The Actuarial Profession
making financial sense of the future

# Finance, Investment and ERM Conference
# Investing to meet long term inflation working party

## Time to get real!

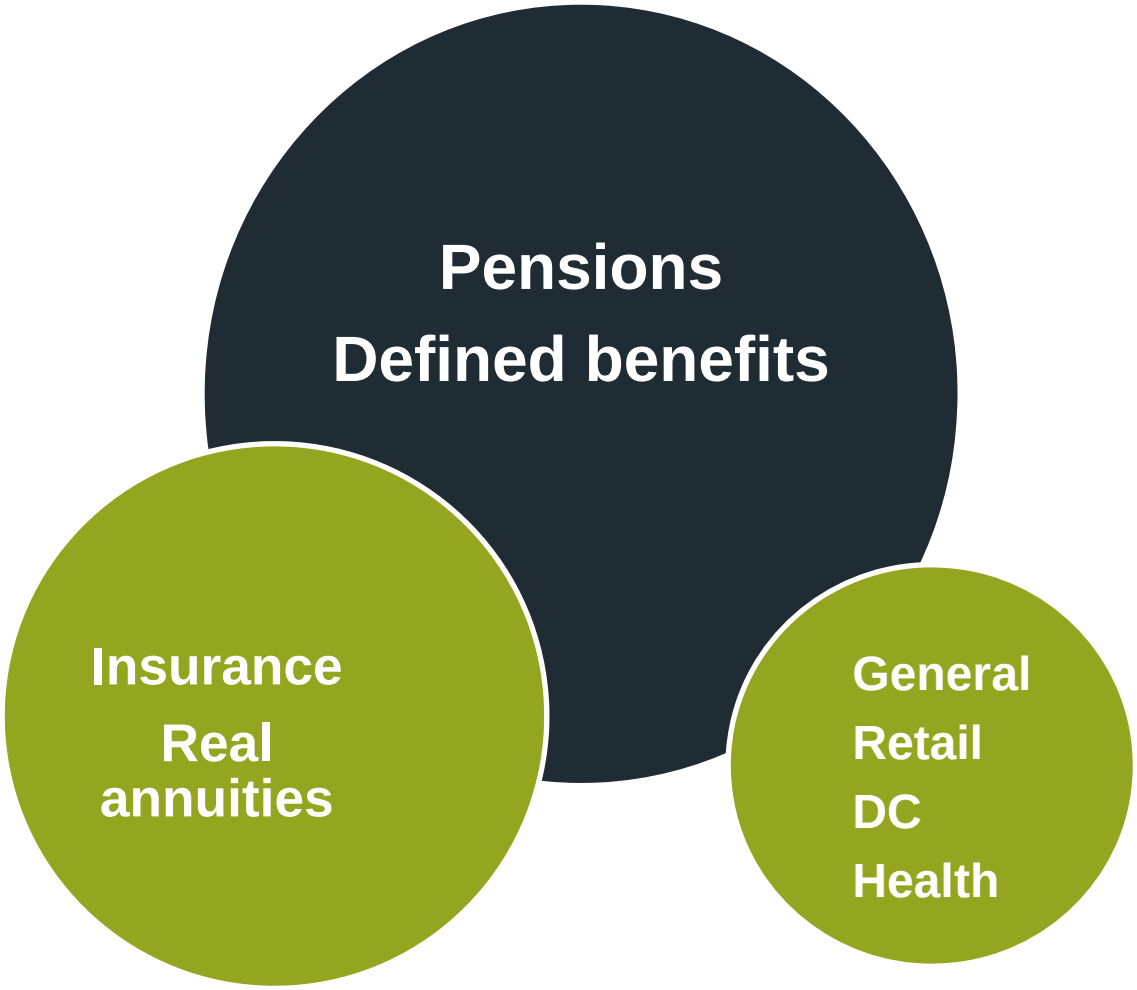
June 2011

# Agenda

- Introduction to inflation
- 1. The perfect match
  - *Study: Supply and demand for UK linkers*
- 2. Less than perfect … basis risks
- 3. Property, commodities and other real assets
  - *Study: Impulse function to test inflation hedge*
- Conclusion

# Introduction to inflation

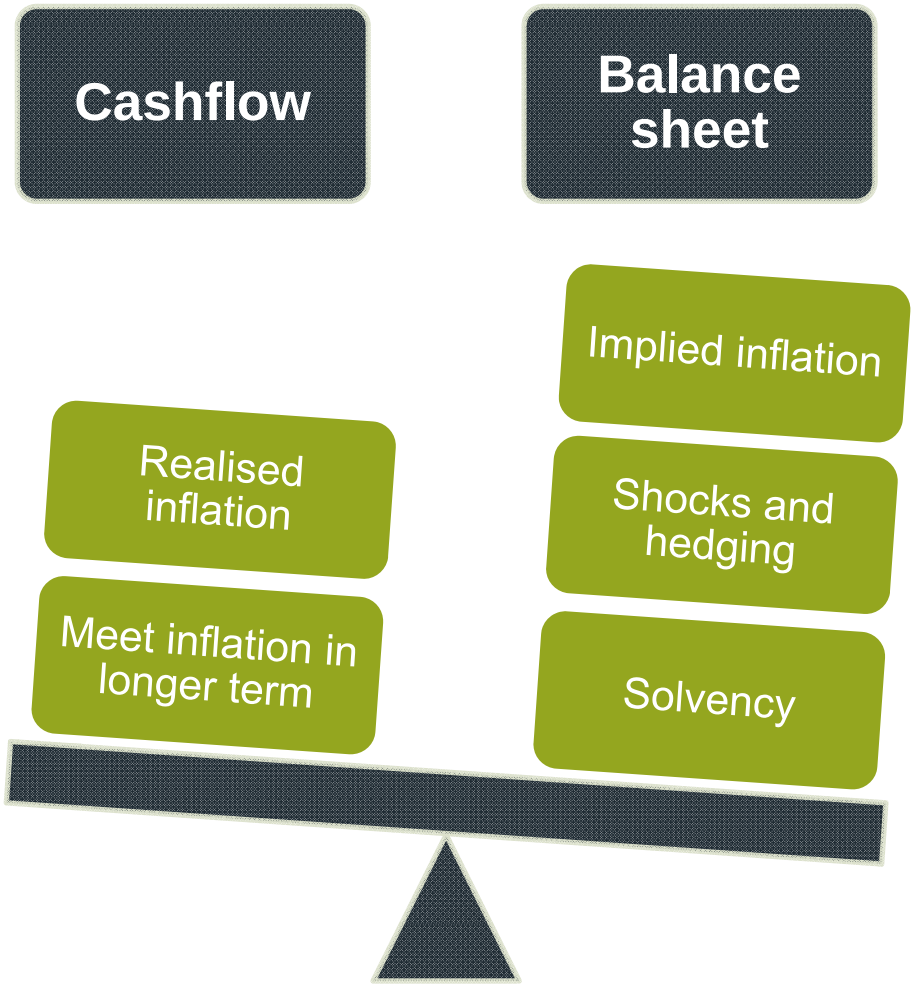
## *Inflation encountered by Actuaries*




- Pensions
  - Increases
  - Revaluation
  - Wage
  - Caps and floors, term or year-on-year
  - CPI and RPI
- Life
  - Annuities and pensions
  - Expenses
- General
  - Claims inflation
- Retail
  - DC accumulation and other savings

# Introduction to inflation

## *Inflation risks in more detail*

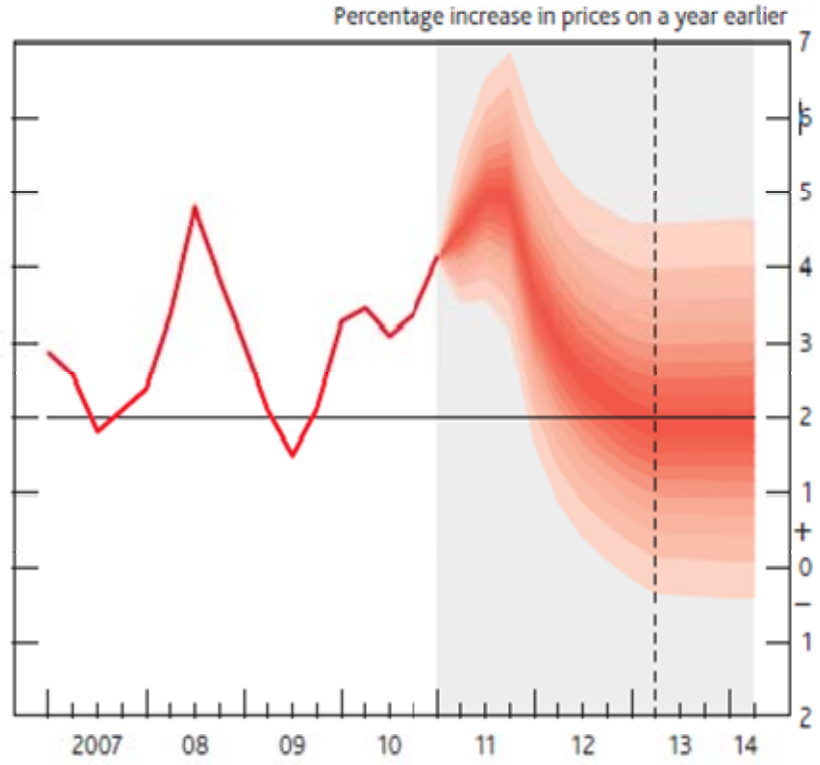



- Different types of inflation risks
  - Shocks
  - Persistent trends
  - Sectoral inflation, e.g. Property or medical costs
- Different impact on different types of investor
  - Caps and floors
  - Balance sheet versus cash flow/accumulation
- High unexpected inflation has been devasting to real values historically

# Current outlook

- UK CPI has overshot for c40 months. Current high inflation due to:
  - Energy Prices (c1%)
  - Import Prices/Global inflationary pressure (c2%)
  - VAT (0.8%)

- Inflation currently ‘highly uncertain’. Medium term risks:
  - Change to inflation target
  - Higher inflation expectations
  - Commodity prices and global price pressures.




- *Source: BOE May Inflation Report*

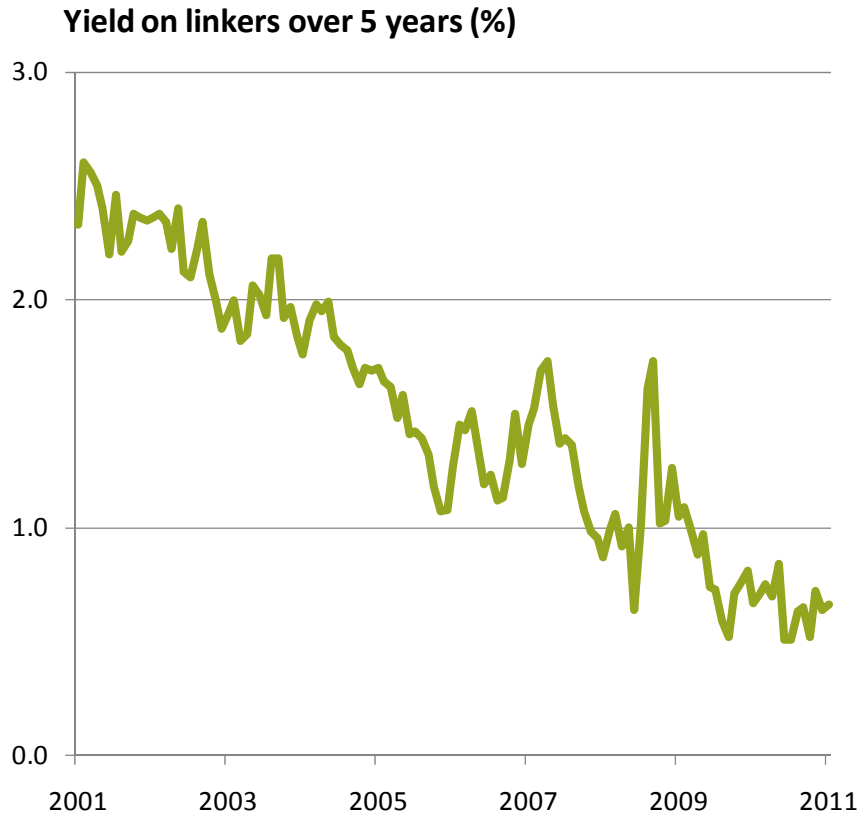
# Current outlook

| Longer term issues | |
|---|---|
| Global rebalancing | Growth of developing economies and their currency strength<br>Asia as inflation, not deflation, exporter |
| Central bank policies | Inflation targeting<br>Speed of tightening |
| Commodity scarcity | Population growth<br>Less energy dependence than 1970s<br>Technological and political responses uncertain |

# 1. The Perfect Match

## *Index-linked bonds*

- Inflation linked bonds
- Linkers main source for RPI swap inflation supply
- Very expensive?
- Supply / demand dynamics
- Basis risks
- Better off using other real assets

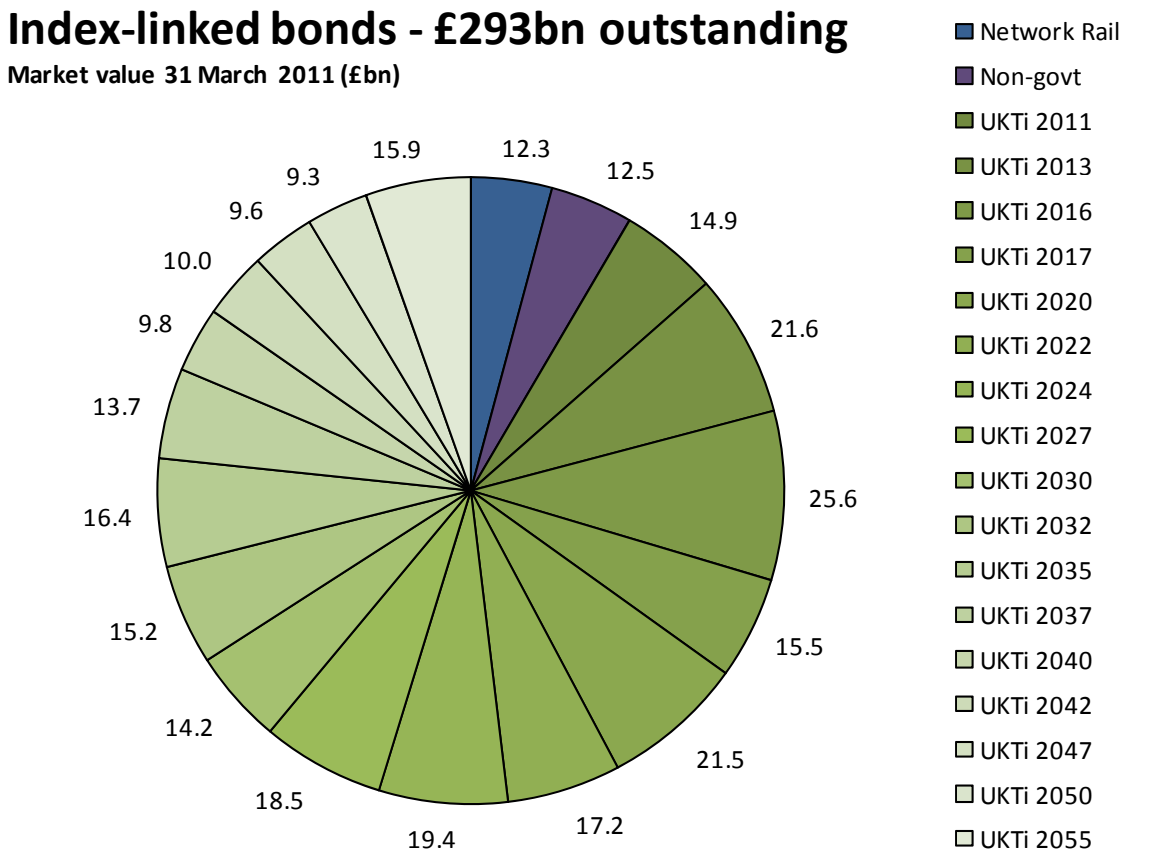



Source: Towers Watson 31 March 2011

# 1. The Perfect Match

## *Linker supply*

- Government main issuer, with currently 17 Index-linked gilts outstanding (making up over 90% of index-linked bonds)
- Network Rail main non-govt issuer
- We project this to 31 March 2017 (in line with the Budget 2011)
- Taking into account:
  - Coupons/redemptions
  - Future issuance
  - Real yield levels

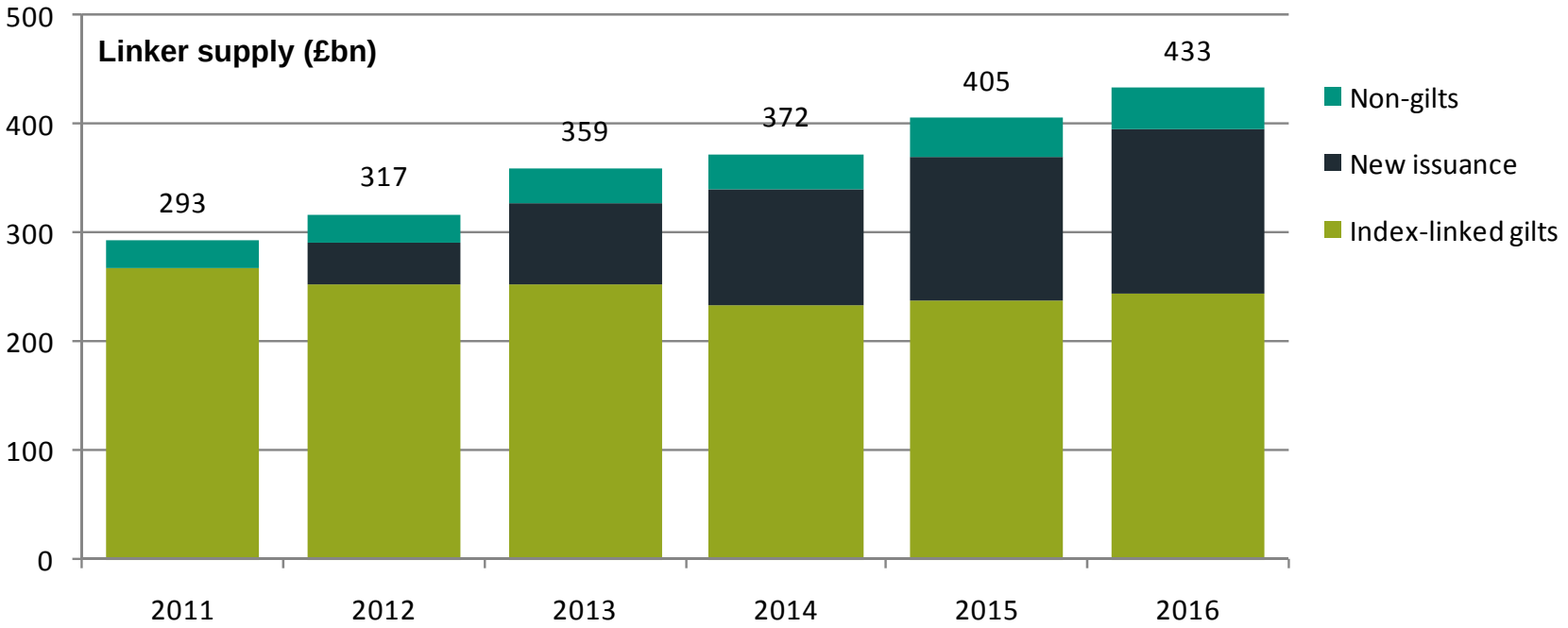



Source: FTSE / Barclays 31 March 2011
Includes Network Rail & 2011 issue

# 1. The Perfect Match

## *Linker supply projected*

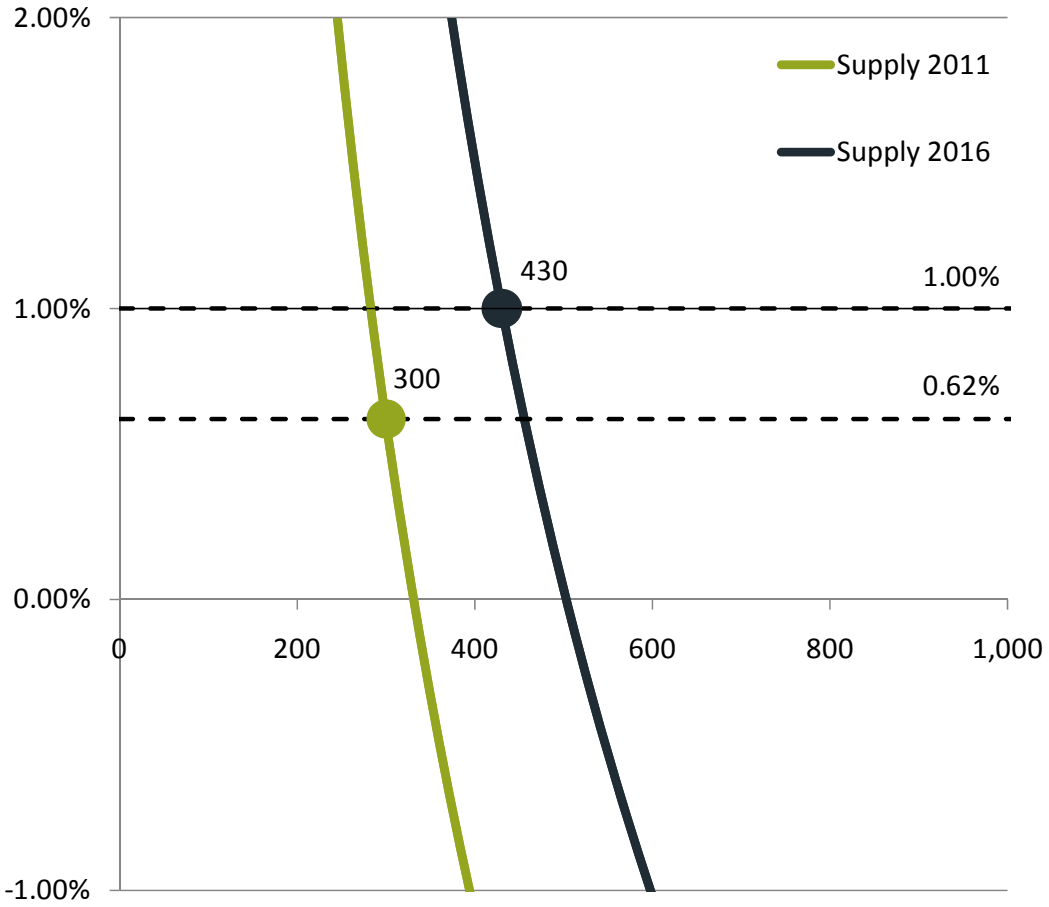
- Based on current yields, coupons, redemptions and expected future issuance the index-linked bond supply is projected to increase from the current £293bn to £433bn in 2016
- From budget 2011, assuming the government issues 23% of total supply in linkers and non-gilts market size will increase proportionally with the linker market



# 1. The Perfect Match

## *Linker supply today and in 2016*

- At an average real yield on the index of 0.62%, the initial market value is £300bn (rounded)
- Current yields imply an average real yield of around 1.00% in 2016 when the supply is around £430bn
- Nominal supply is assumed to be inelastic to real yield levels
- This curve therefore represents the market value of a supply which is fixed in nominal stock outstanding
- This explains why the curves are not perfectly vertical



# 1. The Perfect Match

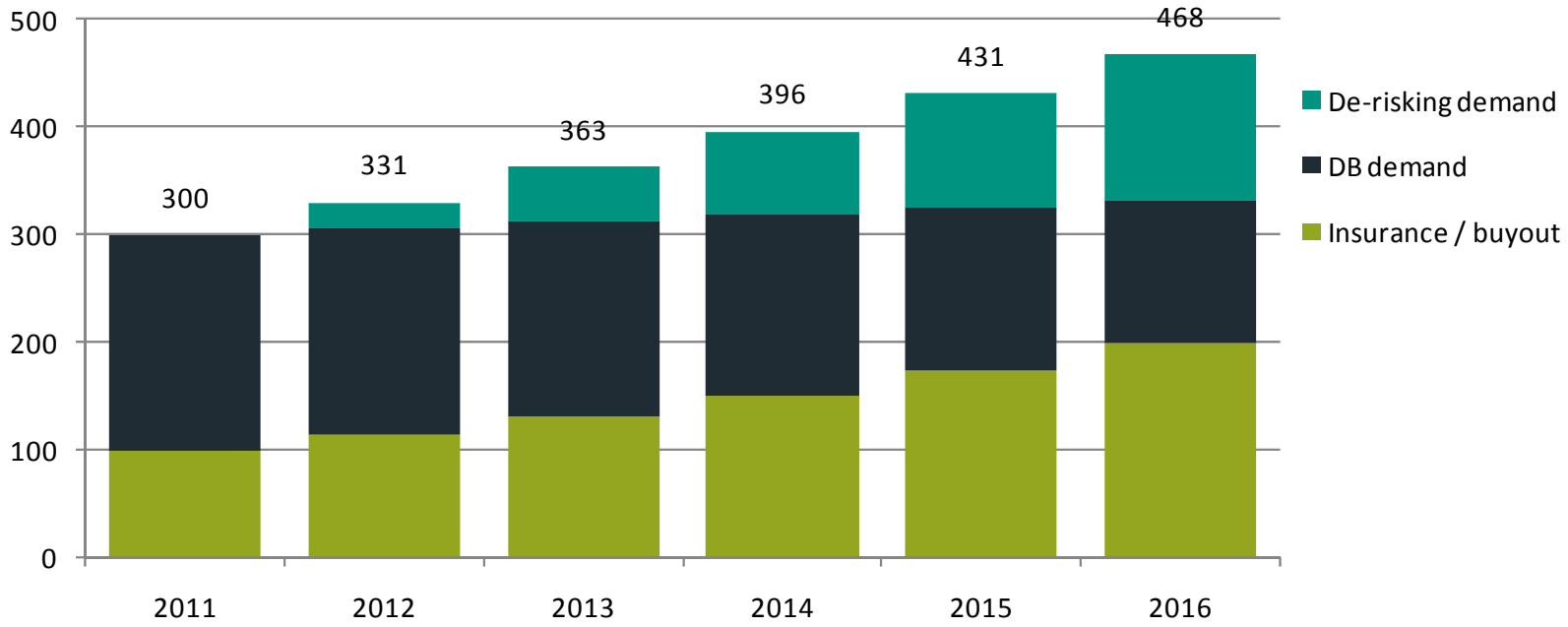
## *Linker demand*

- Estimated £200bn of linkers held by defined benefit pension funds (directly via linkers or indirectly via inflation swaps or other derivatives) and £100bn held by insurance companies and other
- With buy-out liabilities of some £1,350bn, assuming two-thirds inflation linked, this implies a potential demand from defined benefit pension funds of some £900bn (of which only £200bn is currently met)
- Demand characteristics of pension funds:
  - Mainly buy-and-hold to maturity with little appetite to re-risk
  - Large potential demand, waiting for attractive entry levels (real yield levels / funding levels)
  - This leads to asymmetric demand (buy when yields rise / hold when yields fall) which may provide a ceiling on the level of real yields
  - Funds closing, maturing and de-risking

# 1. The Perfect Match

## *Linker demand projected*

- Assuming DB funds to be fully closed, with an average 20 year duration and journey plan to become fully funded after 20 years
- Initial DB balance sheet £1.35tr liabilities, £1.00tr assets, 20% linkers. Target balance sheet is 100% funded with 67% linkers in 2031

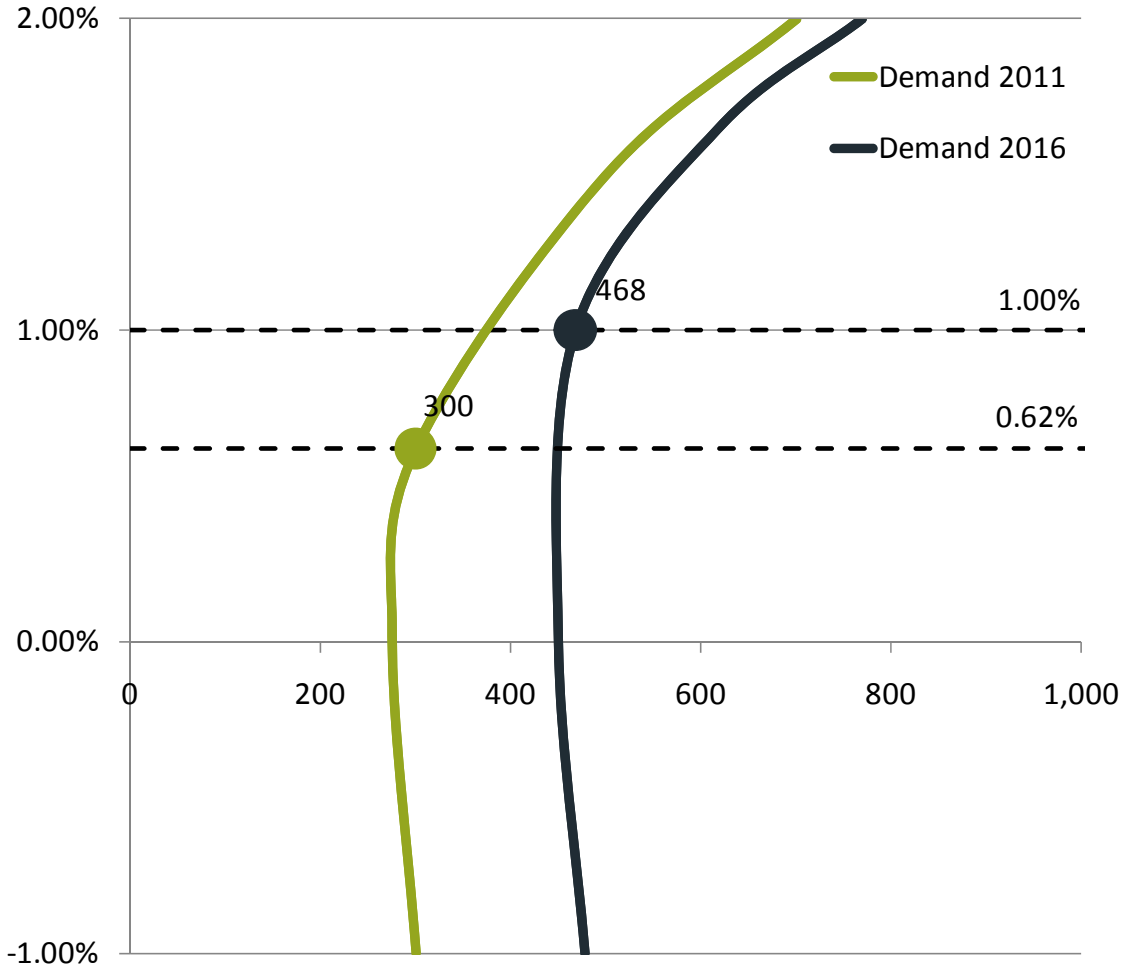



Source: Towers Watson / FTSE / Purple Book 31 March 2011

# 1. The Perfect Match

## *Linker demand today and in 2016*

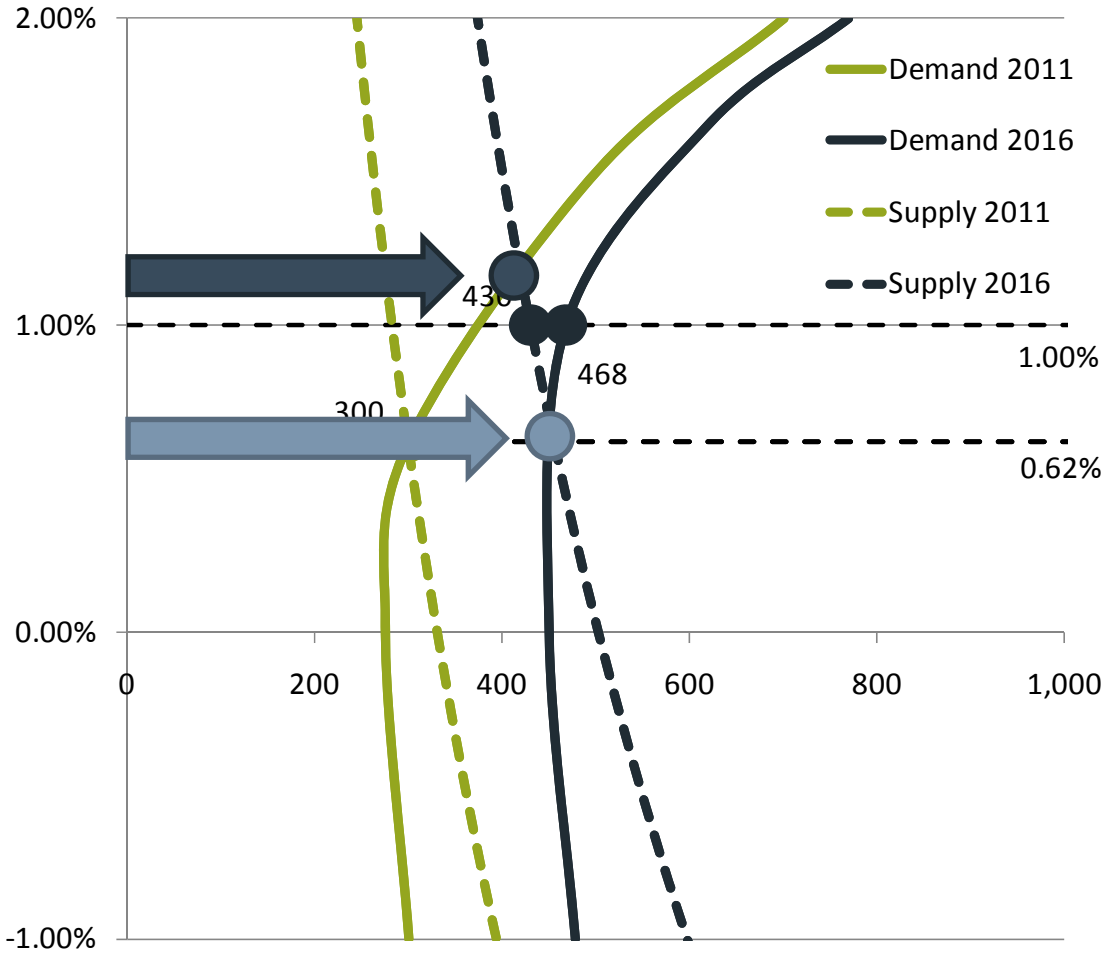
- At current yields the initial demand was £300bn, expected to increase to £468bn
- Demand is expected to be asymmetric, average duration is expected to be 20 years in 2011, reducing to 17 years in 2016
- Rising yields are expected to induce schemes to lock in earlier than their journey plan, while falling yields lead to only limited selling



# 1. The Perfect Match

## *Supply and demand*

- Based on the supply and demand projections, real yields may be expected to stay around 0.60%, well below yields priced in the market at present (light blue arrow)
- However, if funds don't de-risk (and therewith move their demand curve), yields may be expected to increase beyond 1.00% (dark blue arrow), just above current yields
- Model sensitive to assumptions – provides useful framework to test impact on certain behavioural aspects of pension fund actions



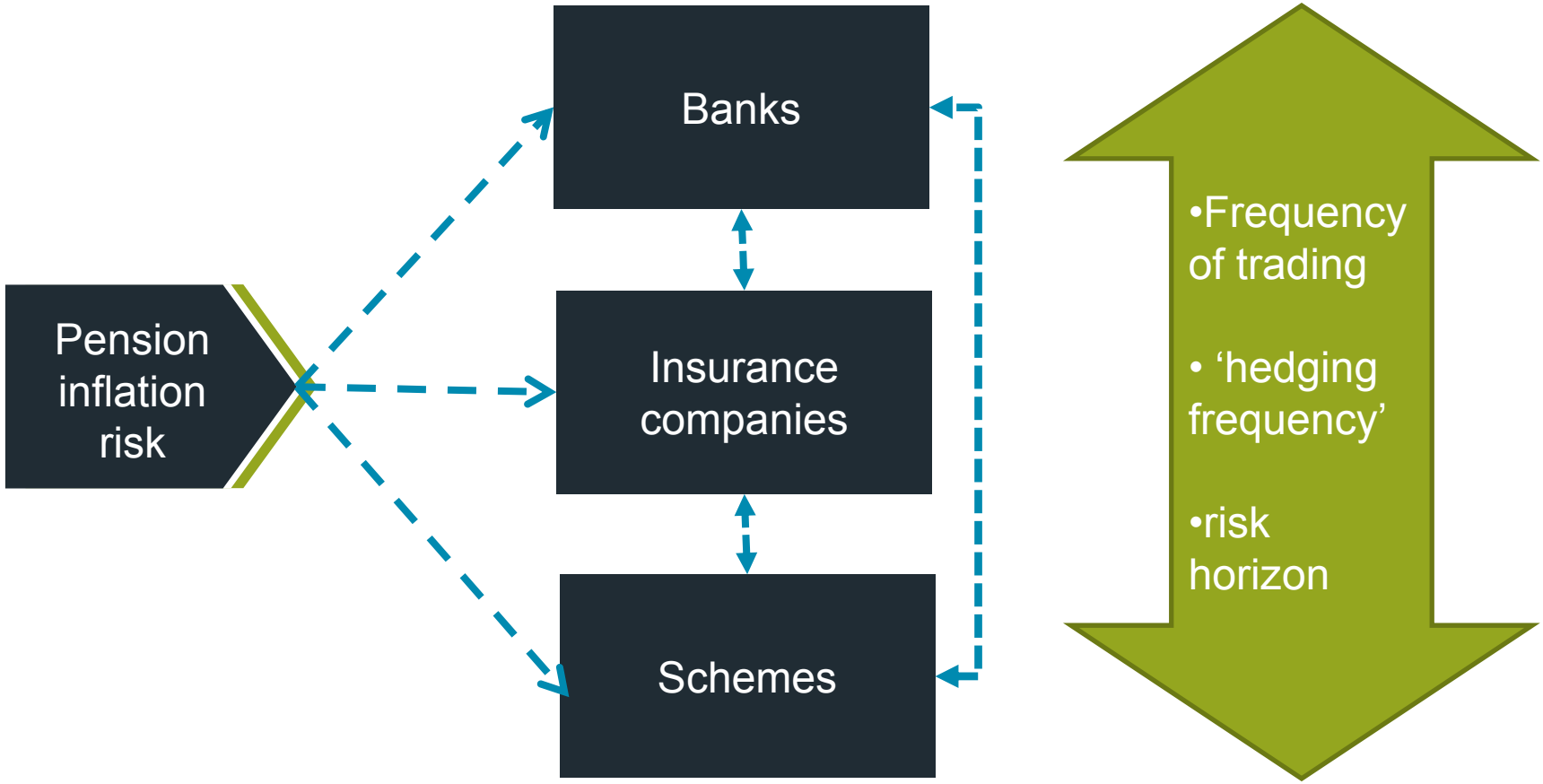
# 1. The Perfect Match

***Model outcomes and considerations***

- The relative pace and elasticity of de-risking relative to new issuance is key. Timeframe of 20 years to self-sufficiency relatively conservative? Faster collective de-risking could lead to very low yields…
- Should pension schemes wait for higher yields or buy linkers before issuance dries up and yields become even lower?

***"It's just a model…"***

# Risk transfer



# 2. Less than perfect … basis risks

- Lumpy cash flows from linkers
- Caps and floors on increases
- Hybrid increases
- Inflation lags, reference months
- Move to CPI

***"Why pay dearly for an average match?"***

# 3. Asset Class Summary

| Type | Inflation sensitivity | Asset class | Hedge reliability | Performance more likely under | Issues |
|---|---|---|---|---|---|
| Matching | Matched | ILGs/ Swaps | High | N/A | Value, basis risks |
| Diversified Real & Cash | Medium | Cash | Medium | Domestic/demand driven inflation | Dependant on monetary policy |
| | | Equities/ Property | Medium | Emergence from deflation. Higher steady inflation. | Often negative betas. Stock selection required |
| High beta | High | Commodities | Low | Global inflation & shocks | Roll risk, high volatility |
| | | Precious metals | Low | Shocks & economic uncertainty | High volatility |

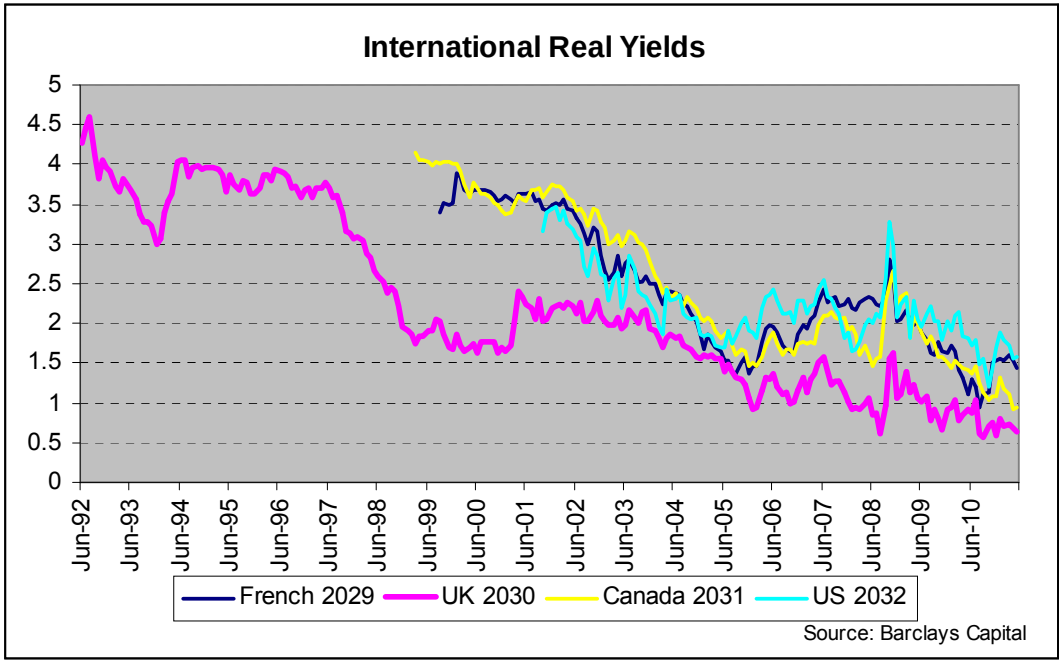
# 3. Others

- Infrastructure
  - Arguably more private equity-like than perceived
  - Limited selection provide the inflation link
- Timber, farmland etc.
  - Mixture of real asset and commodity exposure

- Expect assets where the underlying income has a link to inflation, eg equities and property to act as a hedge, but risk premiums also often rise. Real assets with lower p/e ratios perform better

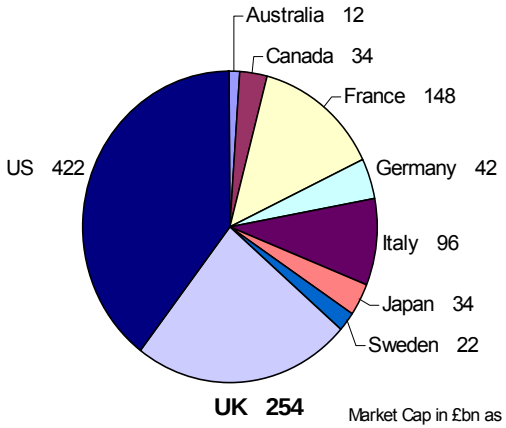
# 3. The International Alternative?

- Real yields down worldwide
  - monetary policy easing by Central Banks.
- Limited demand for inflation-linked bonds from domestic pension schemes
  - Except Netherlands
- Higher yields than UK



# 3. The International Alternative?

**Developed IL Markets**

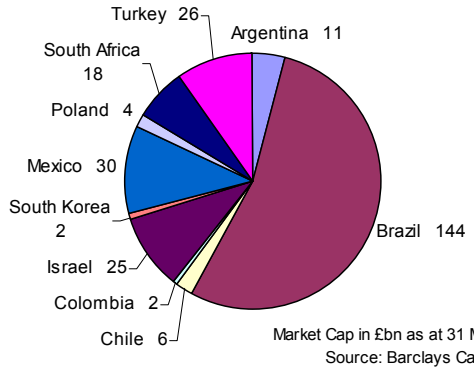



Market Cap in £bn as at 31 March 2011
Source: Barclays Capital

- All G7 countries have now followed the UK's lead by issuing inflation-linked debt.
- With globalisation leading to more correlation between international inflation rates, international inflation-linked can be seen as an alternative inflation hedge.

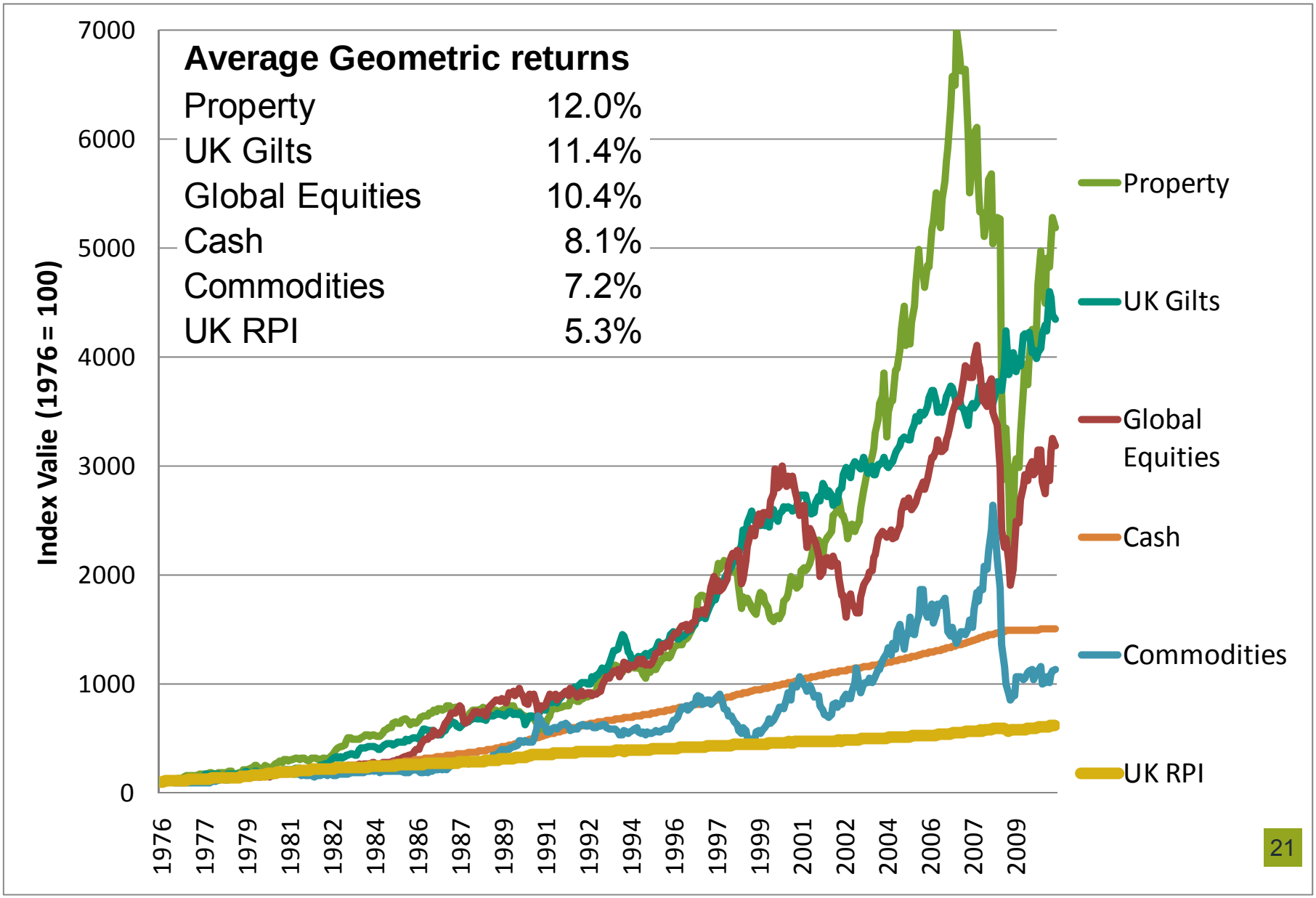
- More Emerging Market economies have also started to issue inflation-linked debt.
- With EM inflation recently exceeding that in developed markets, interest has grown in these assets.
- However liquidity is still relatively limited.

**Emerging Markets**




Market Cap in £bn as at 31 March 2011
Source: Barclays Capital

# 3. RPI and Asset Returns since 1976



# 3. Observations

- Correlation not satisfactory measure of dependence as not capturing long term linkages, eg:
  - Cash has the highest correlation with inflation
  - Equities have the lowest correlation with inflation

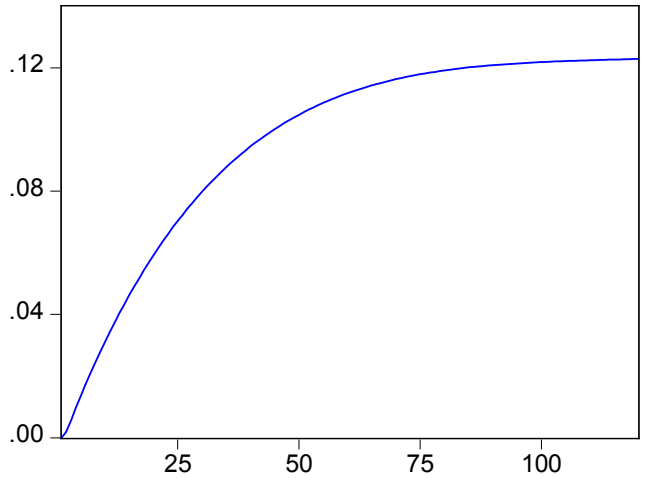
- Fit Vector Error Correction Model (VECM) to capture long term linkages

- Stress RPI by one s.d. to determine how returns in fitted model respond

# 3. Impulse Response Functions

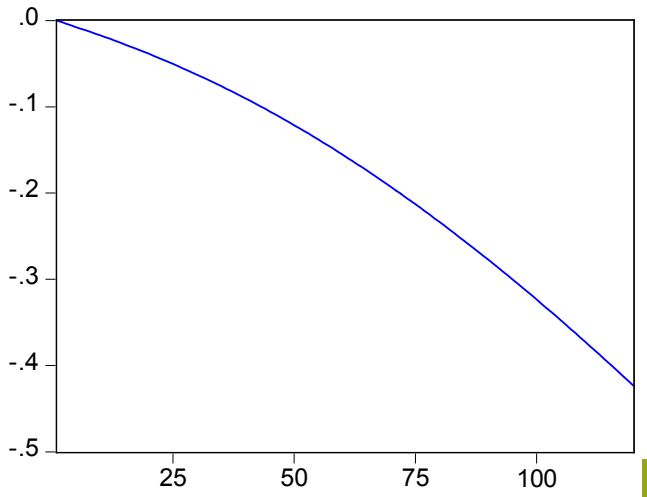
- Property – offers a partial hedge

Accumulated Response of LOG(PROP) to LOG(RPI)




- Gilts – experience losses

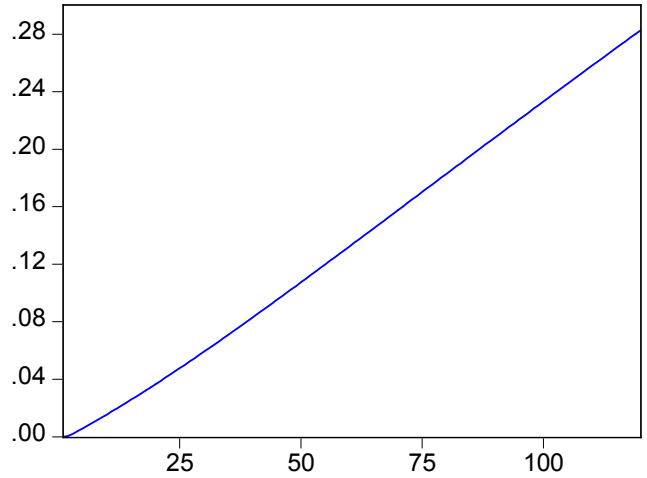
Accumulated Response of LOG(GILT) to LOG(RPI)



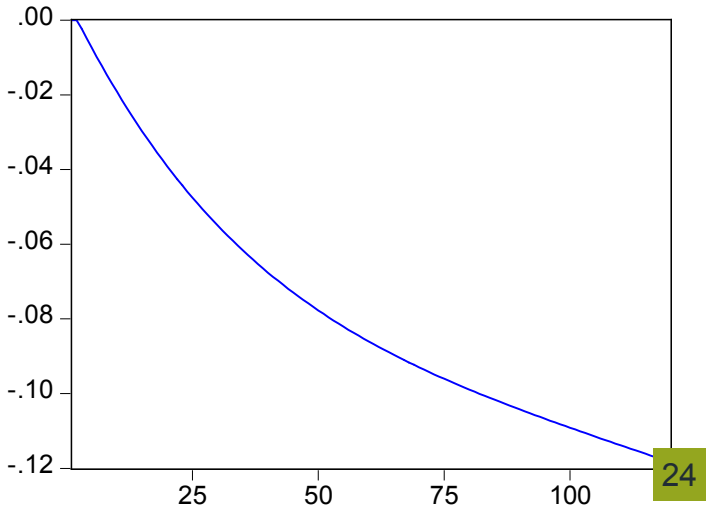
# 3. Impulse Response Functions

- Equities – offers a partial hedge
- Commodities – experience losses
- Cash – offers a partial hedge

Accumulated Response of LOG(EQ) to LOG(RPI)




Accumulated Response of LOG(COMM) to LOG(RPI)



# 3. Summary

Impulse response functions:

- Qualitative tool to examine dependence
- Give sense of time dependency
- Results sensitive to the data period used to fit the models
- Stable inflation/strong equity & property returns in this period

➔ Diversify and consider risk/reward preferences of investor:

  - Cash, selected equities and property
  - Foreign FX exposure to protect against domestic only inflation.
  - Small amounts of commodities and precious metals against inflationary shocks

➔ Cannot rely on past relationships repeating so need to balance with forward looking economic view and consideration of entry price into asset classes

# 4. Conclusions

- Outlook:
  - Highly uncertain with drivers changing from past
- Matching:
  - Supply/demand dynamics limit scope for cheapening of inflation protection
- Other asset classes:
  - Depends on nature of inflation, time horizon, risk preferences...and views.

# Working party

- David Bowie (chair)
- Shajahan Alam
- David Dyer
- Keith Feldman
- Rawnak ul Islam
- Martijn de Vree
- James Walton

# Appendix

# A1. Impulse analysis: Descriptive Statistics

| | Cash | Commodities | Global Equities | Gilts | Real Estate | UK Inflation |
|---|---|---|---|---|---|---|
| **Mean** | 7.8 | 6.9 | 9.9 | 10.8 | 11.3 | 5.2 |
| **Median** | 6.8 | 8.9 | 14.6 | 10.5 | 15.0 | 4.6 |
| **Maximum** | 15.8 | 247.8 | 133.5 | 232.1 | 296.0 | 50.6 |
| **Minimum** | 0.5 | -397.5 | -251.8 | -130.7 | -432.0 | -17.4 |
| **Std. Dev.** | 1.1 | 19.3 | 15.0 | 11.3 | 17.2 | 2.0 |
| **Skewness** | 0.179 | -0.621 | -0.880 | 0.617 | -1.603 | 1.694 |
| **Kurtosis** | 2.301 | 6.523 | 5.525 | 6.285 | 13.931 | 10.829 |

Mean, Median, Maximum, Minimum and Standard Deviation in %

# A1. Correlations

| | Cash | Commodities | Global Equities | Gilts | Real Estate | UK Inflation |
|---|---|---|---|---|---|---|
| **Cash** | 100% | 4% | 4% | 8% | 0% | 41% |
| **Commodities** | | 100% | 23% | -3% | 17% | 13% |
| **Global Equities** | | | 100% | 15% | 57% | 4% |
| **Gilts** | | | | 100% | 9% | 5% |
| **Real Estate** | | | | | 100% | 8% |
| **UK Inflation** | | | | | | 100% |

# A1. Vector Autoregressive Models (VAR)

VAR process of order p

$$y_t = v + A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t, \quad t \in \mathbb{Z}$$

- $y_t$ is a $k$ x 1 random vector
- the $A_i$ are $k$ x $k$ fixed coefficient matrices
- is a $k$ x 1 fixed vector of intercept terms
- $u_t$ is a $k$ x 1 random vector,
- a *white noise* or *innovation process*.

# A1. Cointegration

- Let $y_t$ *be* a $k$ x 1 random vector
  $y_t \sim I(d)$ (integrated of order $d$)
  if $\Delta^d y_t$ is stationary
  but $\Delta^{d-1} y_t$ is not

- I(0) is stationary

- $y_t \sim I(d)$ is cointegrated
  if there exists $k$ x 1 fixed vector $\beta \neq 0$
  so $\beta' y_t$ is integrated of order $< d$

- We say $y_t \sim CI(d)$

# A1. Vector Error Correction Models (VECM)

VECM process of order p

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \ldots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t, \quad t \in \mathbb{Z}$$

- $y_t$ is a $k$ x 1 random vector, ~ CI(1)
- $\Pi$ $k$ x $k$ fixed cointegration matrix
- the $\Gamma_i$ are $k$ x $k$ fixed coefficient matrices
- $u_t$ is a $k$ x 1 *white noise process*.
- Additionally, we assume that $u_t$ is Gaussian

# A1. VAR Lag Order Selection

| VAR Lag Order Selection Criteria | | | | | | |
|---|---|---|---|---|---|---|
| Endogenous variables: LOG(CASH) LOG(COMM) LOG(EQ) LOG(GILT) LOG(PROP) LOG(RPI) | | | | | | |
| Exogenous variables: C | | | | | | |
| Date: 05/25/11 Time: 14:37 | | | | | | |
| Sample: 1976M01 2010M12 | | | | | | |
| Included observations: 408 | | | | | | |
| | | | | | | |
| Lag | LogL | LR | FPE | AIC | SC | HQ |
| | | | | | | |
| 0 | 744.8051 | NA | 1.08E-09 | -3.621594 | -3.562604 | -3.598251 |
| 1 | 6680.003 | 11666.74 | 2.98E-22 | -32.53923 | -32.12631 | -32.37584 |
| 2 | 7189.194 | 985.9332 | 2.93e-23* | -34.85879* | -34.09193* | -34.55534* |
| 3 | 7222.64 | 63.77787 | 2.96E-23 | -34.84628 | -33.72548 | -34.40277 |
| 4 | 7244.236 | 40.54483 | 3.18E-23 | -34.77567 | -33.30094 | -34.19211 |
| 5 | 7273.062 | 53.27209 | 3.30E-23 | -34.7405 | -32.91184 | -34.01689 |
| 6 | 7295.538 | 40.87401 | 3.53E-23 | -34.6742 | -32.4916 | -33.81054 |
| 7 | 7322.907 | 48.96902 | 3.69E-23 | -34.63189 | -32.09536 | -33.62818 |
| 8 | 7340.164 | 30.36979 | 4.05E-23 | -34.54002 | -31.64955 | -33.39625 |
| 9 | 7360.105 | 34.50549 | 4.40E-23 | -34.4613 | -31.21689 | -33.17748 |
| 10 | 7393.44 | 56.70292 | 4.47E-23 | -34.44824 | -30.84989 | -33.02436 |
| 11 | 7422.503 | 48.58045 | 4.65E-23 | -34.41423 | -30.46195 | -32.8503 |
| 12 | 7459.804 | 61.25426* | 4.64E-23 | -34.42061 | -30.1144 | -32.71663 |

- Therefore 2 lags are used

* indicates lag order selected by the criterion

# A1. Cointegration Rank Test

| Unrestricted Cointegration Rank Test (Trace) | | | | |
|---|---|---|---|---|
| | | | | |
| Hypothesized | | Trace | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| | | | | |
| None * | 0.097182 | 134.5191 | 95.75366 | 0 |
| At most 1 * | 0.080499 | 91.88725 | 69.81889 | 0.0003 |
| At most 2 * | 0.054376 | 56.89102 | 47.85613 | 0.0057 |
| At most 3 * | 0.038066 | 33.57633 | 29.79707 | 0.0175 |
| At most 4 * | 0.028393 | 17.39282 | 15.49471 | 0.0256 |
| At most 5 * | 0.012822 | 5.381441 | 3.841466 | 0.0203 |

| Unrestricted Cointegration Rank Test (Maximum Eigenvalue) | | | | |
|---|---|---|---|---|
| | | | | |
| Hypothesized | | Max-Eigen | 0.05 | |
| No. of CE(s) | Eigenvalue | Statistic | Critical Value | Prob.** |
| | | | | |
| None * | 0.097182 | 42.63189 | 40.07757 | 0.0252 |
| At most 1 * | 0.080499 | 34.99623 | 33.87687 | 0.0366 |
| At most 2 | 0.054376 | 23.31469 | 27.58434 | 0.1604 |
| At most 3 | 0.038066 | 16.18351 | 21.13162 | 0.2143 |
| At most 4 | 0.028393 | 12.01138 | 14.2646 | 0.1102 |
| At most 5 * | 0.012822 | 5.381441 | 3.841466 | 0.0203 |

- Trace test indicates 6 cointegrating equations at the 0.05 level
- Max-eigenvalue test indicates 2 cointegrating equations at the 0.05 level
- Therefore 2 cointegrating equations are used

* denotes rejection of the hypothesis at the 0.05 level

# A1. Other Studies using longer time series data

- Today's value of £100 invested at the end of 1899 without reinvesting income would be in real terms £180 for equities and £1 for gilts
- Today's value of £100 invested at the end of 1899 with income reinvested gross would be in real terms £24,133 for equities, £369 for gilts and £286 for cash
- Importance of income and long investment horizon

# A1. Cash – offers a partial hedge

- Cash initially reacts positively to inflation shocks
- After around six years the cash return starts to drop
- By year 10 the cash return due to the inflation shock is negative.

# A1. Gilts – experience losses

- Gilts total return reacts negatively to inflation shocks both in the short and to 10 years.
- Nominal value is eroded by inflation
- Do not protect against unexpected inflation

# A1. Equities – offers a partial hedge

- Equities react positively to an inflation shock both in the short term and to 10 years.
- The reaction is not 1 for 1 so this provides a loose hedge even if in the same direction.
- Result possibly due to stabilising effect of the dividends which match inflation very well.
- Inflation in the analysis period has been stable.

# A1. Property – offers a partial hedge

- Reacts positively to inflation shocks.
- The positive reaction tails off after six years.
- Reasons similar to equities due the REITS are an equity market index even if with property focus.
- Need to find reliable unlisted property returns to eliminate this effect.

# A1. Commodities – experience losses

- The GSCI total returns react negatively to inflation shocks in the short term and begins to level off after 10 years.
- Inflation in the analysis period is due to the demand pull rather than the cost push inflation.
- High volatility of commodities makes it difficult to hedge inflation which is much less volatile.
- Heavy energy sector influence on the GSCI could distort the true relationship.