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# Derivative Prices and Market Behaviour

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Session G  
10:20 – 10:40, 21 June 2005

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# Agenda

- Market views and how to construct them
- How do market views compare to observed economic behaviour?
- How can we explain the differences?

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# What is the market view?

- The “market view” is the scenario [or distribution] under which all investments have the same [expected] return
  - If everyone agreed in this scenario then no investment would offer superior returns.
- Buzzwords that may indicate a market view:
  - market consistent valuation
  - realistic balance sheet
  - market consistent embedded value
- Buzzwords that probably don't indicate a market view:
  - realistic approach to pension funding
  - market based valuation

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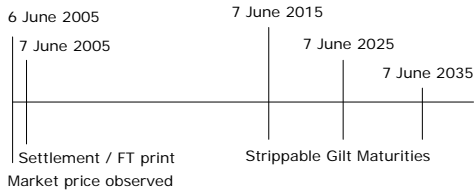
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## Observing Interest Rates



All data used in this presentation (except swaption volatilities) are taken from FT or DMO on 7 Jun 2005, to use gilts with integer maturities.

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## Discount Bond Prices

| Term | Price | Yield |
|------|-------|-------|
| 0    |       |       |
| 1    | 95.81 | 4.32% |
| 2    | 91.96 | 4.23% |
| 3    | 88.23 | 4.22% |
| 4    | 84.63 | 4.22% |
| 5    | 81.16 | 4.22% |
| 6    | 77.75 | 4.24% |
| 7    | 74.45 | 4.26% |
| 8    | 71.28 | 4.28% |
| 9    | 68.32 | 4.28% |
| 10   | 65.47 | 4.28% |

$P$  = price of zero coupon bond

Spot yield  $s$ , where  
 $P = (1 + 0.5 \cdot s)^{-2 \cdot T}$

Source: Debt Management Office, Closing Prices on 6 June 2005

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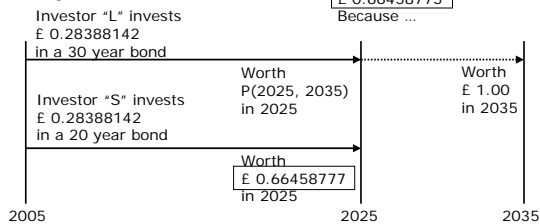
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## Market Interest Rate View

Let  $P(2025, 2035)$  be

- the price on 07/06/2025
- of a ten year zero coupon bond
- maturing with value £1 on 07/06/2035

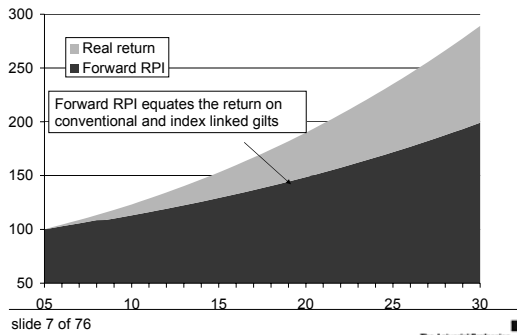
The market view of  
 $P(2025, 2035)$  is  
 £ 0.66458775  
 Because ...



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## Inflation




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## Currencies

|                  | US Dollar | Euro    | GB Pound |  |
|------------------|-----------|---------|----------|--|
| Japan Yen        |           |         |          | The tabulated forward rates are those for which two investors see the same return on zero coupon bonds in their respective currencies. |
| spot             | 106.735   | 131.097 | 194.183  |  |
| 1 month          | 106.455   | 130.868 | 193.418  |  |
| 3 month          | 105.835   | 130.393 | 191.858  |  |
| 1 year           | 102.905   | 128.418 | 185.543  |  |
| Philippine Peso  |           |         |          |  |
| spot             | 54.510    | 66.952  | 99.170   |  |
| 1 month          | 54.606    | 67.127  | 99.212   |  |
| 3 month          | 54.801    | 67.518  | 99.344   |  |
| 1 year           | 55.917    | 69.780  | 100.819  |  |
| South Korean Won |           |         |          |  |
| spot             | 1007.50   | 1237.46 | 1832.94  |  |
| 1 month          | 1007.70   | 1238.77 | 1830.87  |  |
| 3 month          | 1007.60   | 1241.42 | 1826.58  |  |
| 1 year           | 1003.10   | 1251.79 | 1808.62  |  |

source: FT, 07/06/2005

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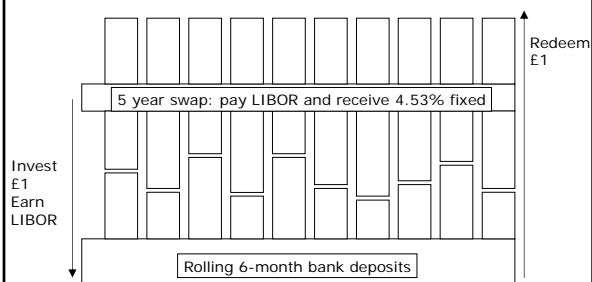
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## Modelling Bank Risk – Synthetic Bank Bonds




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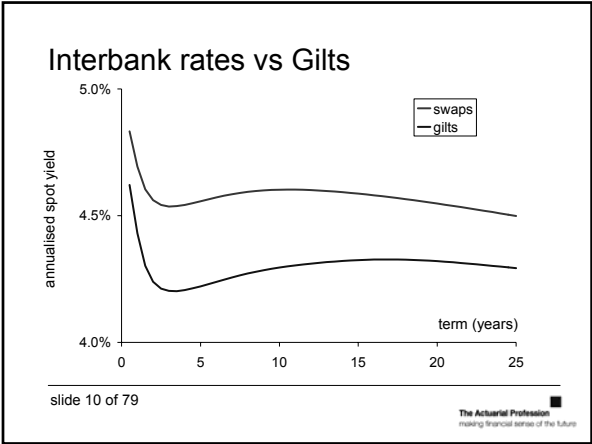
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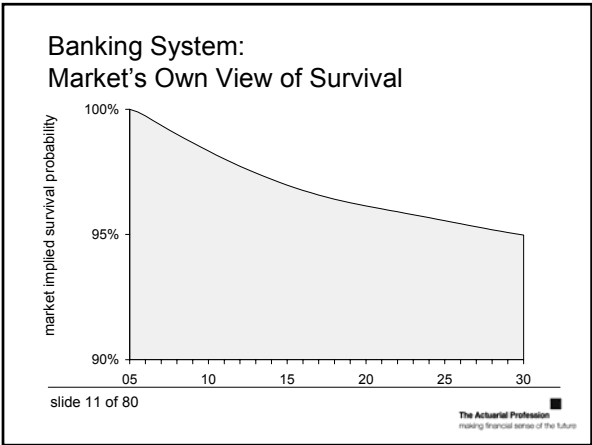
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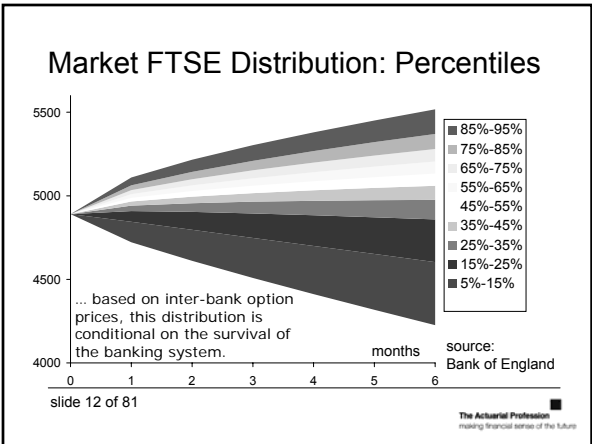
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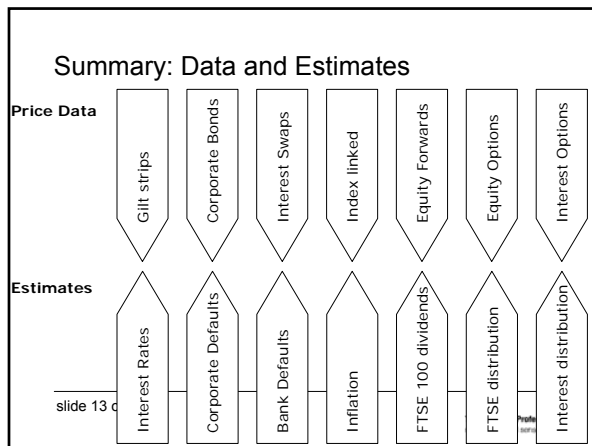
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### What do Market Views Tell Us about Economic Behaviour?

- How good is the Market View as a predictor of outcomes?
- Is it as good as:
  - naïve forecast: tomorrow's price = today's
  - statistical methods?
- If market views are bad forecasts then this implies a profit opportunity
  - because you can lock in the market forecast and profit if your forecast turns out to be correct

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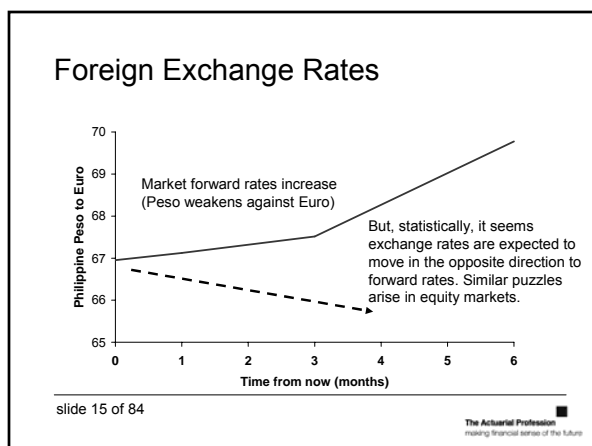
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## Forward Premium Puzzle: Literature

Tryon, Ralph. (1979). "Testing for rational expectations in foreign exchange markets," *International Finance Discussion Paper* no. 139. Federal Reserve Board (May).

Hansen, Lars Peter, and Robert J. Hodrick. (1980). "Forward Exchange Rates as Optimal Predictors of Future Spot Rates: An Econometric Analysis," *The Journal of Political Economy*, Volume 88, Number 5, 829-853 (October).

Frankel, Jeffrey. (1980). "Tests of Rational Expectations in the Forward Exchange Rate Market," 46, no. 4, April. Reprinted in *On Exchange Rates*, 1997, 189-205. (Cambridge: MIT Press).

Froot, Kenneth, and Richard Thaler. (1990). "Anomalies: Foreign Exchange," *Journal of Economic Perspectives* 4, June, 179-192.

Fama, Eugene F., (1984). "Forward and Spot Exchange Rates," *Journal of Monetary Economics*, Volume 14, 319-338.

Polito, E. (2000). Is the Forward Exchange Rate a Useful Indicator of the Future Exchange Rate? <http://www.edon.edu/pe/polito.pdf>

Roll & Yan (2000) An Explanation of the Forward Premium Puzzle. *European Financial Management*, Vol. 6, No. 2

Bansal, Ravi and Magnus Dahlquist, (2000). "The forward premium puzzle: different tales from developed and emerging economies," *Journal of International Economics*, Volume 51, 115-144.

Backus, D., S. Foresi and C. Telmer. 2001. "Affine Models of Currency Pricing: Implications for the Forward Premium Anomaly," *Journal of Finance*, 56, 281-311.

Radaj, K. (2002) Risk Premiums and the Forward Rate Anomaly: A Survey. <http://www.iemss.org/iemss2002/proceedings/pdf/volume%20due%20due%20radaj.pdf>

Frankel, J and Poonawala, J. (2004) The Forward Market in Emerging Currencies: Less Biased than in Major Currencies. [http://sghome.harvard.edu/~jfrankel/Forward\\_Market\\_in\\_Emerging\\_Currencies.pdf](http://sghome.harvard.edu/~jfrankel/Forward_Market_in_Emerging_Currencies.pdf)

Richard T. Baillie and Rehim Kilic (2005) Do Asymmetric and Nonlinear adjustments Explain the Forward Premium Anomaly? <http://www.lanca.ac.uk/staff/lubberin/seminars/pdffiles/bailliepaperapr181.pdf>

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## Risk Free Rates

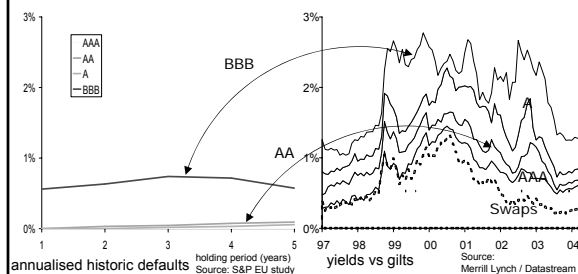
| Implied Spot Yields |      | maturity date   |       |       |       |       |       |
|---------------------|------|---|-------|-------|-------|-------|-------|
|                     | 2005 | 2010  | 2015  | 2020  | 2025  | 2030  | 2035  |
| valuation date      | 2005 | 4.26%   | 4.33% | 4.37% | 4.34% | 4.32% | 4.29% |
|                     | 2010 |   | 4.39% | 4.42% | 4.37% | 4.34% | 4.29% |
|                     | 2015 |   |       | 4.44% | 4.36% | 4.32% | 4.27% |
|                     | 2020 |   |       |       | 4.28% | 4.26% | 4.21% |
|                     | 2025 | Market view: yield on 2020 bond increases to compensate lower return in early years |       |       |       | 4.23% | 4.17% |
|                     | 2030 |   |       |       |       |       | 4.11% |
|                     | 2035 |   |       |       |       |       |       |

| Most Likely Yields |      | maturity date  |       |       |       |       |       |
|--------------------|------|--|-------|-------|-------|-------|-------|
|                    | 2005 | 2010   | 2015  | 2020  | 2025  | 2030  | 2035  |
| valuation date     | 2005 | 4.26%  | 4.33% | 4.37% | 4.34% | 4.32% | 4.29% |
|                    | 2010 |  | 4.33% | 4.37% | 4.34% | 4.32% | 4.29% |
|                    | 2015 |  |       | 4.37% | 4.34% | 4.32% | 4.29% |
|                    | 2020 |  |       |       | 4.34% | 4.32% | 4.29% |
|                    | 2025 | Statistical view: bonds with higher initial yield deliver higher returns over their terms. |       |       |       | 4.32% | 4.29% |
|                    | 2030 |  |       |       |       |       | 4.29% |
|                    | 2035 |  |       |       |       |       |       |

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## Credit Spreads and Default History



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## Interest Rates: Literature

### Forward interest rates

- Fama, Eugene F. "The Information in the Term Structure." *Journal of Financial Economics*, vol. 13, no. 4 (December 1984): 509-528.
- Fama, Eugene F. "Term Premiums and Default Premiums in Money Markets." *Journal of Financial Economics*, vol. 17, no. 1 (September 1986): 175-196.
- Fama, Eugene F., and Robert R. Bliss. "The Information in Long-Maturity Forward Rates." *American Economic Review*, vol. 77, no. 4 (September 1987): 680-692.
- Bouchaud, Cont, El Karoui, Potters & Sagna (1997) Phenomenology of the Interest Curve. <http://econwp.wustl.edu/ewp-fin/9712009>
- Corporate Bond Yields and Default Rates
- Elton E. J., M. J. Gruber, D. Agrawal and C. Mann (2001). "Explaining the Rate Spread on Corporate Bonds." *The Journal of Finance* 56, 247-277.
- Huang, J-Z. and M. Huang (2003). How Much of the Corporate-Treasury Yield Spread is Due to Credit Risk ?, Working paper, Graduate School of Business, Stanford University.
- Longstaff, Mithal and Neis (2004). Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit-Default Swap Market [http://www.modyksmy.com/conf04/pdf/papers/corp\\_yield\\_sprds.pdf](http://www.modyksmy.com/conf04/pdf/papers/corp_yield_sprds.pdf)
- Dionne, Gauthier, Hammami & Simonato (2005) Default Risk in Corporate Yield Spreads. [http://www.rotman.utoronto.ca/finance/seminars/050408\\_simonato.pdf](http://www.rotman.utoronto.ca/finance/seminars/050408_simonato.pdf)

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## What is Small Sample Bias?

### No Feedback

- Fixed  $X_n$ ;  $n=1, 2, \dots, N$
- $Y_n = \alpha + \beta X_n + N(0, 1)$
- Estimate:
 
$$\hat{\beta} = \frac{N \sum_{n=1}^N X_n Y_n - \sum_{n=1}^N X_n \sum_{n=1}^N Y_n}{N \sum_{n=1}^N X_n^2 - \left[ \sum_{n=1}^N X_n \right]^2}$$
- We know  $\hat{\beta}$  is best linear unbiased estimator of  $\beta$

### With Feedback

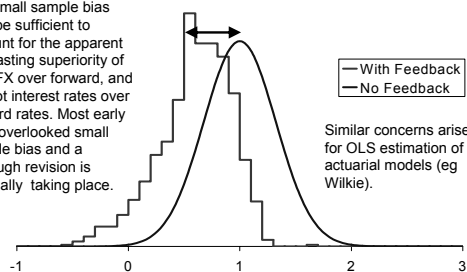
- Now suppose
  - $N = 10$
  - $\alpha = 0$
  - $\beta = 1$
  - $X_{n+1} = Y_n$
- $X_n$  no longer fixed
  - it's a random walk now
- Question: is the regression still valid?

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## Simple Investigation: Density of $\hat{\beta}$

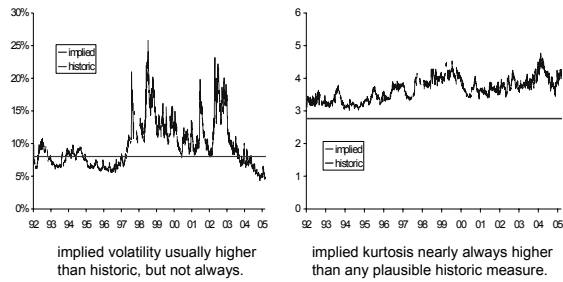
The small sample bias may be sufficient to account for the apparent forecasting superiority of spot FX over forward, and of spot interest rates over forward rates. Most early work overlooked small sample bias and a thorough revision is gradually taking place.



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## Option Implied Distributions (3 month)



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## Option Implied Distributions: Literature

Jens Carsten Jackwerth and Mark Rubinstein (2001). Recovering Stochastic Processes from Option Prices.  
<http://www.uni-konstanz.de/FuF/wiwi/jackwerth/jackwerth/paper3.pdf>

Clews, Panigirtzoglou & Proudman (2002). Recent developments in extracting information from options markets.  
<http://www.bankofengland.co.uk/publications/quarterlybulletin/qb000101.pdf>

Anagnou, Bedendo, Hodges, and Tompkins (2002). The Relation Between Implied And Realised Probability Density Functions.  
[http://institute.mathfinance.de/workshop2002/papers/tompkins\\_ImpDistPres-Apr03.pdf](http://institute.mathfinance.de/workshop2002/papers/tompkins_ImpDistPres-Apr03.pdf)

Carr, P., Geman, H., Madan, D., Yor, M., (2002). The fine structure of asset returns: An empirical investigation. Journal of Business 75, 305–332.

Busch, T (2004). Testing the Martingale restriction for option implied densities. University of Aarhus Working Paper. <http://www.cis.dk/cat/wp/wp-192.pdf>

Alonso, Blanco, Rubio (2004) Testing the forecasting performance of Ibox 35 option-implied risk neutral densities. Bank of Spain working paper. <http://www.ehu.es/FAEII/workingpapers/wp2005-09.pdf>

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## Explaining the Differences

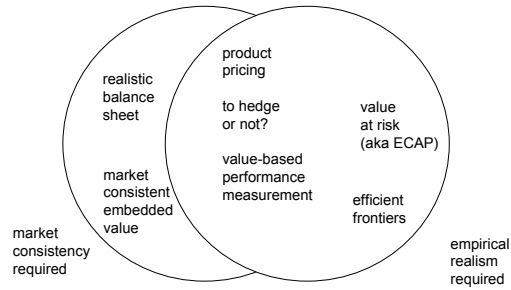
- Risk premiums
  - you can't get risk premiums from market prices alone
  - large deflators in rare / extreme events
  - is this the same as market inefficiency?
- Frictional costs
  - Costs of capital, tax, transactions and other frictions are already implicit in option prices
  - Impact greatest for extreme strikes
  - The market "implied volatility" is not a pure volatility estimate
- Misinterpretation of statistical tests
  - small sample biases
  - outliers, non-normal distributions
  - Peso effects (unobserved rare but extreme outcomes)

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## Market Implied vs Real World differences drive many commercial decisions.



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## Conclusions

- A large and inconclusive literature debates the predictive abilities of implied vs historic models.
- Tempting to choose the model that tells you whatever you want to prove, citing the appropriate subset of the literature to support your case.
- Many outstanding issues relate to statistical bias; these are mathematical questions that can in principle be resolved definitively one way or the other. However, awareness of this issue disseminates slowly.
- Avoid double counting of frictional costs, for example in risk retention / hedge evaluations, pricing or MCEV work.

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