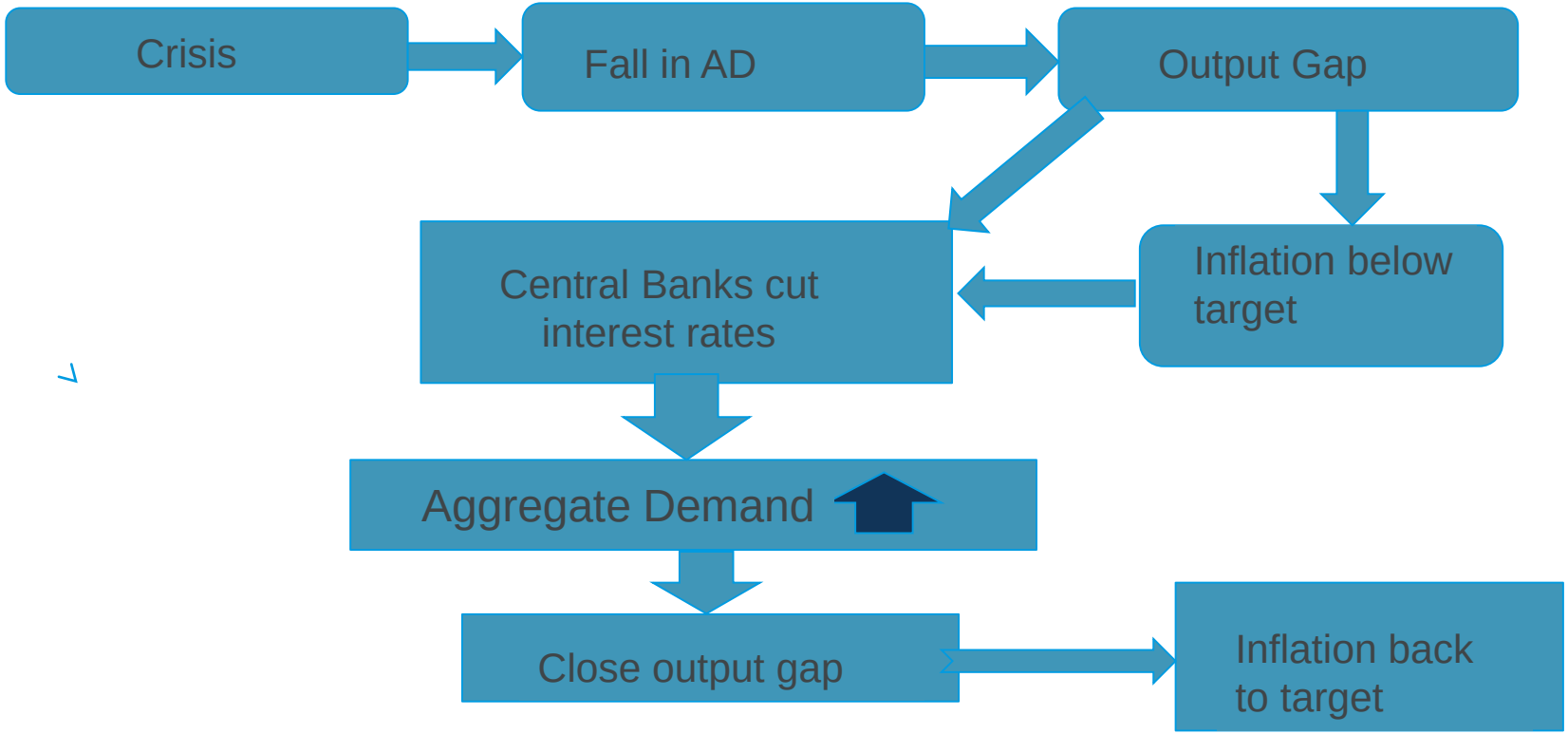
Drivers for recent behaviour

Quantitative Easing and “flight to quality”

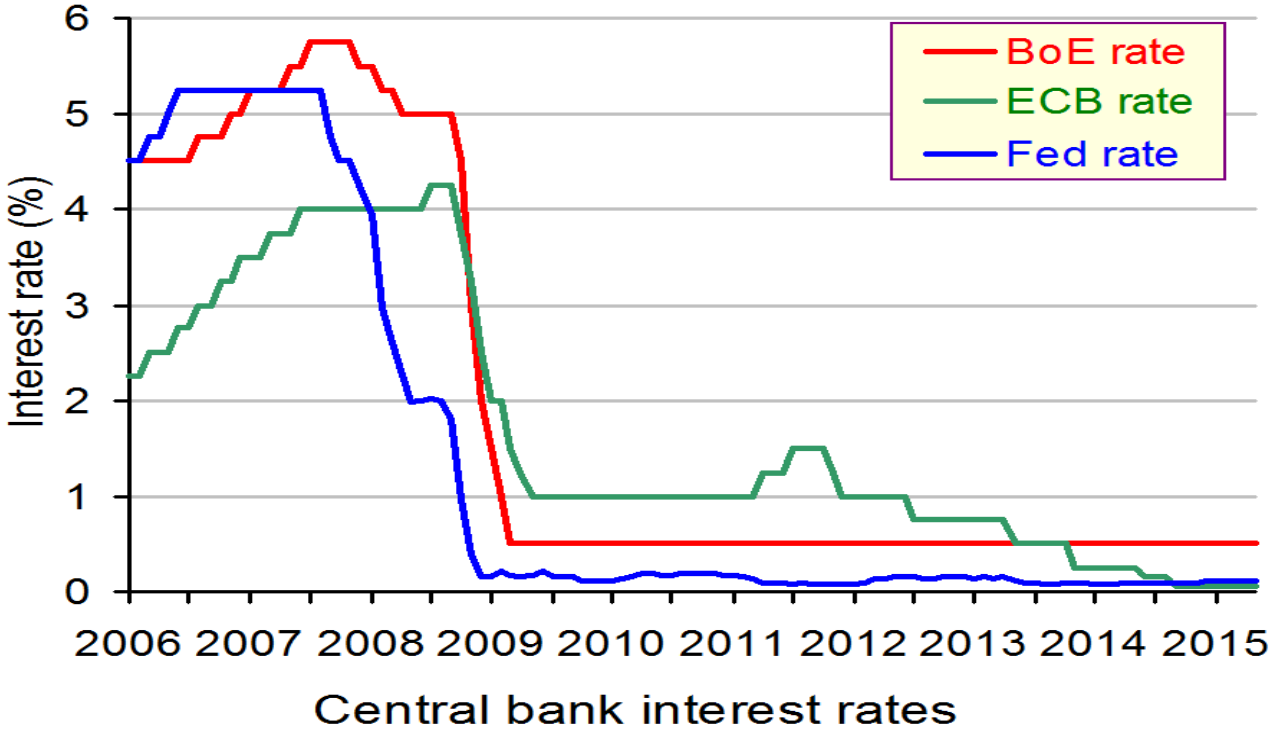
Conventional Monetary Policy



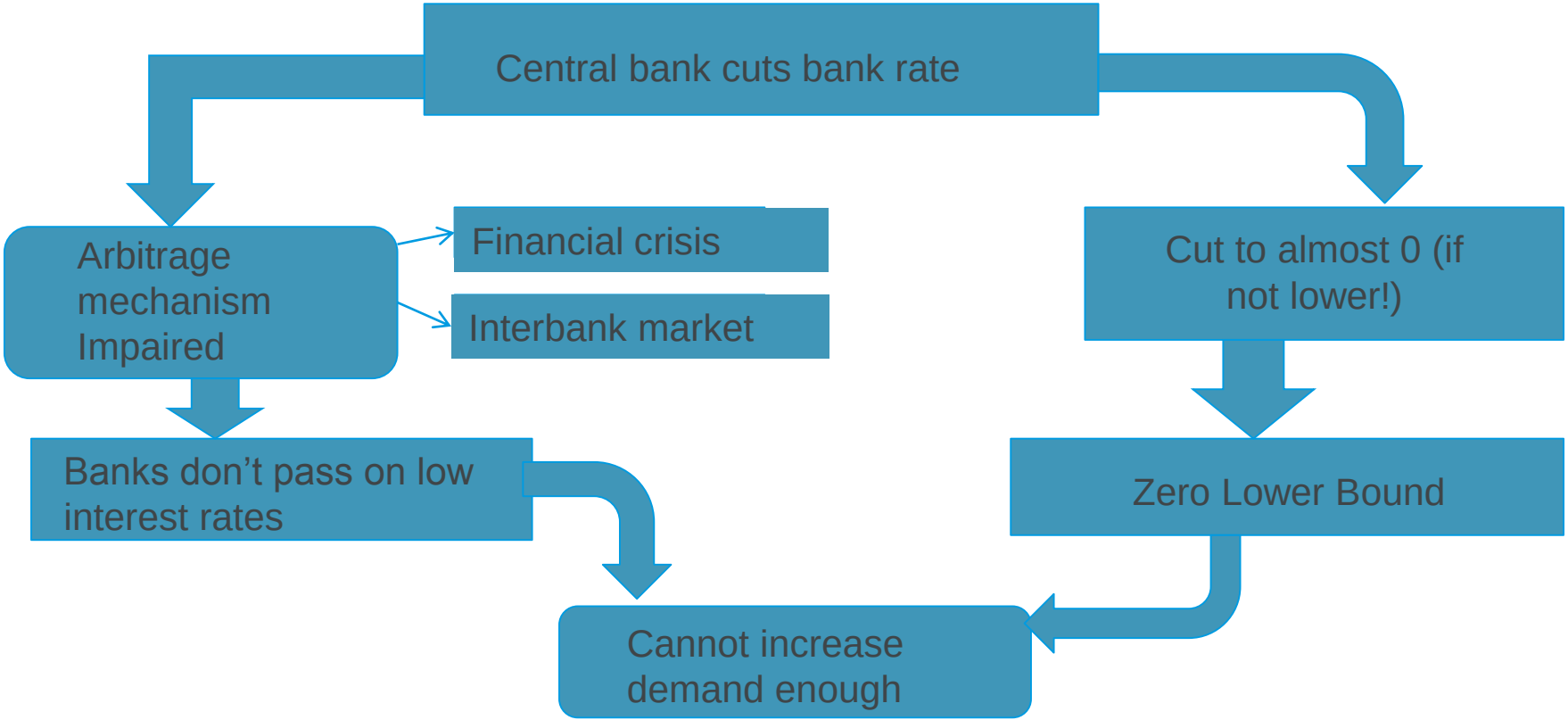
In a Perfect world:



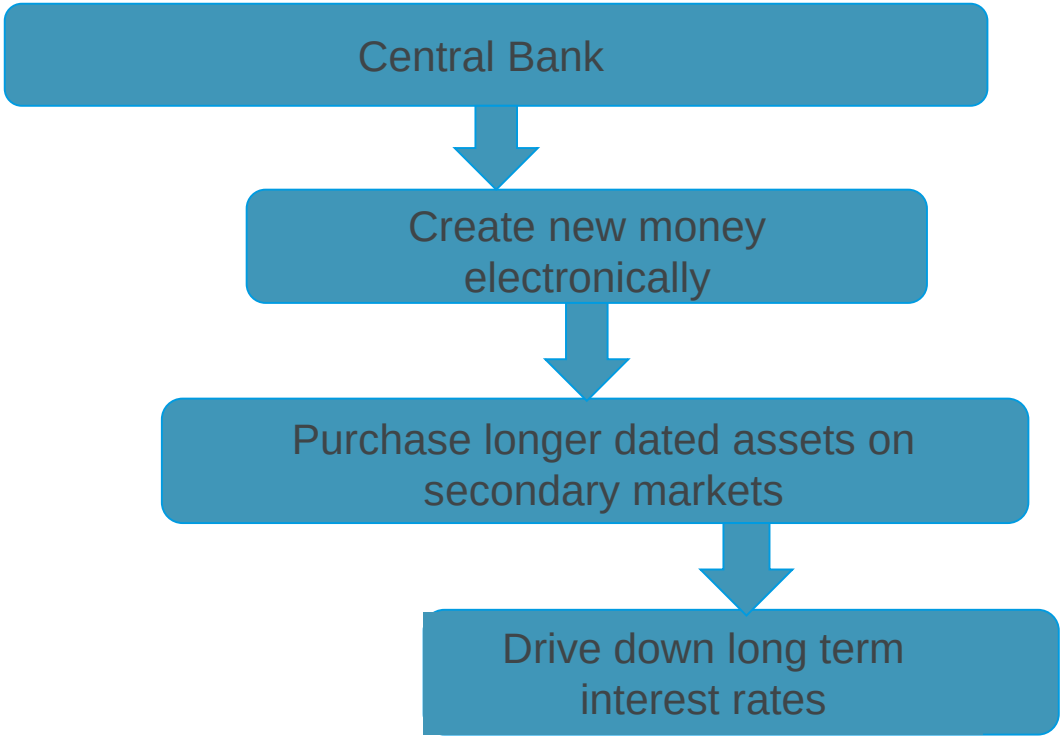
What did Central Banks do during the 2008-09 financial crisis?



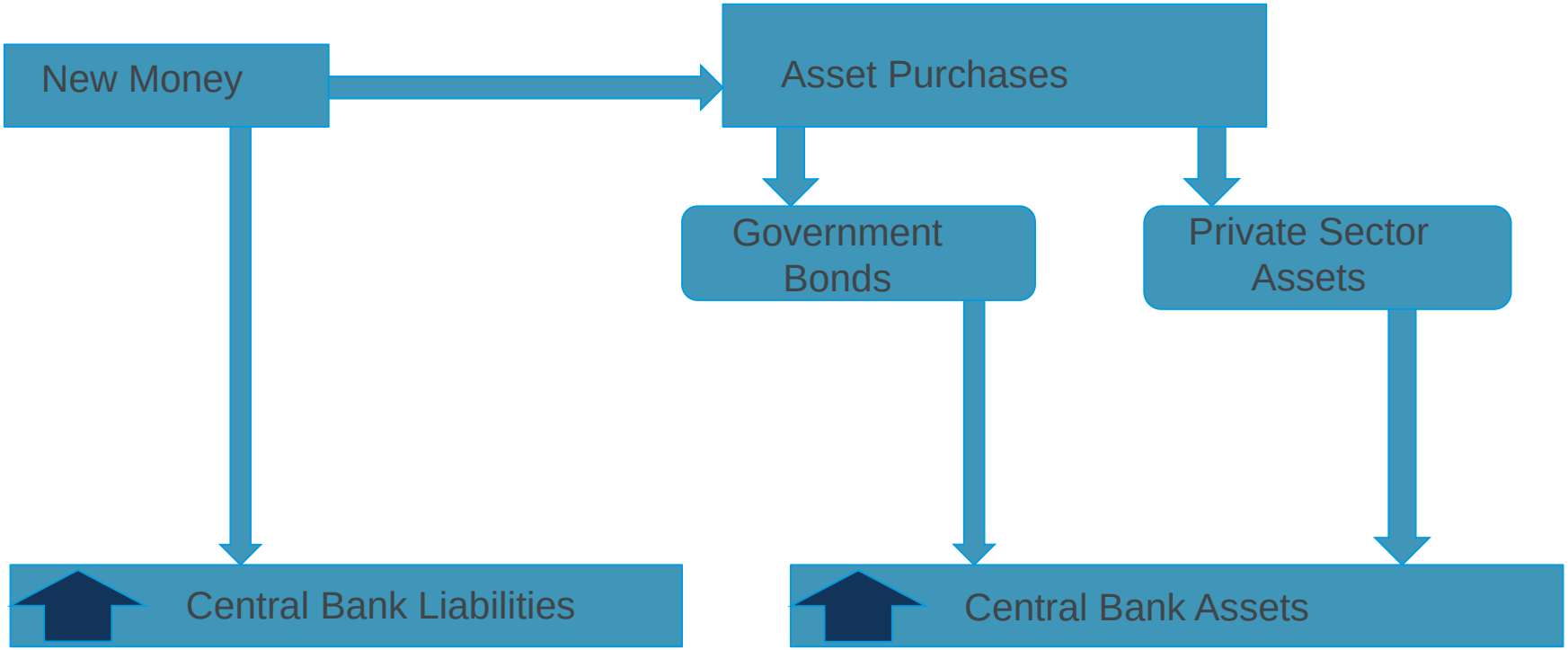
Problems:


Central bank cuts bank rate
Arbitrage mechanism Impaired
Financial crisis
Interbank market
Banks don't pass on low interest rates
Cut to almost 0 (if not lower!)
Zero Lower Bound
Cannot increase demand enough

Quantitative Easing



Central Bank Expands Its Balance Sheet



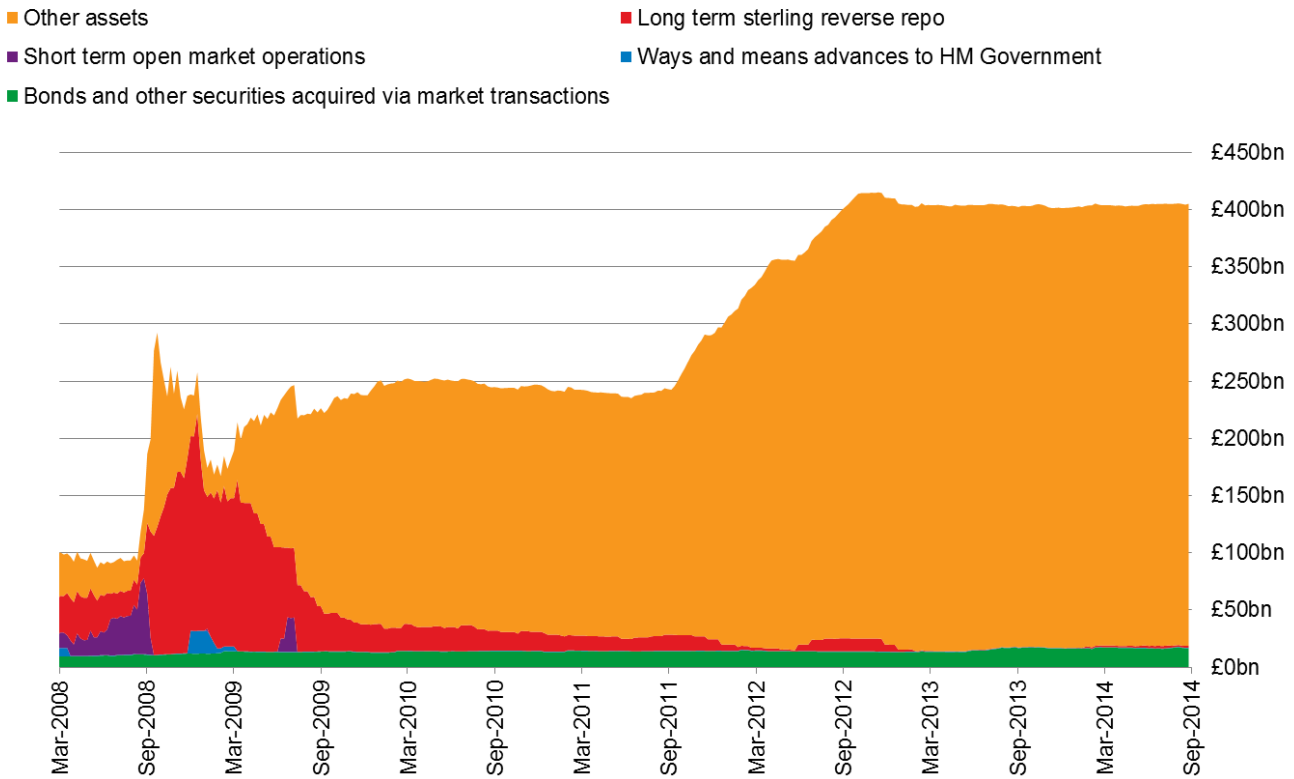
QE – amounts and timing

- USA
  - QE1 –Nov 2008, the Fed started buying $600Bn mortgage backed securities(MBS). The Fed also bought Treasury Securities(TS) (it already held $700Bn of these) and total holding was $2.1Tn at Jun 2009
  - QE2 – Nov 2010 the Fed started buying another $600Bn of TS
  - QE3 – Sept 2012 – Fed started buying another$40Bn/month of TS. Raised to $85Bn/month. Tapering started in Feb 2014 & new purchases ceased Oct 2014
- UK
  - Mar 2009 BoE started buying gilts and had accumulated £175Bn by Oct 2009
  - Subsequent additional purchases of £75Bn (Oct 2011), £50Bn (Feb 2012) and £75Bn (July 2012)
- EU
  - ECB (Jan 2015) announced would start buying €60Bn/month of central govt debt and EU institution debt. Started Mar 2015 and will continue to at least Sept 2016

Evidence

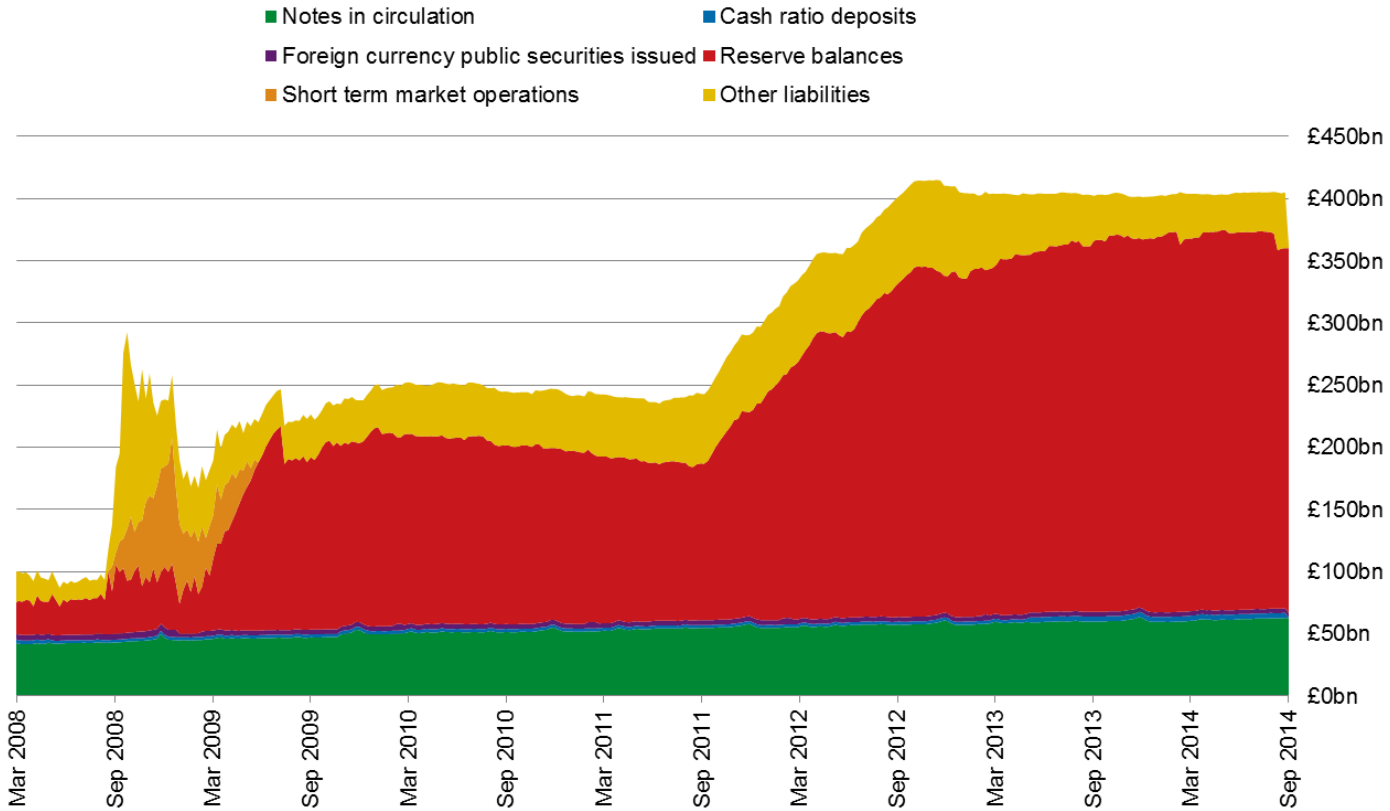
- Event studies: General consensus QE in U.S.A and U.K significantly reduced long term interest rates and increased asset prices
- Seems to work primarily through the portfolio rebalancing channel
- However, no consensus as to size of the effects on financial markets and the extent this was reflected in economic activity
- Does anyone fully understand QE?
- Other factors – such as a “Safe Haven” suggest, at times of greatest uncertainty, returns are not the primary considerations - Switzerland?

Bank of England Balance Sheet: assets



Source: Bank of England

Bank of England Balance Sheet: liabilities



Source: Bank of England

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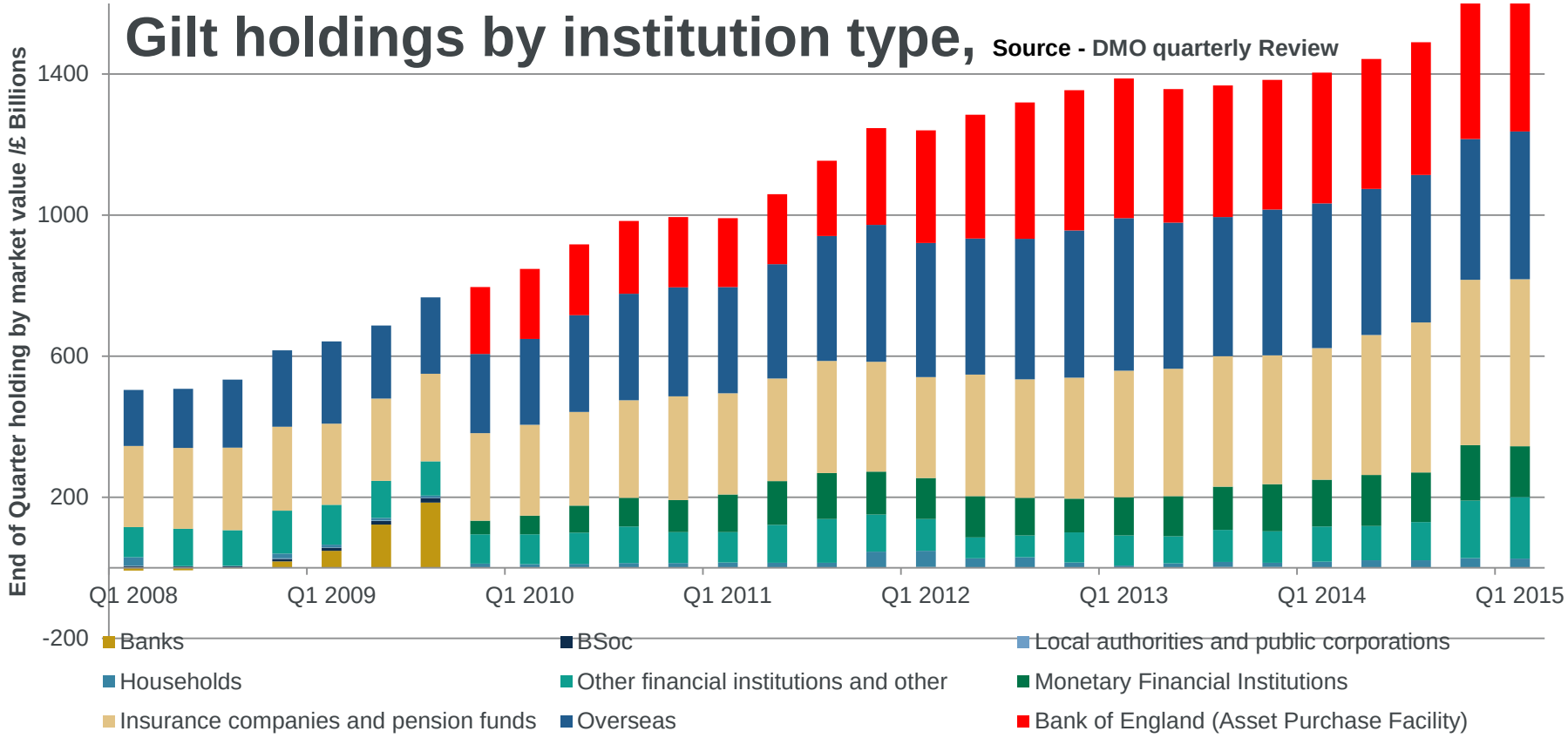
Implications for Investment

Unwinding of Quantitative Easing

- Will unwinding QE have the opposite effect of its introduction?
  - UK - in the Feb 2014 BoE Inflation Report - statement that the £375Bn of QE gilts on BoE Balance Sheet would be maintained, including reinvesting the cash flows associated with any of those assets that mature, at least until the Bank Rate has been reached a level from which it could be cut materially, if that was needed
  - Conclusion – no imminent “unwinding” – Source: BoE QE FAQ
- US Federal reserve – things will return to normal as recovery progresses
  - St Louis Fed (2014) – calming words on US QE (relative size of US QE to others, the range of options for Fed for unwinding)

Net effect of QE in UK – Total Gilts outstanding



Implications for Investment

- Quantitative Easing Impact – comment on previous chart
  - Net (of BoE APF holdings) Gilts in issue still show substantial growth
    - Even allowing for data being Market Value and not Nominal
  - QE does not tell the whole story

- Long term rates have been declining for 30 years (at least – some argue much longer)
  - Decline evident in real rates and has been global (& was not predicted)
- “Long Term Interest Rates: A Survey” by Office of the US President has reviewed
  - Economic Frameworks suggest interest rates settle at level that balances supply of savings and demand for investment
  - Most Economic Frameworks suggest long term rates closely related to productivity growth – with other factors also playing a role

Implications for Investment

- The US Survey identifies a number of factors, transitory and longer-lived, that have contributed:
    - Transitory factors
    - Longer lived factors
- Conclusion is that analysis of many the factors suggests that long-run equilibrium interest rates have fallen

- Ultimately the Survey concludes
    - “there is no “optimal” long term interest rate of interest. Rather, policy should support long-run growth, maintain price stability and support a stable financial system”

Implications for Investment

Investment in a low interest world

- When the search for yield has pushed expected down returns
  - Do you respond by
    - Increasing your risk?
    - Accept lower returns and await “normalisation”?
  - In meantime traditional portfolio construction process challenged by:
    - Correlations are very different to pre-crisis levels - temporary or the “new normal”?
    - Non-traditional assets with higher yields – generally have poor data
- Non-traditional portfolio construction techniques:
  - Look through to underlying sources of return so that you can compare all assets on a consistent basis
  - Use stochastic scenarios and “game play” historic and future stresses

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Conclusions

Lessons Learned from Recent Rate Moves

- Negative rates are possible, and not necessarily temporary!
- The complexity of interest rate models was hidden under a number of well used models across the industry (e.g. LMM)
- Model output is a function not only of input parameters but also the chosen model structure. Consider several alternative models.
- If a single model says negative rates (or rates above 100%) can’t happen, this does not mean these rates can’t happen.
- Think about fundamental supply and demand in the broader economy, and the practicalities and frictional costs

Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.