An overhead photograph of a business meeting. Several people are seated around a light-colored wooden conference table. One man in a blue striped shirt is looking at a document. Another man in a light blue shirt has his hands clasped. A woman in a white shirt is also visible. On the table, there are papers, a calculator, a water bottle, and a mobile phone. The floor is made of light-colored square tiles.

Inflation Risk: Beyond the One-Year Horizon

GIRO - 19 September 2012

Nigel Hooker, Matthew Lightwood

Conning Risk & Capital Management Solutions



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Do You Remember When...?

Average UK house price – £ 24,188

Gallon of petrol – £ 1.32 (29p per litre)

Yearly inflation rate (UK) – 11.9%

Bank of England interest rate (year end) – 14.38%

First year the word “internet” was mentioned

First IBM PC sold – \$ 1,565 (excl. disk drives): standard model \$ 2,880

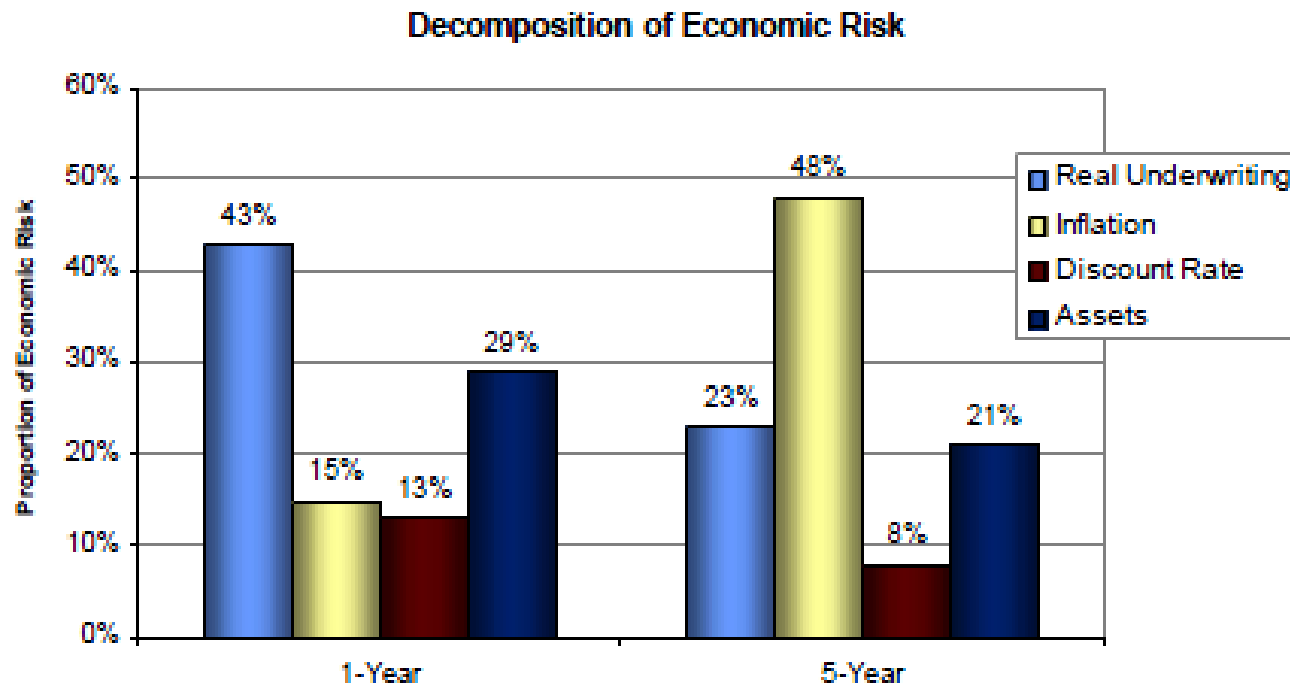
“PC-DOS” was released – \$ 40

Actuarial student starting salary (London) – ca. £ 5,000 pa

Sources:

<http://www.thepeoplehistory.com/1981.html>

http://www.wired.com/science/discoveries/news/2008/08/dayintech_0812

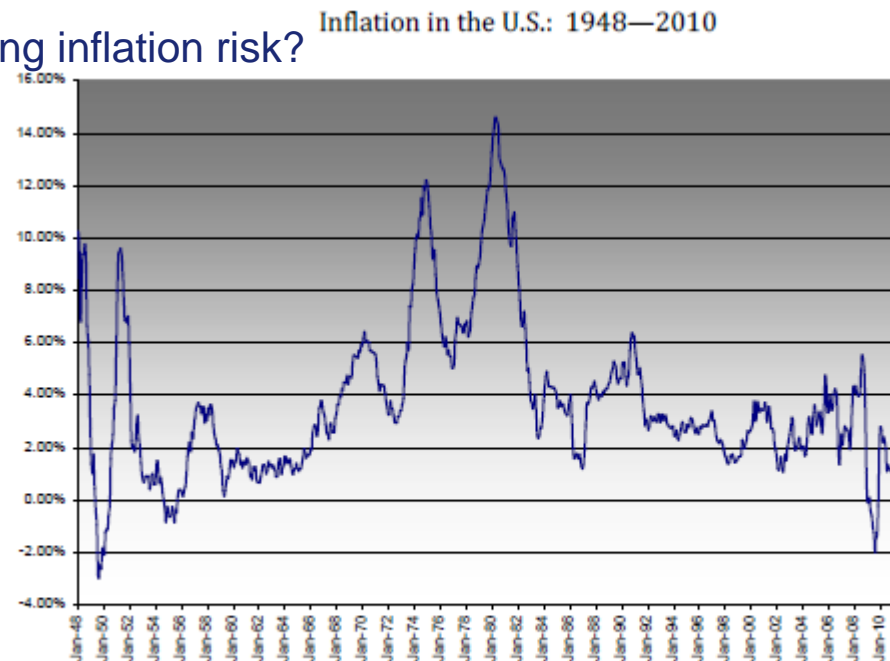


Source: Conning Risk & Capital Management Solutions analytics.

“Catastrophe exposures, asset valuation exposures, and other factors may produce significant volatility in a single year, but bad outcomes are generally random and not repetitive. Inflation is generally sticky and cumulative.” – Conning Strategic Study: Inflation in Property-Casualty Insurance: How bad can it be? 2010



- How do we identify, measure and manage inflation risk?
- What is inflation? What causes inflation? Can inflation be anticipated?
- How does inflation affect P&C insurers?
- How can this effect be modeled?
- What hedging instruments are available?
- Can we model the effect of hedging inflation risk?
- Conclusions



Source: U.S. Bureau of Labor Statistics; Conning Risk & Capital Management Solutions analytics



What is Inflation?

Definition of inflation – sustained trend of rising prices within an economy

Measures of inflation

- Consumer/retail prices
- Producer prices
- Wages
- House price appreciation

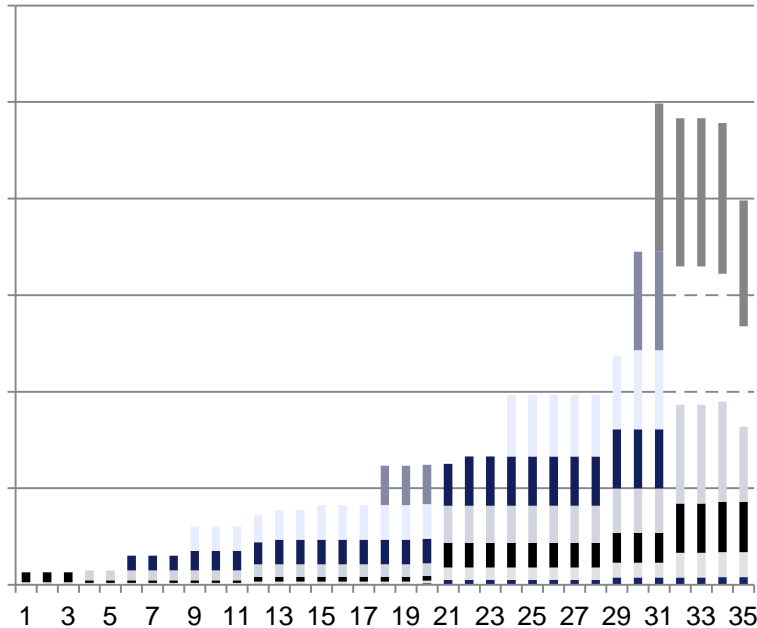
Complications

- “Hedonic” adjustment for quality
- Effect of productivity improvements

Impact on P&C insurers

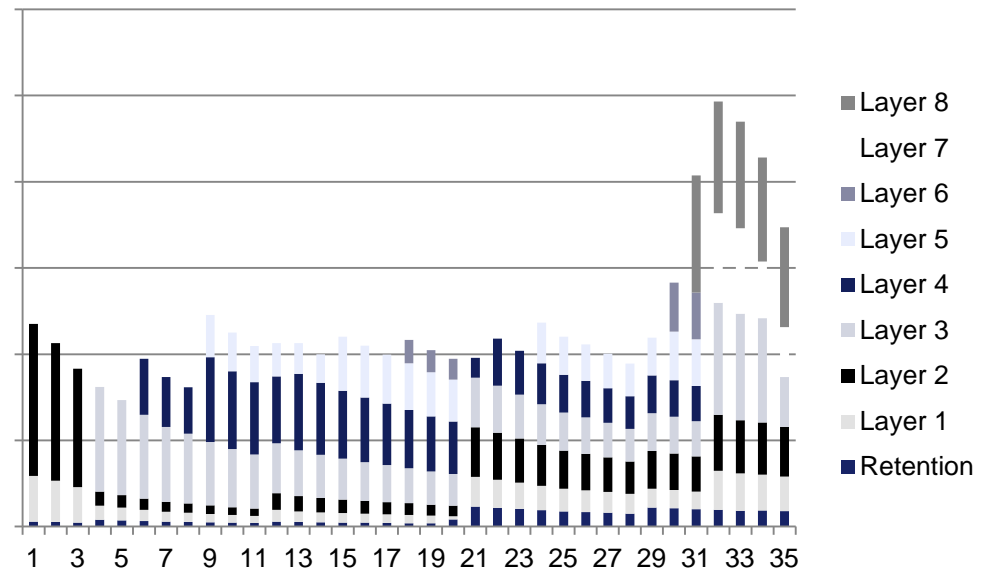
- Claim costs, admin costs, exposure changes
- Real asset appreciation, growth in dividends and rental income
- Reinsurance

Excess of Loss Reinsurance



35-year history of a large European insurer's Liability XL program showing retention and layers in nominal monetary amounts

After adjusting all attachment points and limits for inflation, the program looks relatively stable over most of the period with key step-change features much clearer





Indexation clause / stability clause / severe inflation clause

The subject loss payments are scaled down according to the relative increase in the level of the selected index

Typically found in motor and other third party liability treaties, especially in continental Europe

(There are variations in the clause, which affect which dates for the index are used for which loss payments, a possible threshold (e.g. 10%) for triggering any indexation, and whether the indexation applies on an excess or franchise basis.)

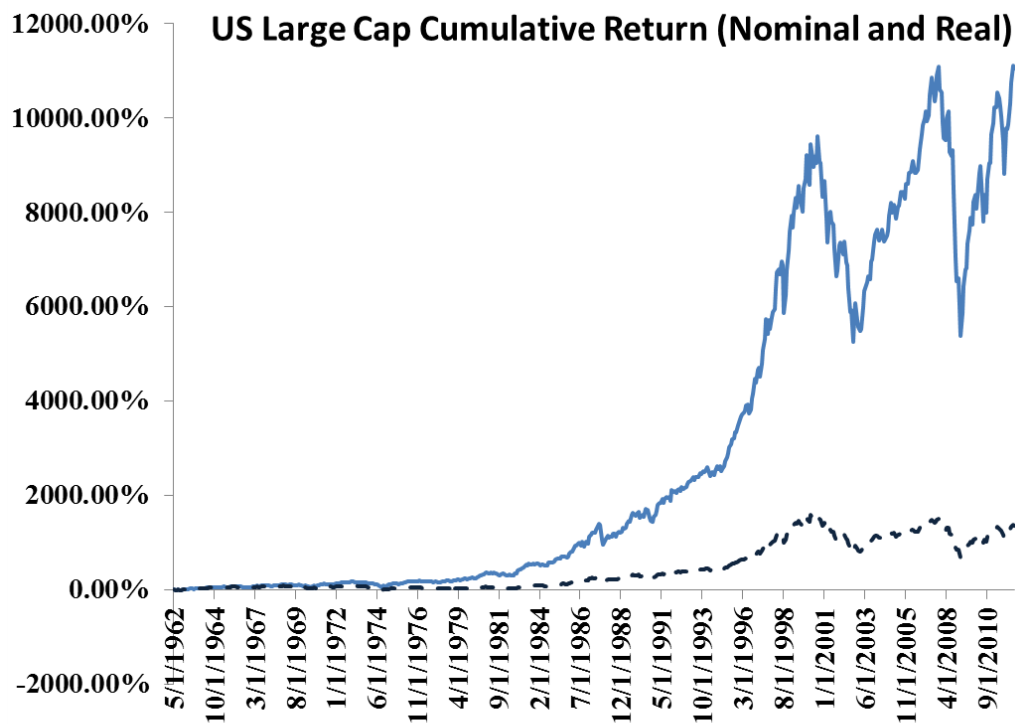
In a typical motor liability XL case with a 10% severe inflation threshold, the impact of the clause can be to decrease the ceded losses by around 30% relative to the situation without indexation

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- I. Inflation: Historical Perspective
 - II. An Introduction to Inflation Linked Products and Derivatives



Inflation and the Inflation Market

- ◆ Why is inflation important?
 - ❖ Investors don't care about absolute (nominal) returns they care about **real** returns
- ◆ Real returns are returns net of inflation
 - ❖ Would you prefer a 2% pay rise with 1% inflation or a 50% pay rise with 50% inflation?
- ◆ Governments want to deliver real GDP growth hence measuring inflation is important
- ◆ Businesses with inflation linked liabilities need to hedge the risk
- ◆ A true a market has sprung up around inflation over the last 2 decades
 - ❖ Inflation linked bonds
 - ❖ Inflation swaps
 - ❖ Inflation linked derivatives
 - ❖ Structured products
- ◆ Anyone wishing to invest in this market should have a good understanding of inflation

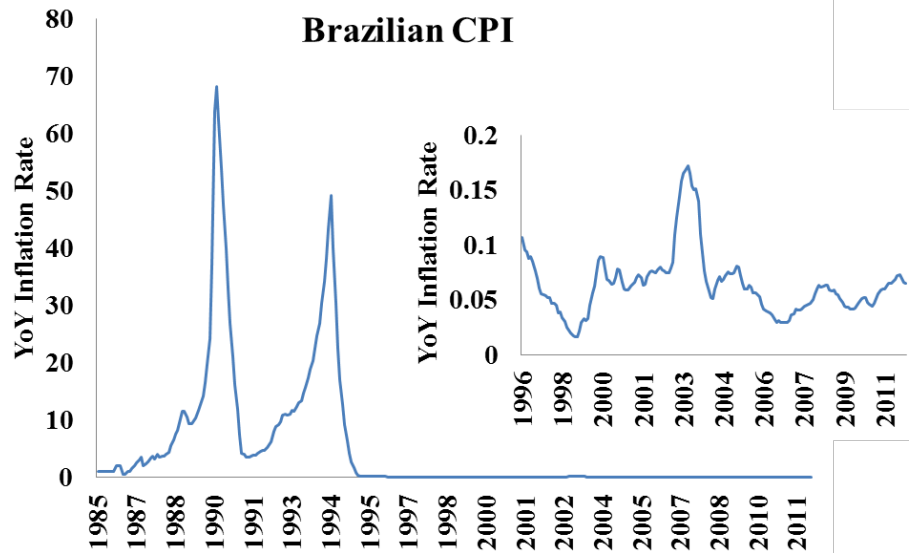
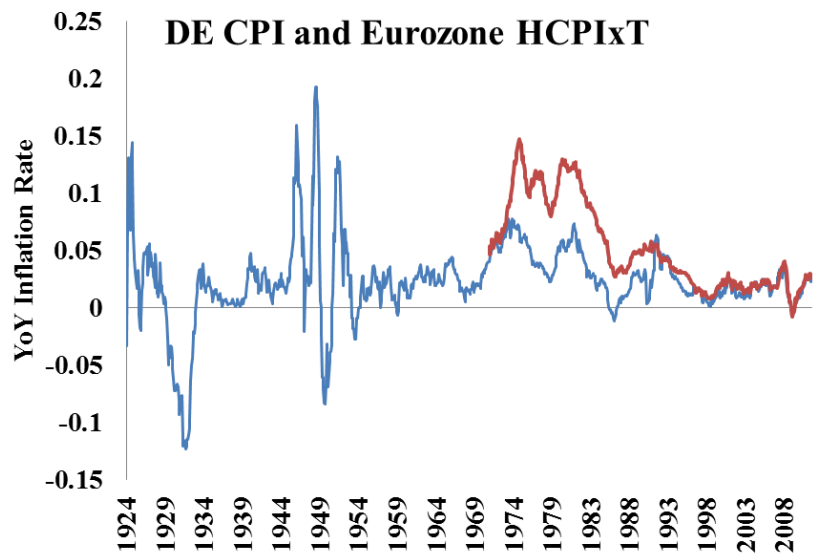
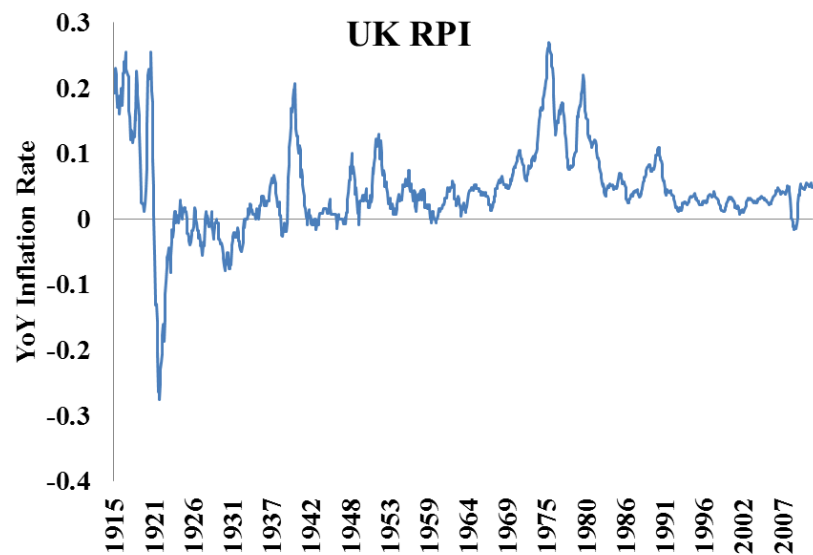
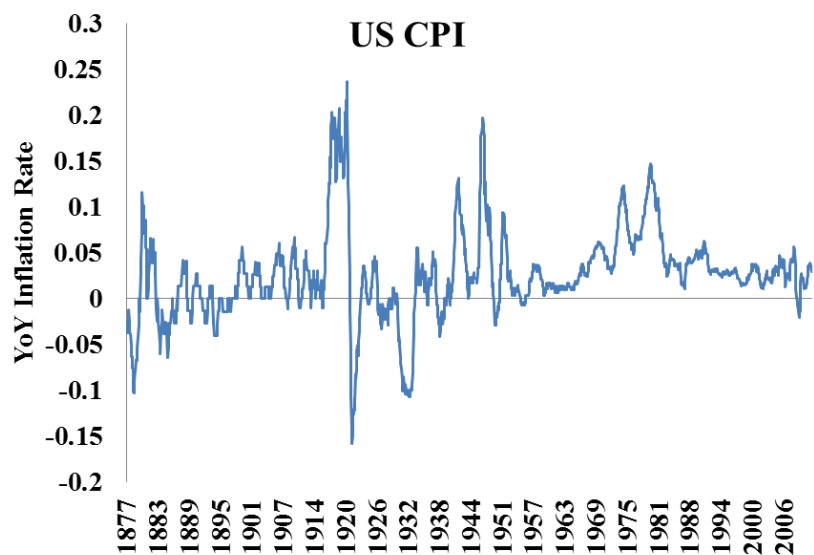


Source: Bloomberg/Conning





Historical Inflation Rates in 4 Economies



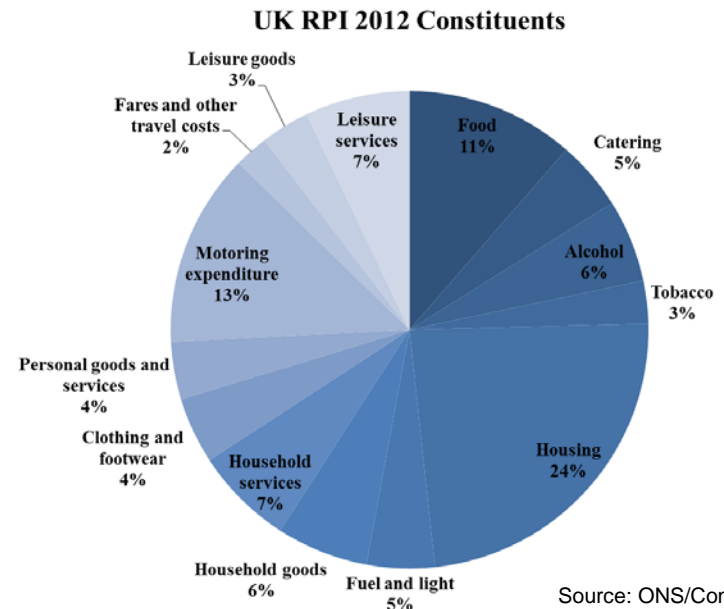
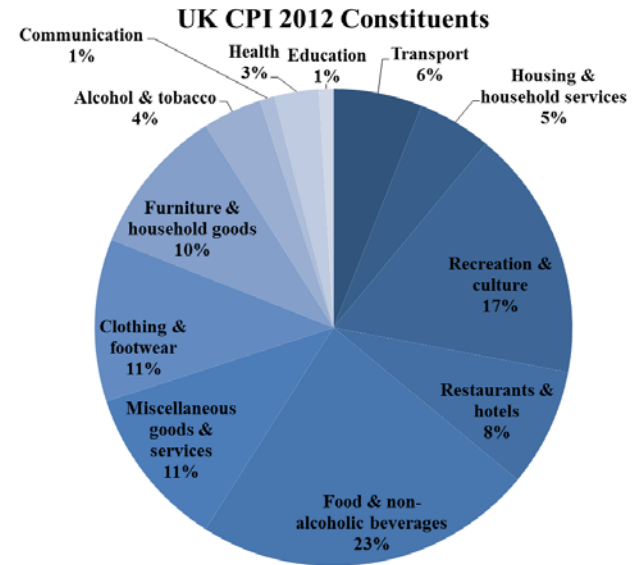
Source: Bloomberg/Conning





Inflation Indices and UK CPI and RPI

- ◆ Measuring inflation is by no means easy
 - ❖ Inflation indices are based on the price of a “basket of goods”
 - ❖ The basket is usually defined based upon a household budget survey to be representative of average household expenditure
 - ❖ For the Eurozone countries are “weighted” based on GDP
- ◆ In the UK we have two inflation indices CPI and RPI
- ◆ RPI is typically higher than CPI by approximately 1%
- ◆ RPI vs CPI
 - ❖ RPI and CPI contain a slightly different basket of goods with different weights (e.g. RPI includes mortgage interest and council tax in the Housing bucket)
 - ❖ **The Formula Effect:** The method of calculating the RPI and CPI are slightly but significantly different



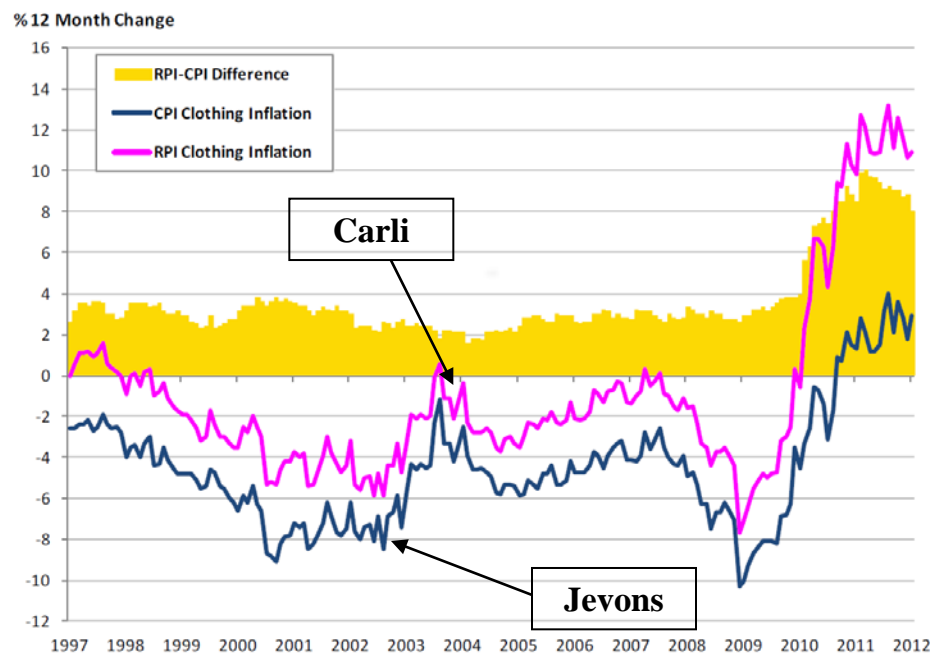
Source: ONS/Conning



Inflation Indices and UK CPI and RPI

- ◆ There are two main stages to calculating the inflation index value
 - ❖ Collect quotes for the prices of each item in the basket and take the average to give a representative price
 - ❖ Multiply the average prices of each item by the weight of the item in the basket and sum over all items to give the final index value
- ◆ It is in step 1 that the main difference lies
 - ❖ RPI uses a combination of arithmetic means
 - ❖ CPI uses a combination of geometric and arithmetic means
- ◆ Jevons < Carli and scales with variance in price differential – this leads to the main differences in CPI and RPI
- ◆ The large difference between UK RPI and CPI can mostly be attributed to the treatment of clothing items
- ◆ Most inflation linked bonds and derivatives are based upon RPI

Name	Index Contribution	RPI	CPI
Carli	$\frac{1}{n} \sum_{i=1}^n \frac{P_t^i}{P_{t=0}^i}$	35%	0 %
Dutot	$\frac{\frac{1}{n} \sum_{i=1}^n P_t^i}{\frac{1}{n} \sum_{i=1}^n P_{t=0}^i}$	55 %	30%
Jevons	$\sqrt[n]{\prod_{i=1}^n \frac{P_t^i}{P_{t=0}^i}}$	0%	70%

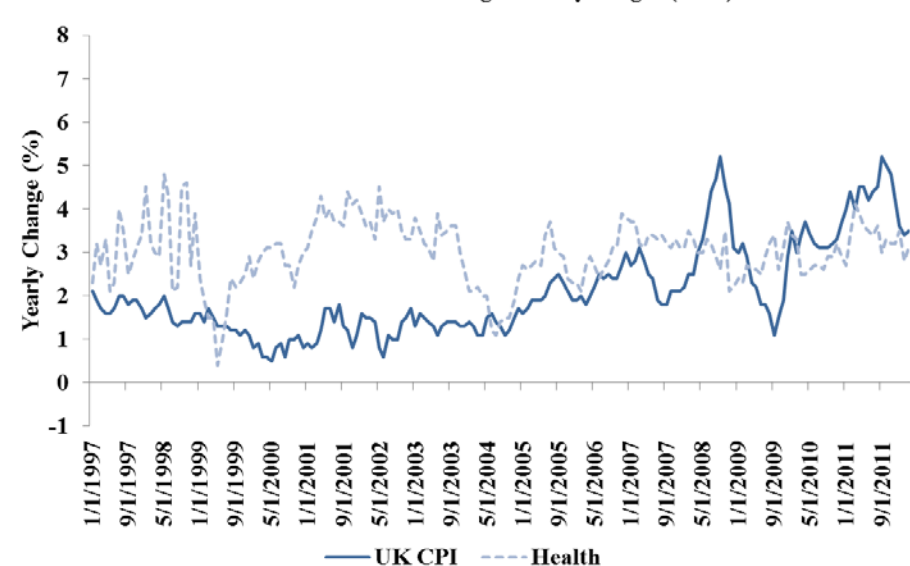
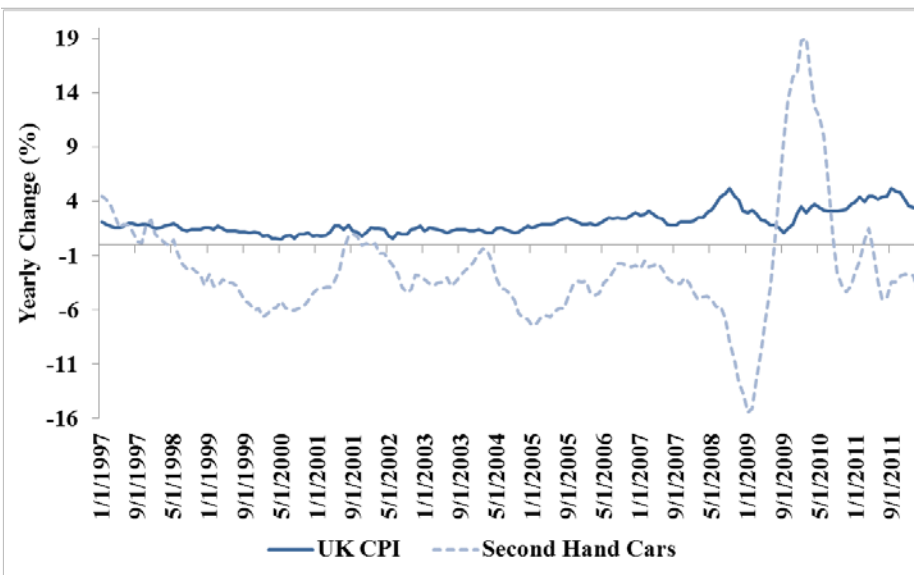
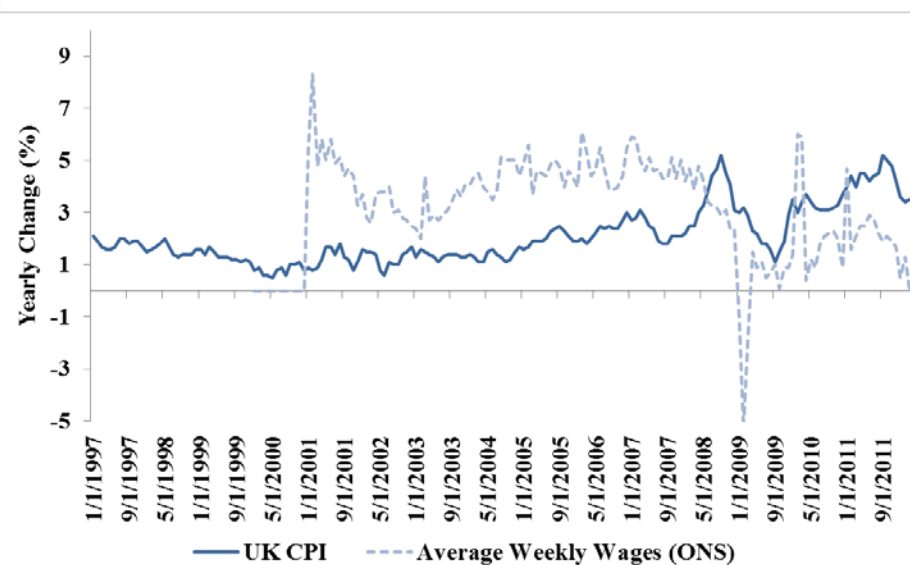
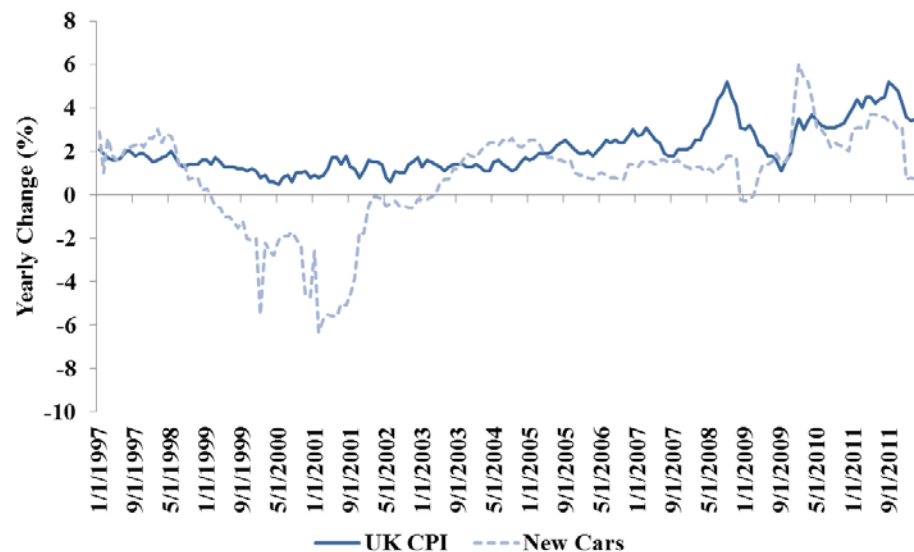


Source: ONS/Conning





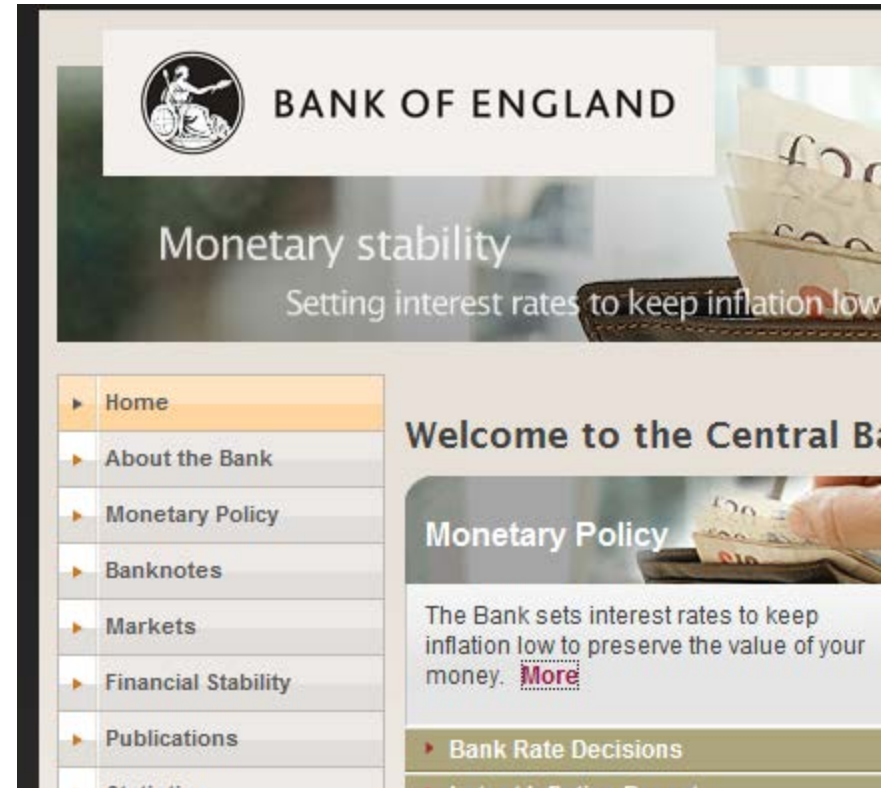
Inflation Components



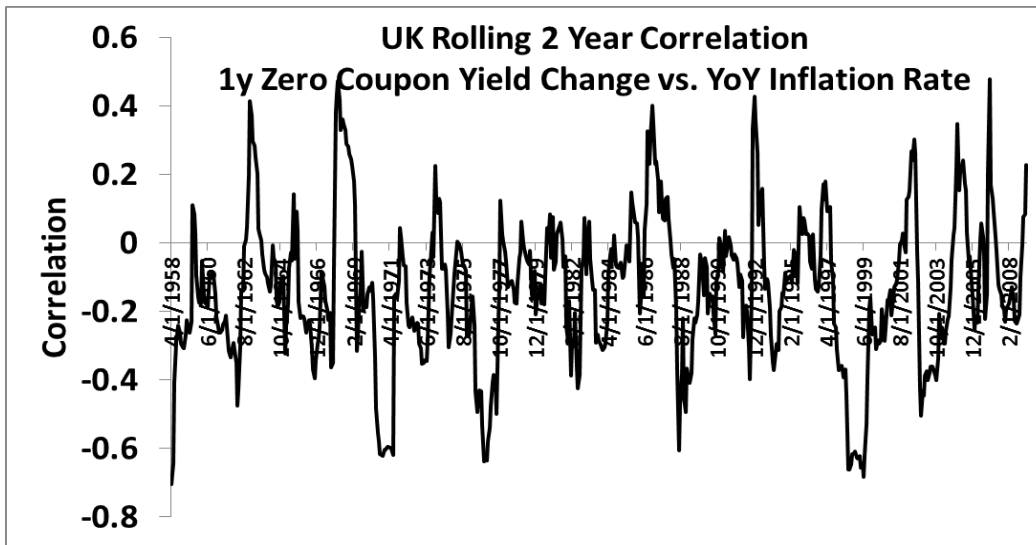
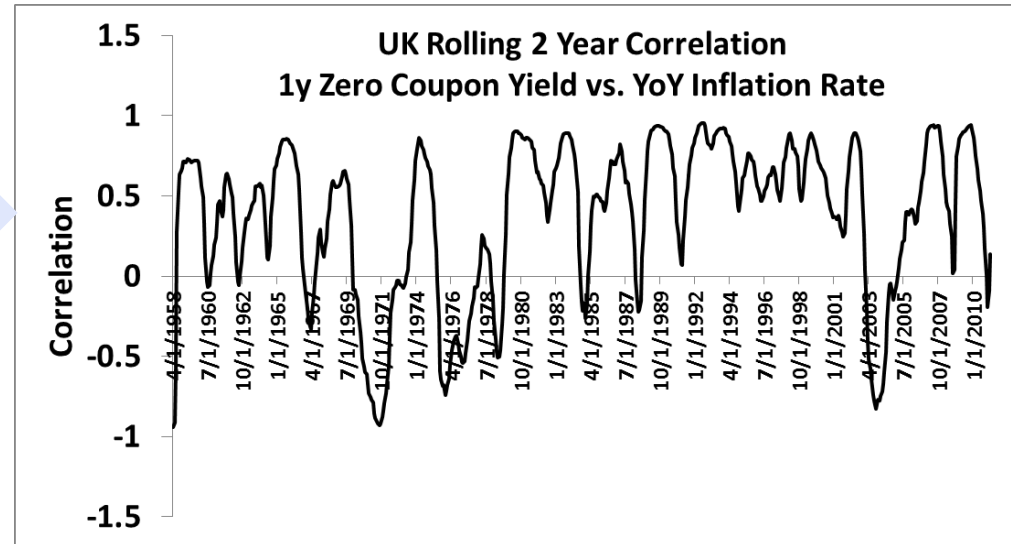
Source: Bloomberg/Conning



- ◆ Most people consider it “fact” that interest rates and inflation are highly correlated
- ◆ It is the BoE stated aim to keep inflation low (the 2% target)
- ◆ More complete and proper analysis is required to:
 - ❖ decide what effects are present in the market data
 - ❖ determine the effect of this on our assets and liabilities



There is a non zero time varying correlation between nominal rates and inflation (corr=0.6)



If one considers change in yields there is very little or no correlation between the variables (corr=-0.03)

Source: Bloomberg/Conning



how long do these effects take to work?



Changes in the official Bank Rate take time to have their full impact on the economy and inflation. All the factors we have described have an impact on demand and, in turn, prices. Some influences, such as those on the exchange rate, work very quickly.

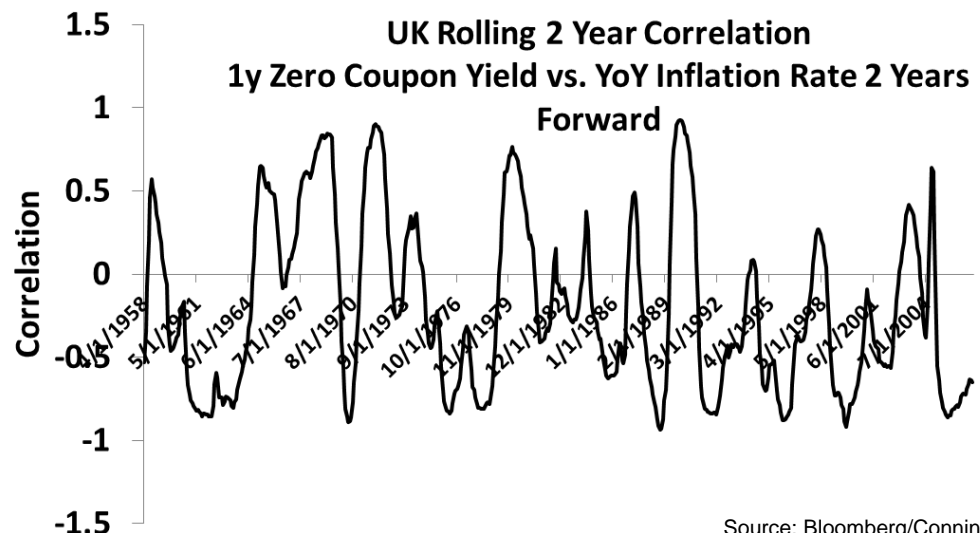
a change in the official Bank Rate takes around two years to have its full impact on inflation

But it often takes time for changes in the official Bank Rate to affect the interest payments made by consumers or firms - such as mortgage payments - or the income from savings accounts. It is likely to take a further period of time before changes in mortgage payments or income from savings lead to changes in spending in the shops, and longer still for this spending to work its way up through the supply chain to producers. Changes in production, in turn, can lead to changes in employment and wages and eventually to changes in prices.

We cannot know with any certainty the precise size or timing of these influences. And the effects might vary depending on factors such as the stage of the economic cycle - for example, the impact of higher consumer demand on inflation just after a recession will be different than that after several years of growth.

- ◆ What about conditional on the inflation environment
 - ❖ i.e. are very high inflation regimes coupled with high interest rate environments?

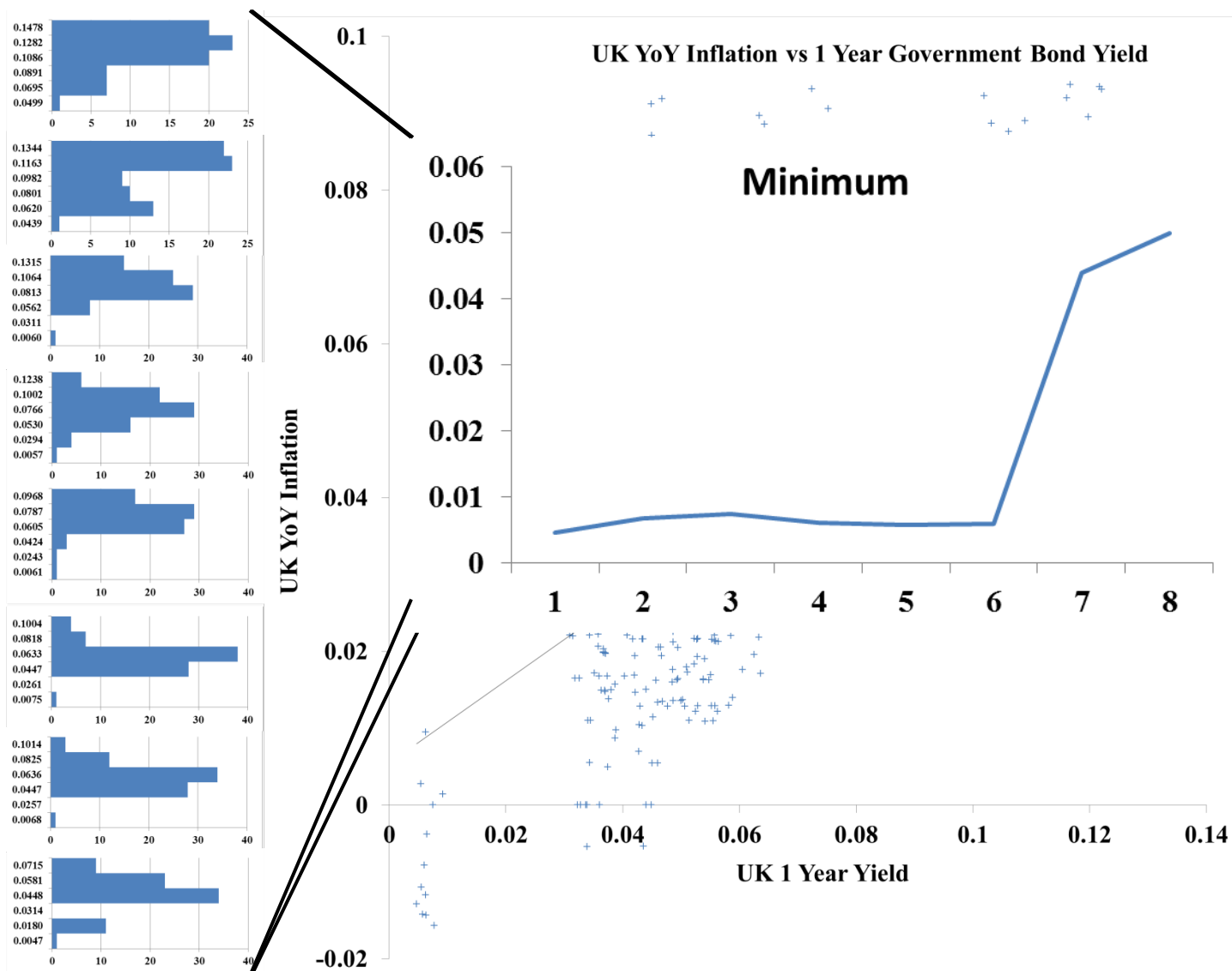
- ◆ The Bank of England is pretty clear that there is a lag of about 2 years...
 - ❖ Although read the small print
- ◆ In the data the mean correlation does indeed drop when introducing a lag
 - ❖ 0.6 to 0.35



Source: Bloomberg/Conning



Interest Rates and Inflation



Source: Bloomberg/Conning

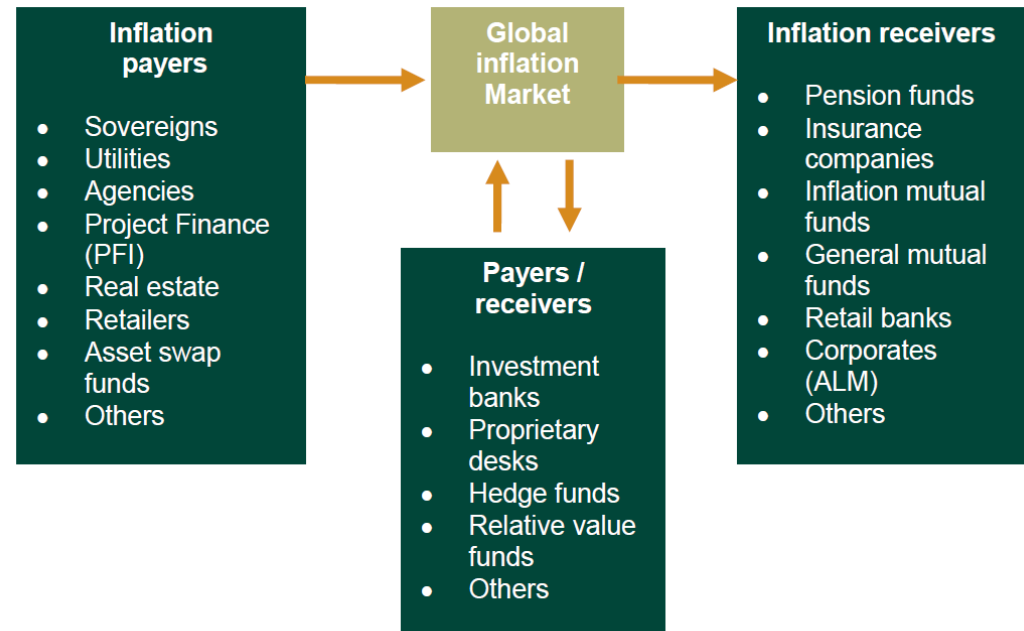


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The Inflation Linked Product Market

- ◆ Indexed linked bonds have been around since the early 80's
- ◆ First Inflation linked derivatives began trading in the 90's
 - ❖ Has since grown to a multi billion euro market
- ◆ Issuers of inflation protection are referred to as “payers”
 - ❖ Tend to have income linked to inflation
- ◆ Those wanting inflation protection are referred to as “receivers”
 - ❖ Tend to be businesses that need to pay inflation linked cash flows
- ◆ Sovereigns however make up by far the largest payers of inflation protection



Source: Lehman Brothers.



Zero Coupon Inflation Linked Bonds

- Zero coupon inflation linked bonds have a single payment at time T (maturity)
 - The payment is linked to RPI in the UK such that a **real** return is guaranteed
- Contrast with a normal Gilt which guarantees a nominal return at maturity
- In reality coupon bonds are traded
- In the real market cash flows are linked to a lagged index value
 - This is partly because the up to date value is not known at the time of the cash flow
 - So the investor has no inflation protection over the lagged period
- For coupon bonds traded between coupons the seller must be compensated for accrued interest
 - Prior to 2005 IL Gilts had an 8 month lag (2mnth reporting lag + 6mnth for accrued interest calculation)
 - Since 2005 a daily reference rate is calculated based on linear interpolation of the index

Illustrative Example:

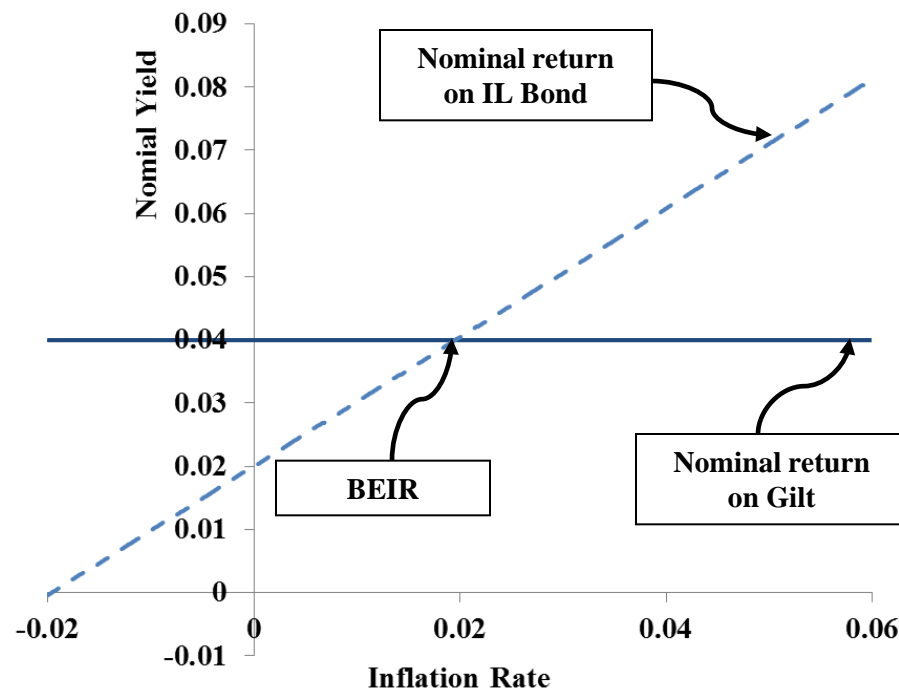
RPI =100	Gilt Price = 0.9615 Time to Maturity 1 year	Indexed Linked Gilt Price = 0.9804 Time to Maturity 1 year
	Nominal return	Real return
	$Y_n = 1/0.9615 - 1$ = 4%	$Y_r = 1/0.9804 - 1$ = 2%
RPI =100	Nominal Yield = 4% Real Yield = 4%	Nominal Return = 2% Real Return = 2%
RPI =102	Nominal Yield = 4% Real Yield = $(100/102)/0.9615 - 1$ = 1.96%	Nominal Yield = $(102/100)/0.9804 - 1$ = 4.04% Real Yield = 2%
RPI =104	Nominal Yield = 4% Real Yield = $(100/104)/0.9615 - 1$ = 0%	Nominal Yield = $(104/100)/0.9804 - 1$ = 6.08% Real Yield = 2%





Inflation Linked vs Nominal Bonds and The Break Even Inflation Rate

- ◆ The nominal yield on an inflation linked bond is then dependent on the inflation rate at maturity
 - ❖ This is of course not known before the maturity date
- ◆ However bonds should price in such a way as to be indifferent between the following investments
 - ❖ GBP 100 in Nominal Gilts
 - ❖ GBP 100 in Indexed Linked Gilts
- ◆ The inflation rate at maturity for which these two investments have identical nominal and real yields is referred to as the **Break Even Inflation Rate**
- ◆ The BEIR can be thought of as a market expectation of inflation
- ◆ Inflation risk premium
 - ❖ Nominal bonds have less real price certainty and investors expect a premium to compensate for this
- ◆ Inflation convexity on nominal bonds increases with maturity
 - ❖ This is attractive to investors and pushes the BEIR down

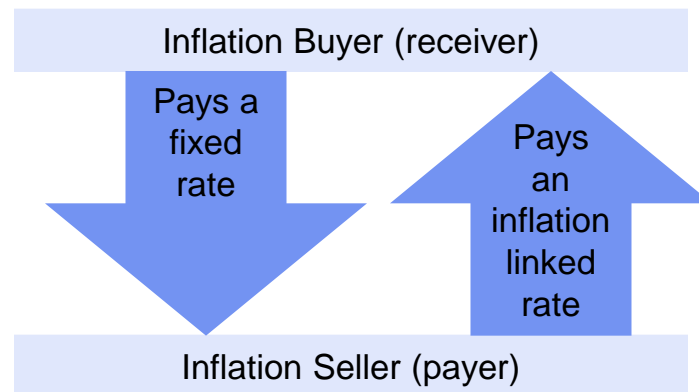


$$BEIR = \frac{1 + y_n(0, T)}{1 + y_r(0, T)} - 1$$



Zero Coupon Inflation Linked Swaps

- ◆ The zero coupon inflation linked swap is the simplest of the inflation derivatives
- ◆ A fixed rate is paid by an inflation buyer in exchange for an inflation linked rate
- ◆ Advantages of using swaps
 - ❖ They can be tailored to particular asset/liability profiles
 - ❖ They can be based on specific sub indices for more precise hedging
 - ❖ More liquidity for long term hedging
 - ❖ Less costly to adjust hedging strategy when asset or liability profiles change



Date at which cash flows occur

UK RPI has a 2 month lag

Fixed leg is the break even swap rate quoted in the market

The inflation leg is paid at the rate quoted on the 1st of the month (with a 2 month lag)

Term Sheet (5 Year Spot Starting)

Notional: GBP 1,000,000

Source: Bloomberg UKRPI Index

Trade Date: 23 May 2012

Start Date: 25 May 2012

End Date: 25 May 2017

First Fixing: 240.8 (March 2012)

Fixed Leg: $(1 + 2.967\%)^5 - 1$

Inflation Leg: $\frac{\text{RPI}(\text{Mar}/2017)}{\text{RPI}(\text{Mar}/2012)} - 1 = \frac{I(01\text{-May-}2017)}{I(01\text{-May-}2012)} - 1$





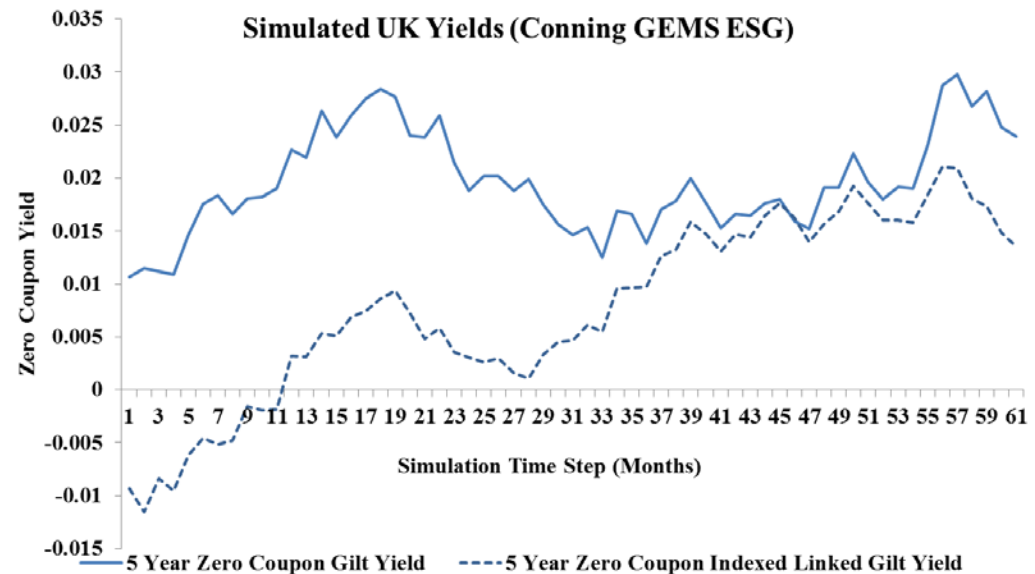
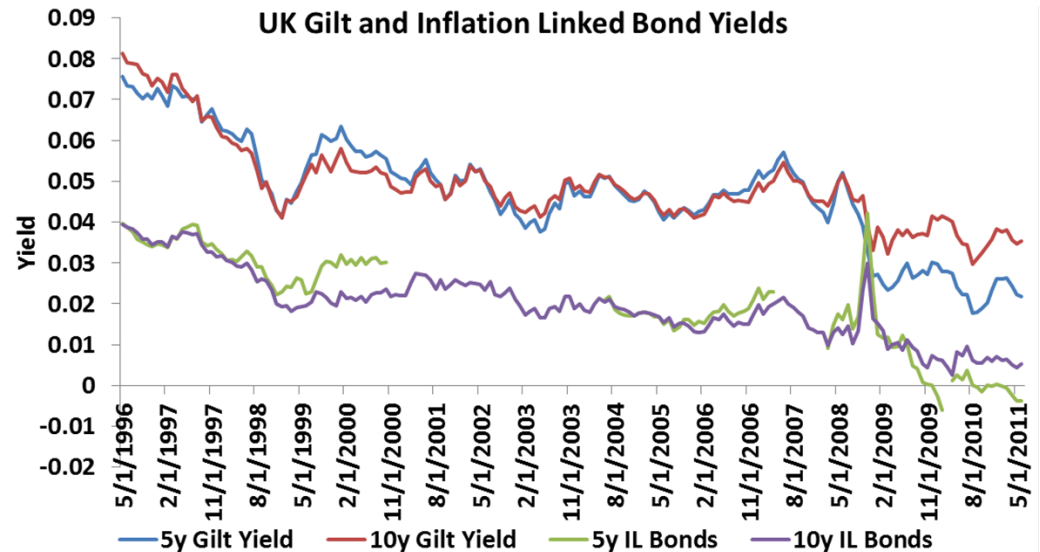
Other Inflation Linked Derivatives

- ◆ A wide range of other inflation linked derivatives exist in the market
- ◆ Various flavours of swap
 - ❖ Floating inflation swap – receiver pays a floating rate
 - ❖ Revenue inflation swap – settle periodically (usually annually) for a period of time
 - ❖ Period-on-period swap – same as a revenue swap except it pays the inflation between periods (rather than the cumulative inflation)
- ◆ Inflation volatility products
 - ❖ Calls and Puts on ZC inflation swaps
 - ❖ Inflation Caps and Floors
 - ❖ Inflation swaptions
- ◆ A number of exotics are also available on the OTC market
 - ❖ Although pricing is somewhat problematic



What all this means.....

- ◆ Firms needing to assess inflation risk and mitigate it need a model of the inflation market – not just the index
 - ❖ Realistic index dynamics
 - ❖ Index linked bond pricing
 - ❖ Ability to reproduce the interplay of inflation and real yields with nominal yields
 - ❖ Inflation derivatives pricing
- ◆ The field is somewhat under developed in the academic literature
- ◆ Such a model fully integrated into an ESG allows for more detailed studies of the importance of inflation risk to a typical P&C company

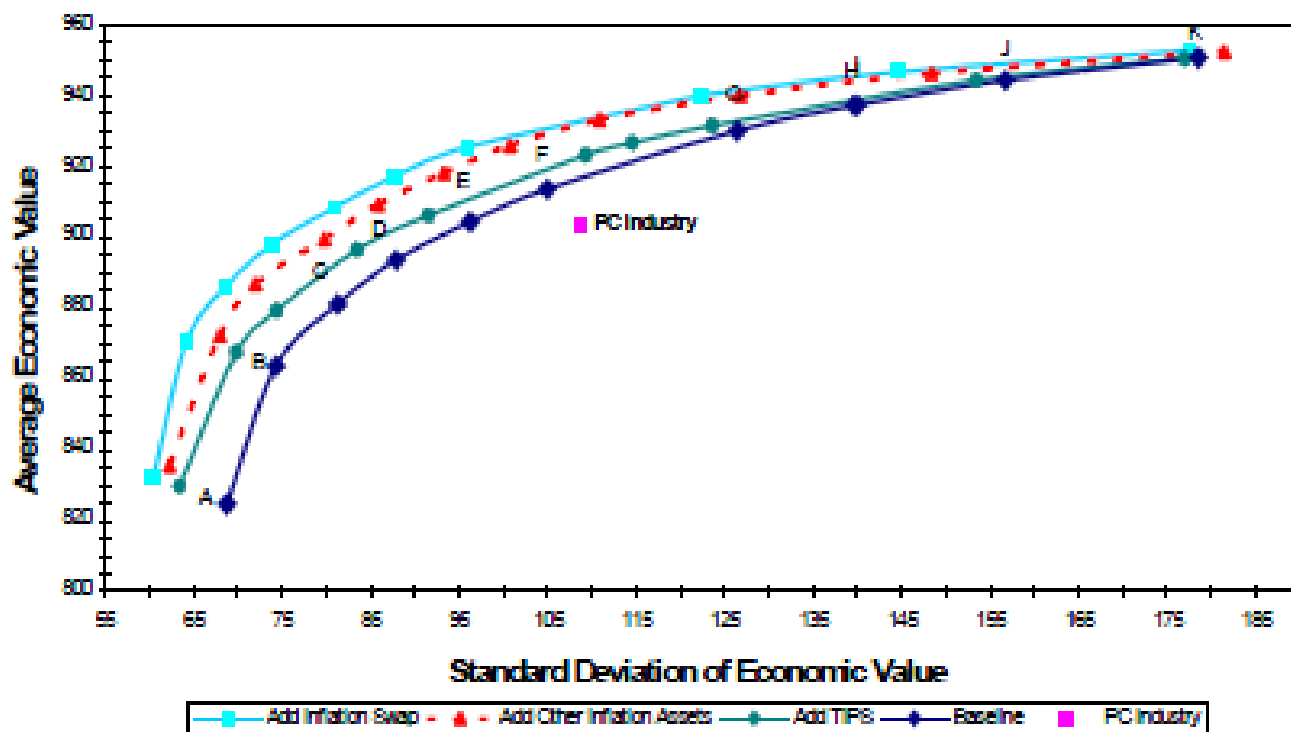


Source: Bloomberg/Conning



Asset Liability Efficient Frontier

End of 5th Year Economic Value



Source: Conning Risk & Capital Management analytics.



Inflation represents a major risk for P&C insurers over the medium to long term

The interplay between inflation and returns on traditional asset classes is complex

Various hedging instruments are available to mitigate the impact of inflation risk

Basis risk has to be taken into consideration

Hedging strategies can be evaluated using DFA methods

Having a realistic model of inflation fully integrated within a sound ESG is key

Inflation risk should be priced into insurance contracts

Actuaries can help raise awareness and provide strategic solutions to management

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